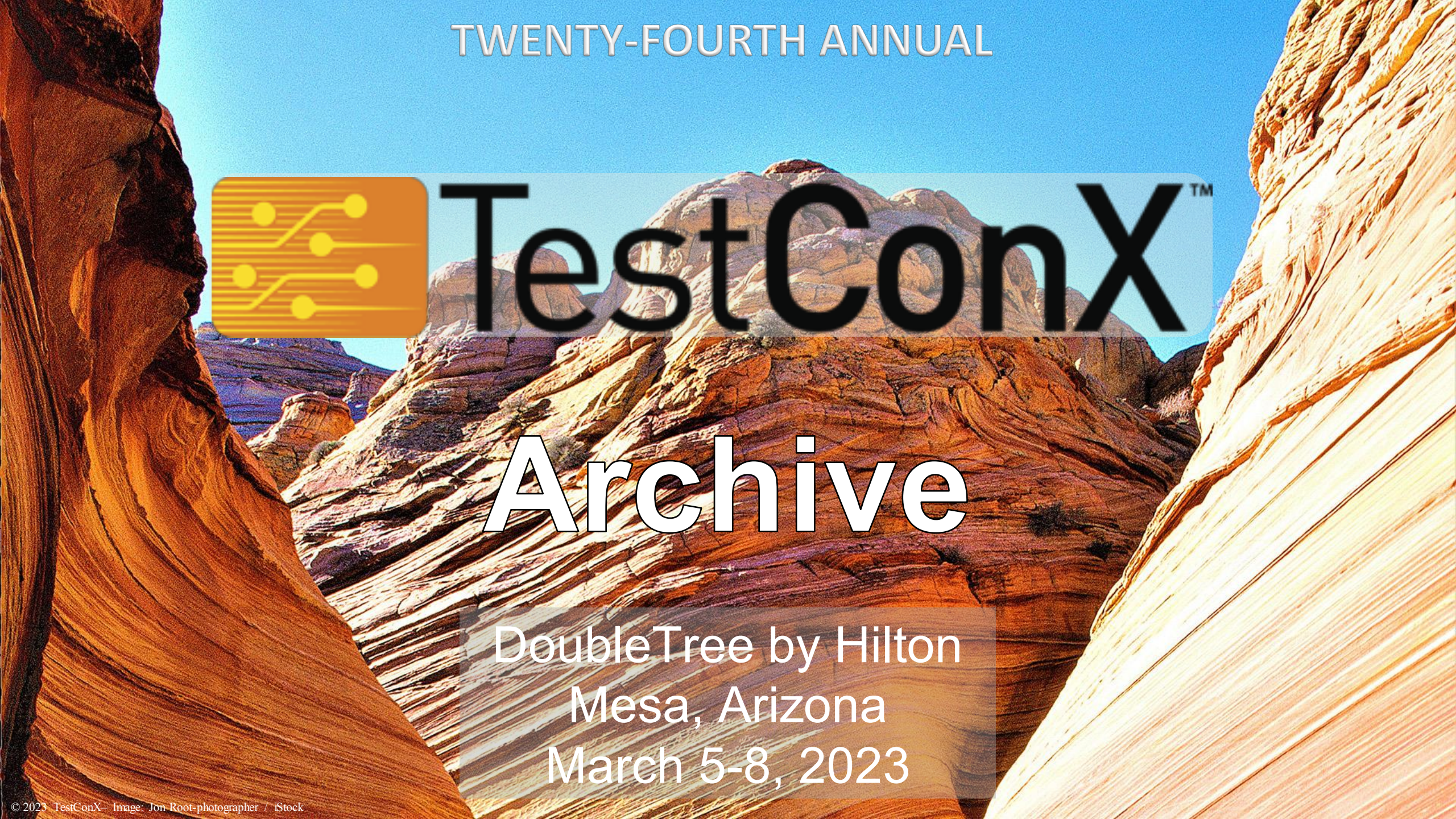

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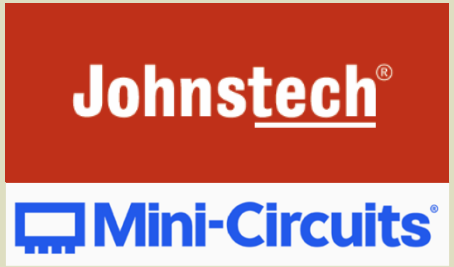
Using Encrypted HFSS Models in HFSS to Determine System Performance

Jeff Sherry - Johnstech International

Mesa, Arizona • March 5–8, 2023



Agenda

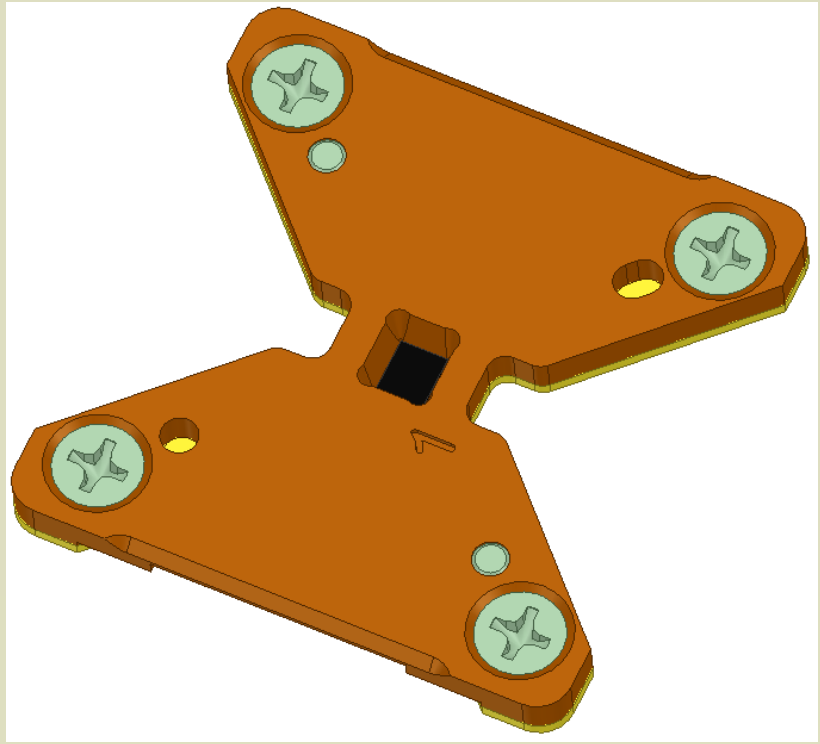
- What is an encrypted model and how to use encrypted models
- Process of using encrypted files or S-parameter data from customers to determine system performance
- Devices susceptible to ground inductance
- Using HFSS and ADS with encrypted models
- Comparison of initial design vs. final optimized design
- How Contactor design (GND and materials) impacts system performance
- Encrypted file examples to improve performance (ROL®100A)
- Measured repeatability of contactor
- Conclusion

What is Encrypted Model and How to Use It

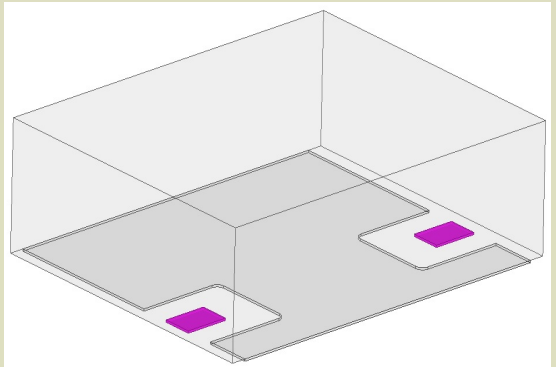
- An encrypted model represents a circuit or device that represents the performance of the circuit or device without showing key information about the circuit or device. Essentially a black box.
- Encrypted model will have an outline of the model or device and interfaces so the model can be used in a system with other components
- Encrypted model of one part of the system can be used with other HFSS models to get system performance. (Example uses an encrypted model of both customer load board and device so can be used with contactor model to gain full system performance of a filter.)

Process to Generate Encrypted Models for Devices and Generating Performance With Device in Contactor

- Get S-parameters of the device
- Generate device model from samples
- Use HFSS Circuit Elements to generate an encrypted model
- Install a device in the contactor and solve



Encrypted Model of Device (Filter)



- Contactor Model Based on Manufacturing Build
- Contacts in Compressed /Test Mode

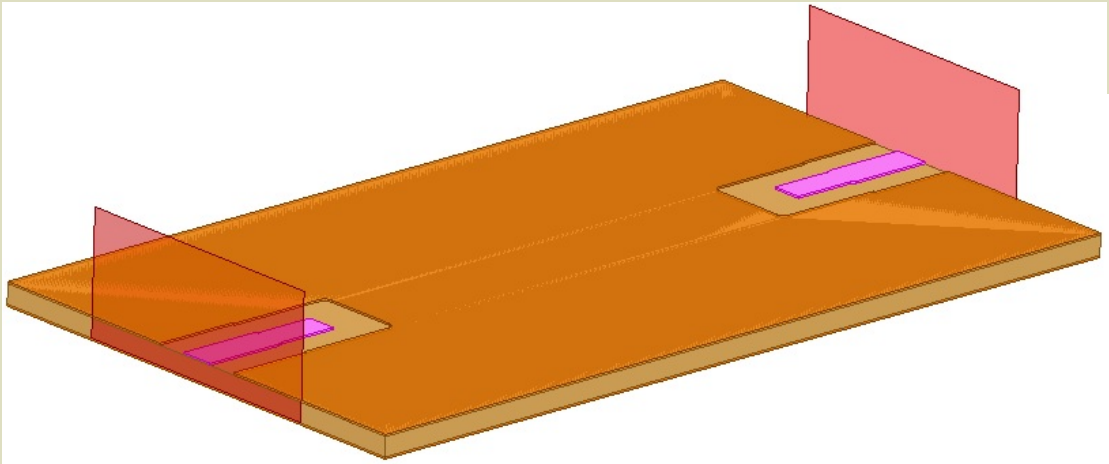
Devices that are Susceptible to Ground Inductance in Test System

- Power Amplifiers
- High Gain Amplifiers (Above 20dB)
- Filters Surface Acoustic Wave (SAW) and Bulk Acoustic Wave (BAW)
- High-Frequency Designs – Above 3GHz
- High-Speed Digital Designs – Above 10 GBits/sec
- High Gain Devices like RX and TX Devices (above 20dB)
- Voltage-sensitive devices – (i.e., High BIT count DACs and ADCs - Voltage per BIT small)

If Contactor Can Handle Device Frequency It May Still Have Issues Testing Device

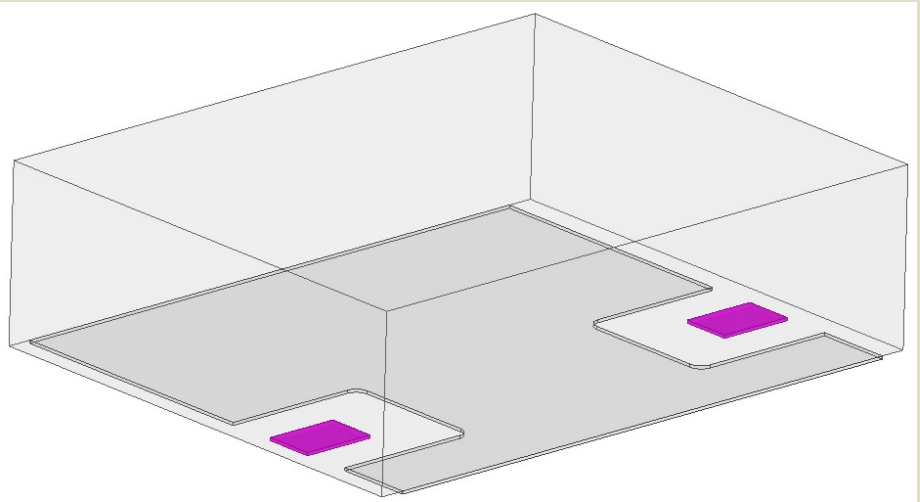
High Frequency Filter Encrypted Models - HFSS

Encrypted Model of Load Board



HFSS Encrypted Models

Encrypted Model of Device (Filter)

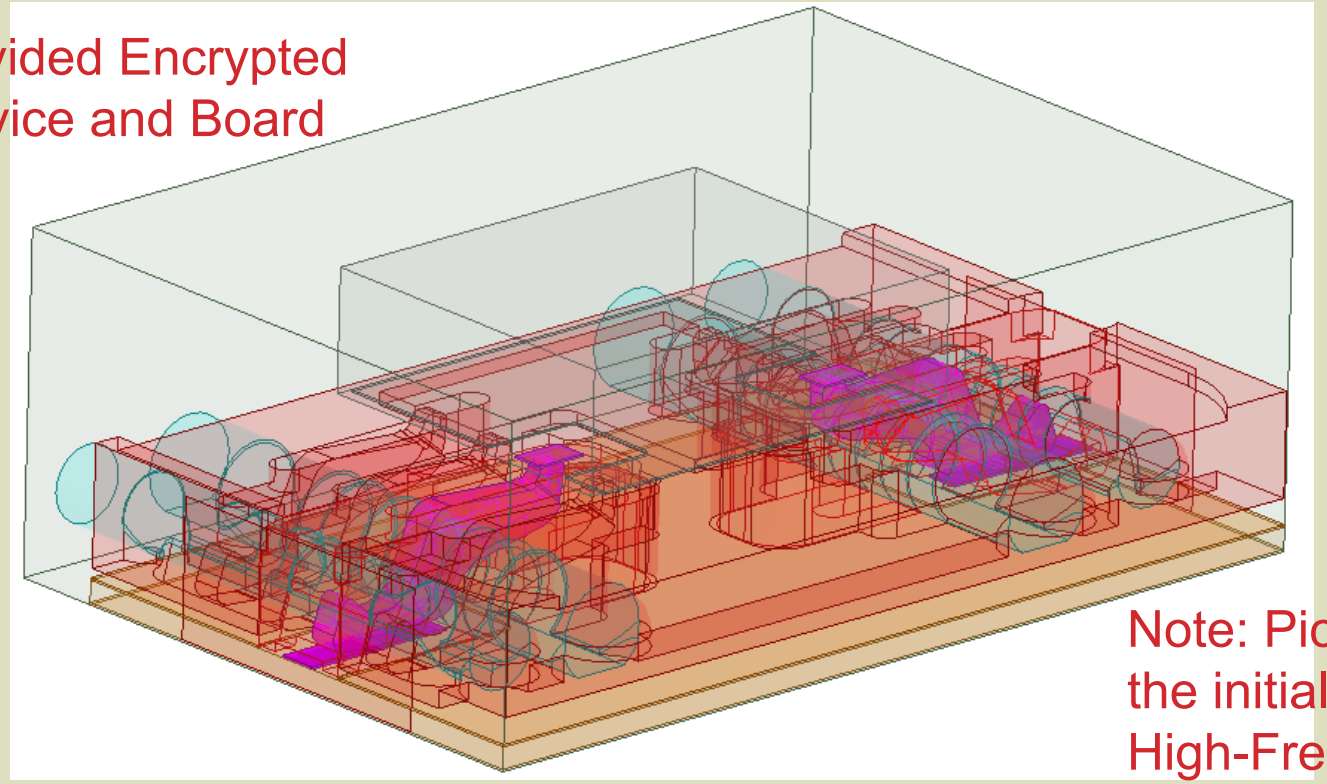


Encrypted Models as Minimum Show Interfaces to Rest of System

High-Frequency Filter System With Encrypted Models - HFSS

System Model in HFSS With Encrypted Model of Load Board and Device

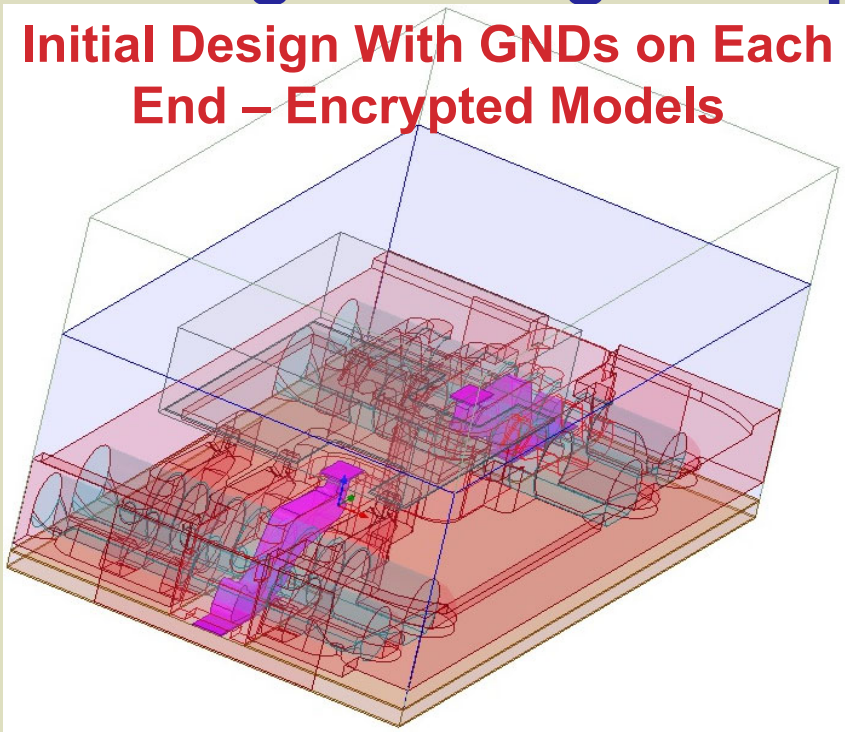
Customer Provided Encrypted models for Device and Board



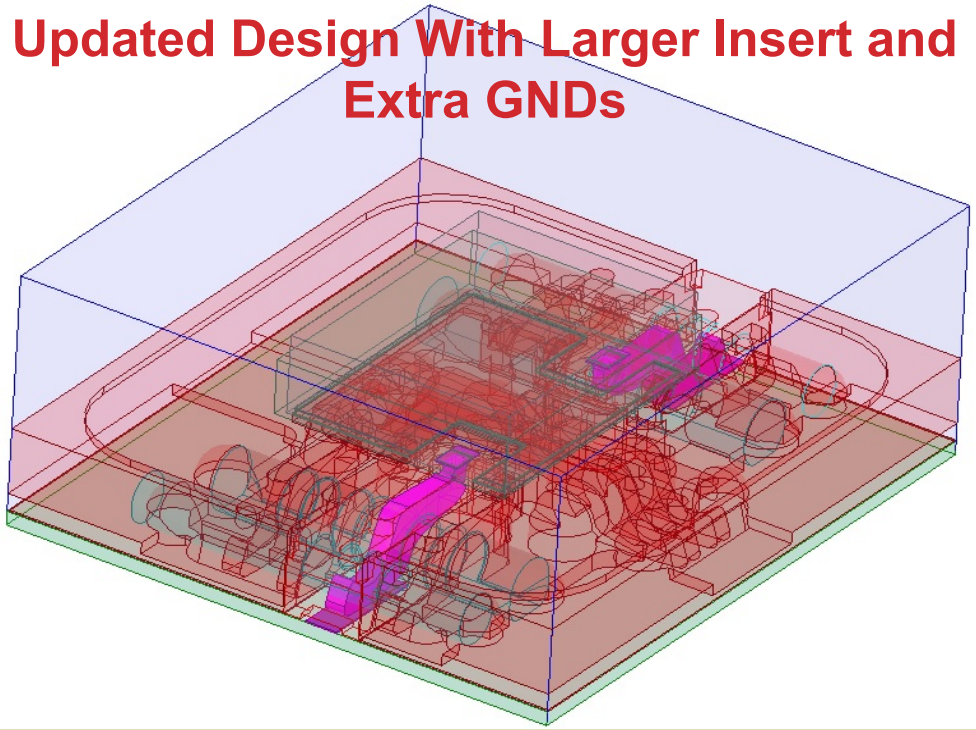
Note: Picture shows the initial contactor for High-Frequency Filter

System Comparison of Initial Design vs. Updated Design for High Frequency Filter Design - HFSS

Initial Design With GNDs on Each End – Encrypted Models

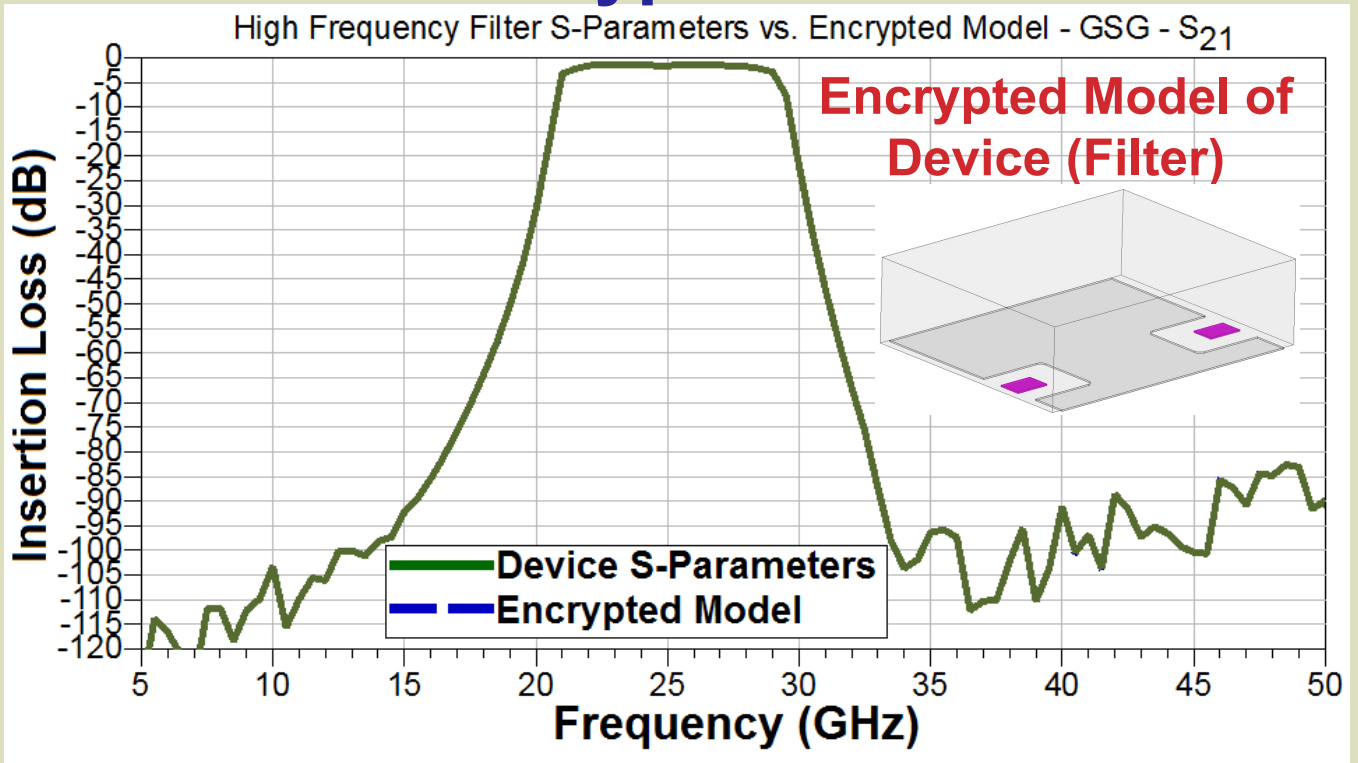


Updated Design With Larger Insert and Extra GNDs



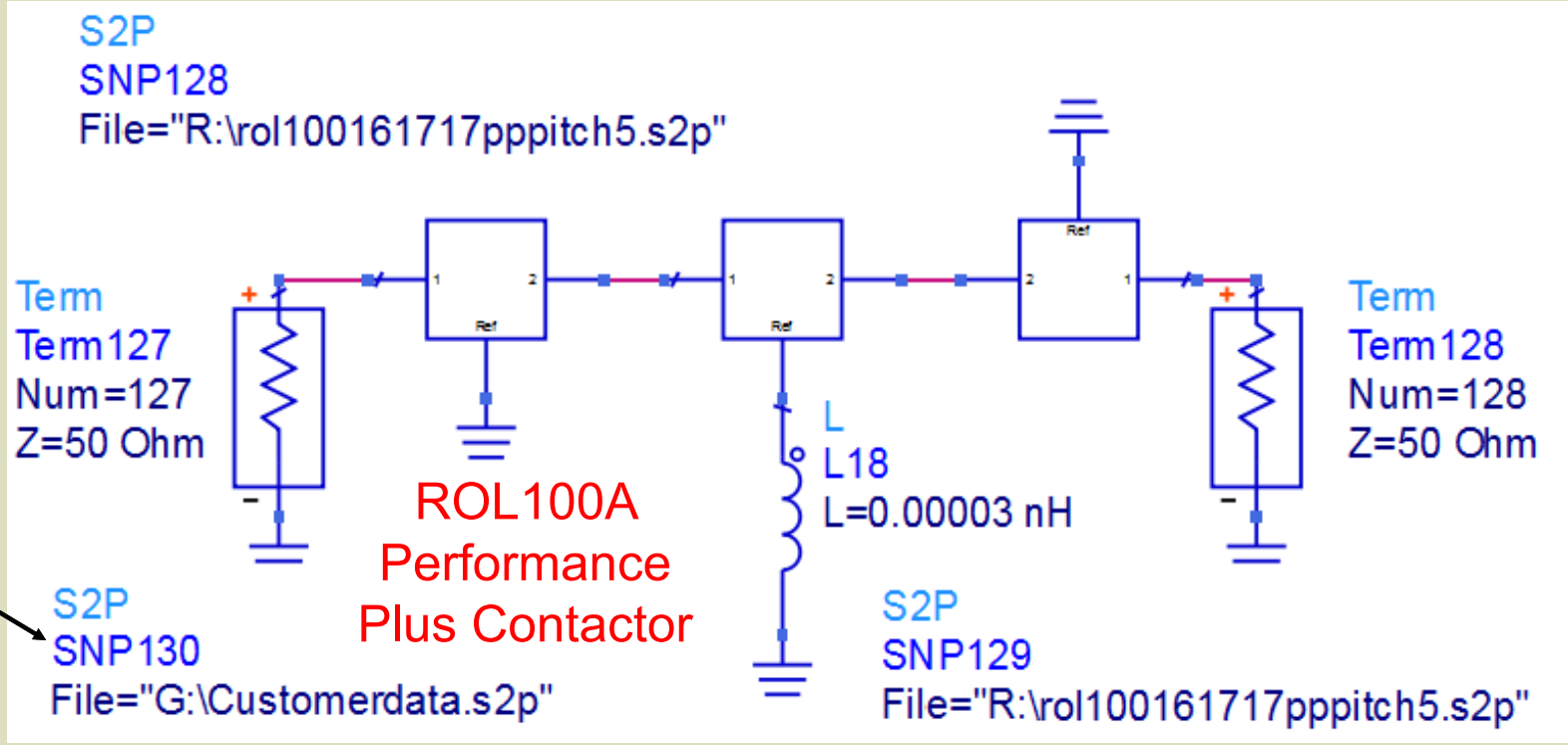
Updated Design Adds Extra Grounds Perpendicular to Signal Flow

S- Parameter File vs. High Frequency Filter Encrypted Model



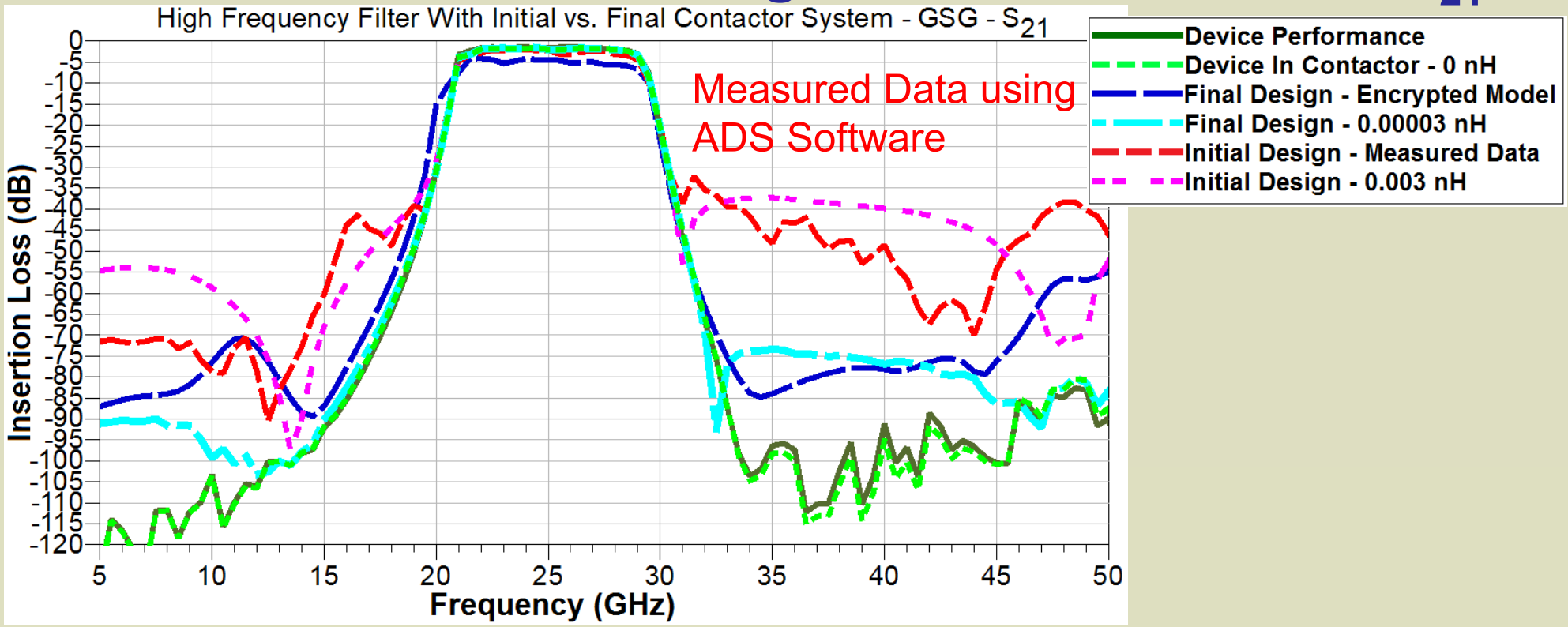
Encrypted Models if set up Correctly Exactly Mimic S-Parameter Data

0.5mm Pitch ROL100A® Contactor System With Encrypted Device – ADS Final Model Equivalent



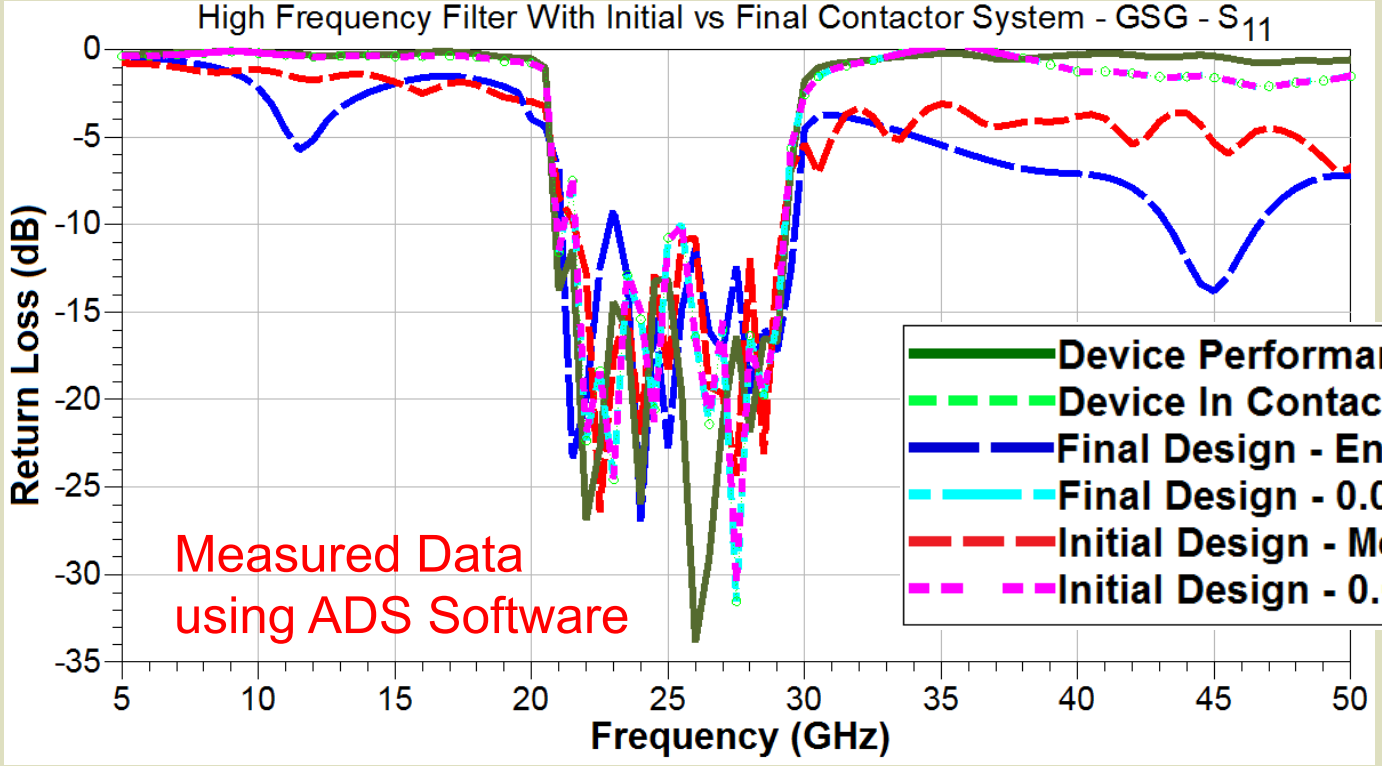
Need to Include in Model the Actual Inductance to GND of Design to Predict Performance

0.5mm Pitch System Simulations of High Frequency Filter Performance Using Different Methods – S_{21}



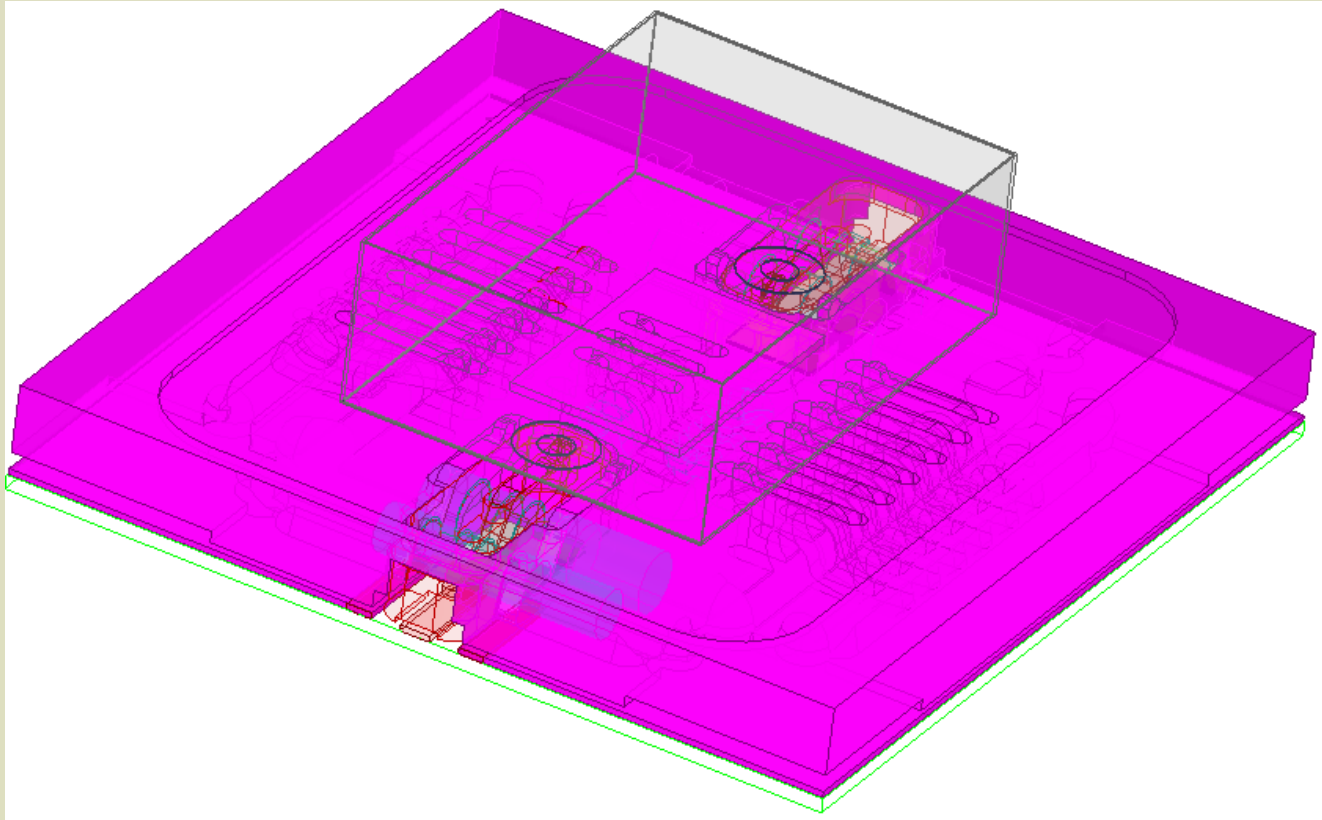
Putting Device in Contactor for Test adds Inductance to System

0.5mm Pitch System Simulations of High Frequency Filter Performance Using Different Methods – S_{11}



Putting Device in Contactor for Test adds Inductance to System

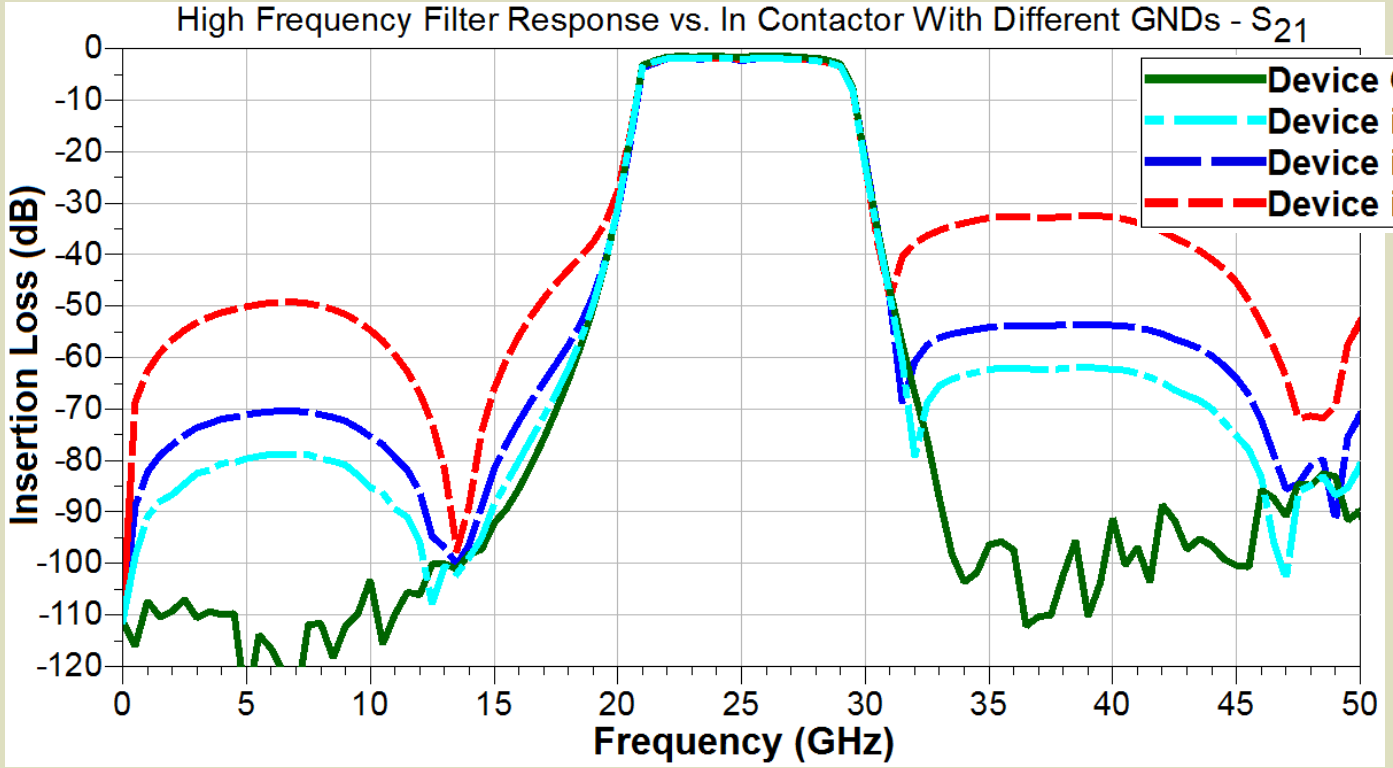
How Contactor Grounding Impacts System Performance - Modeled ROL100A PP Contactor



Contactor Features:

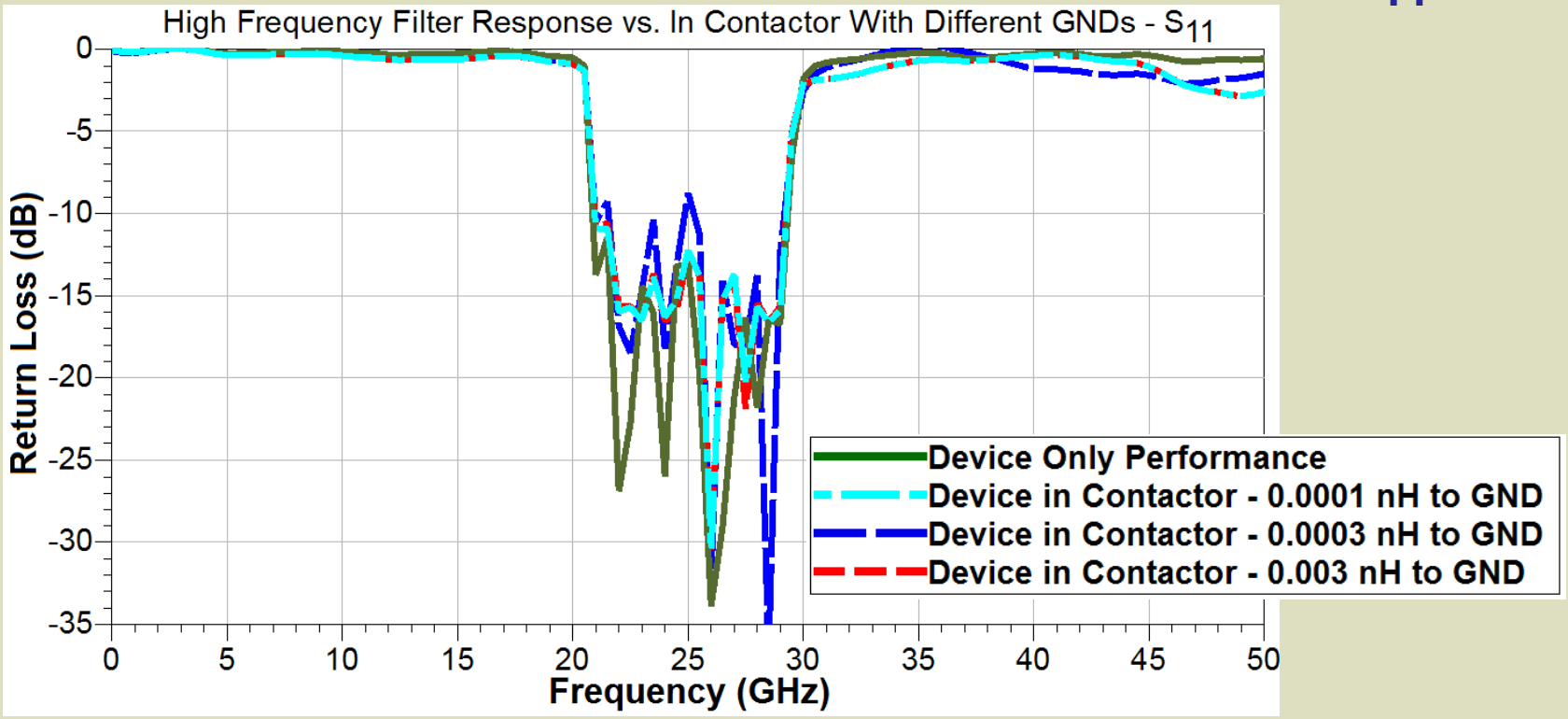
- 19 GND Contacts
- Metal Housing
- 2 Coaxial Inserts
- GND Plane on Top Side of Board
- Thinner Substrate
- Via GND Fences

Modeled ROL®100A PP Contactor System With Different GND Inductances to Match Measured Data – S_{21}



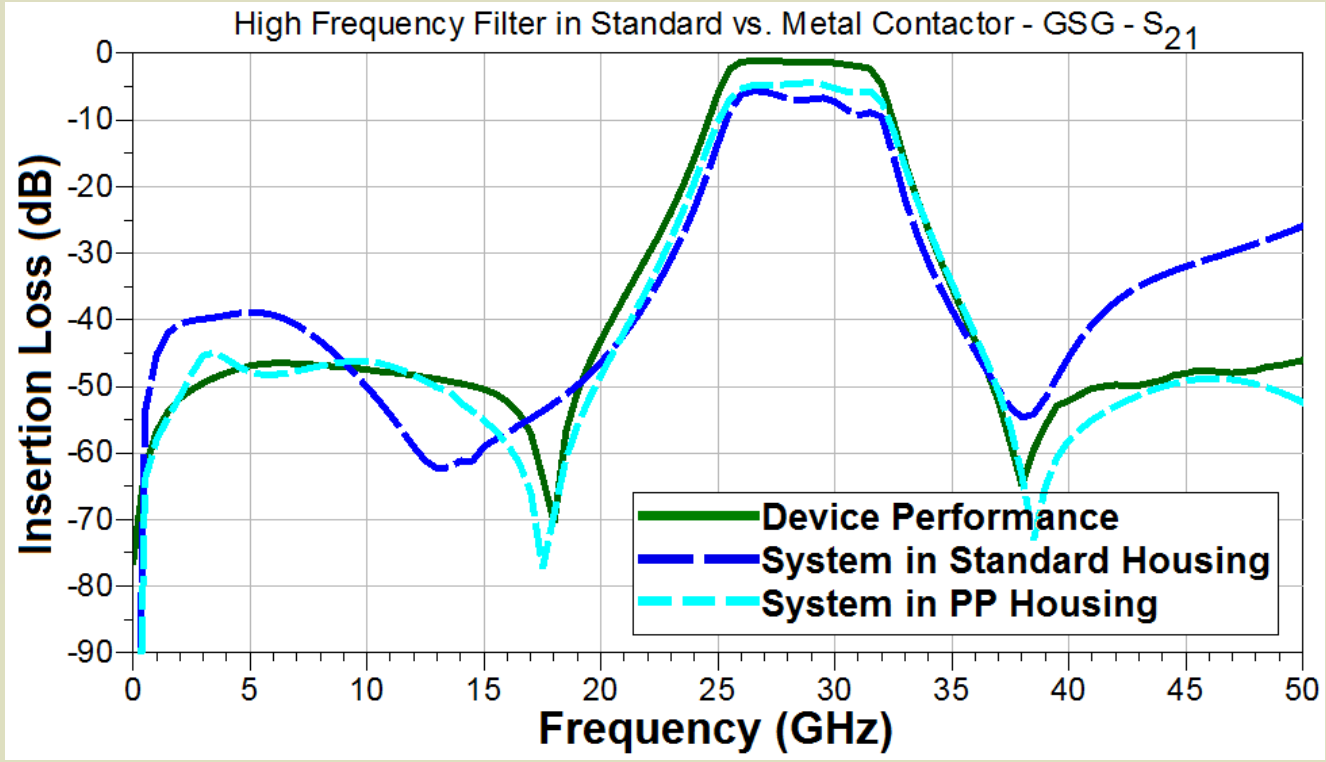
Inductance to Ground Plane Affects Out of Band Rejection and Filter Skirt

Modeled ROL® 100A PP Contactor System With Different GND Inductances to Match Measured Data – S_{11}



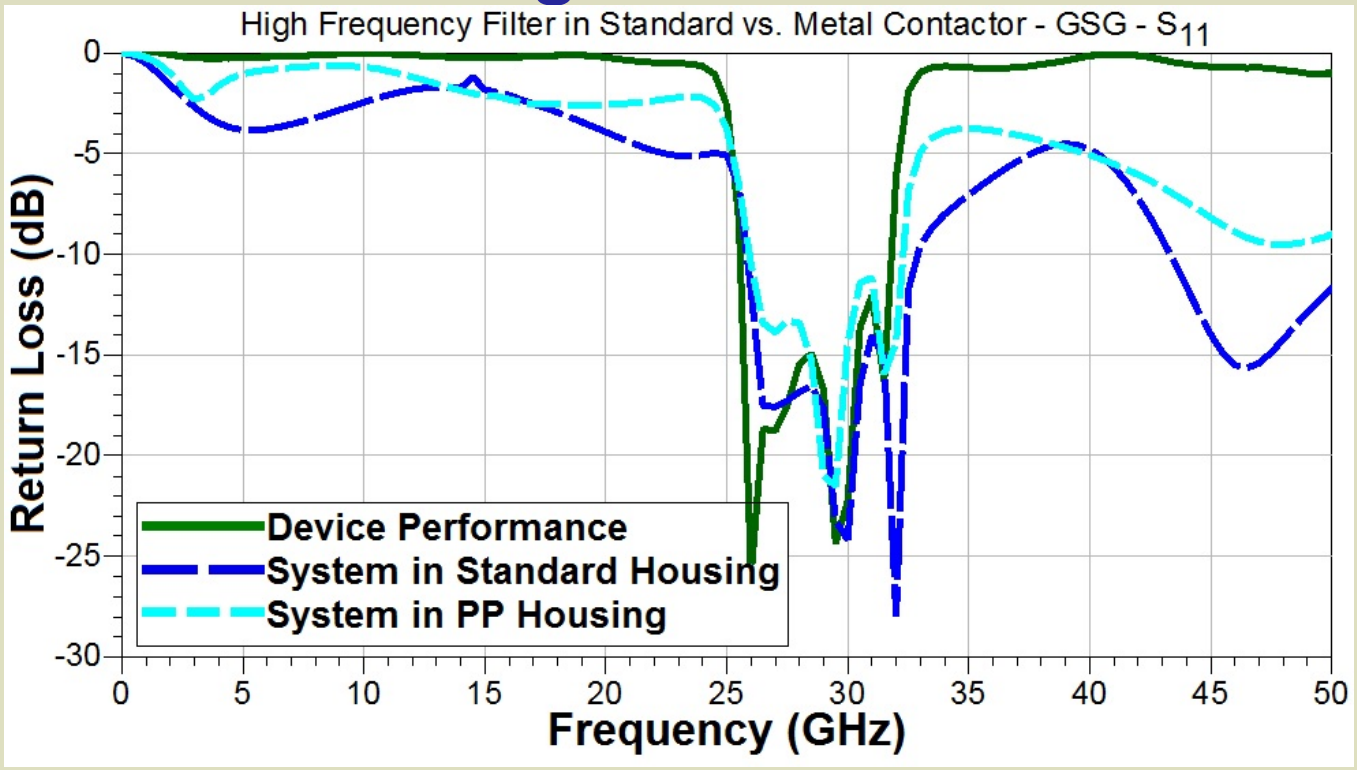
Inductance to Ground Plane Affects In-Band Return Loss

How Contactor Materials Impacts Performance in Standard Housing and Metal Contactor – S_{21}



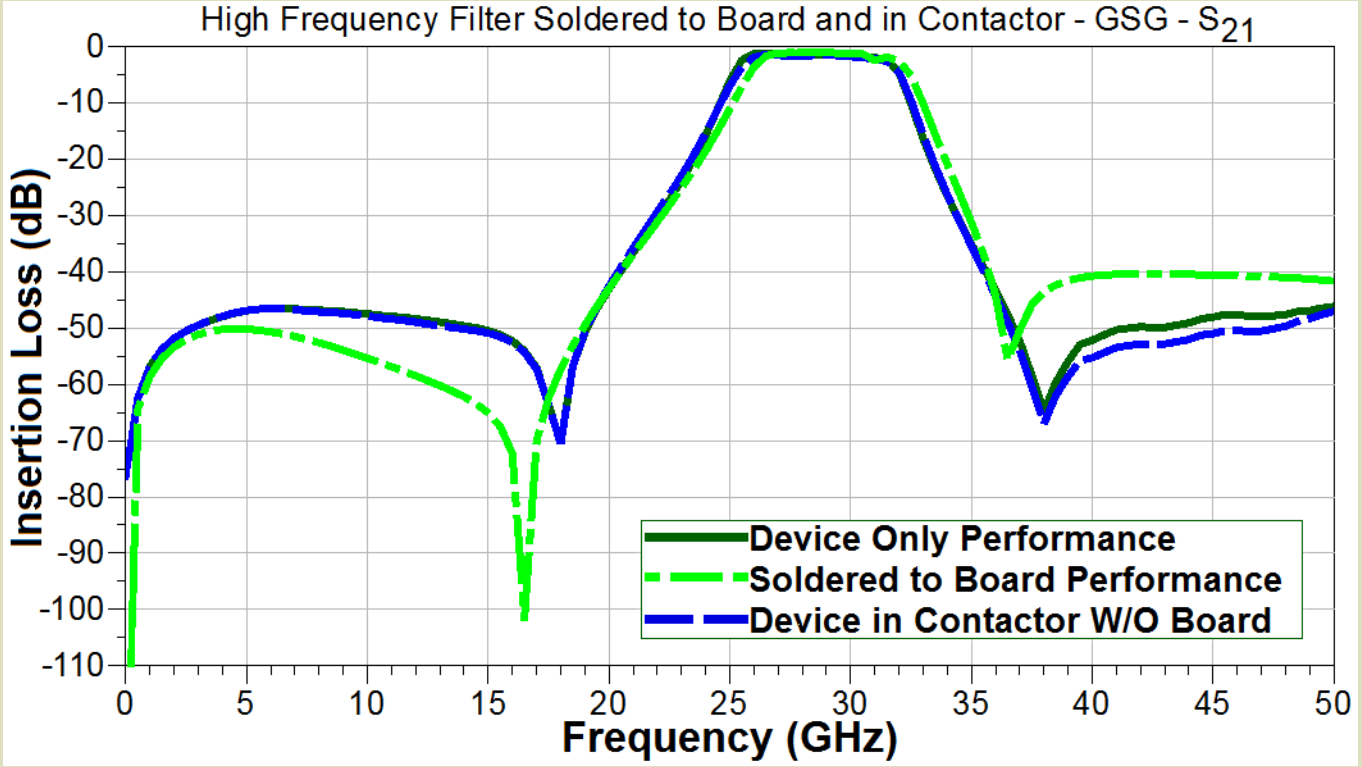
Metal Housing Results in Lower Ground Inductance so Better Performance

How Contactor Materials Impacts Performance in Standard Housing and Metal Contactor – S_{11}



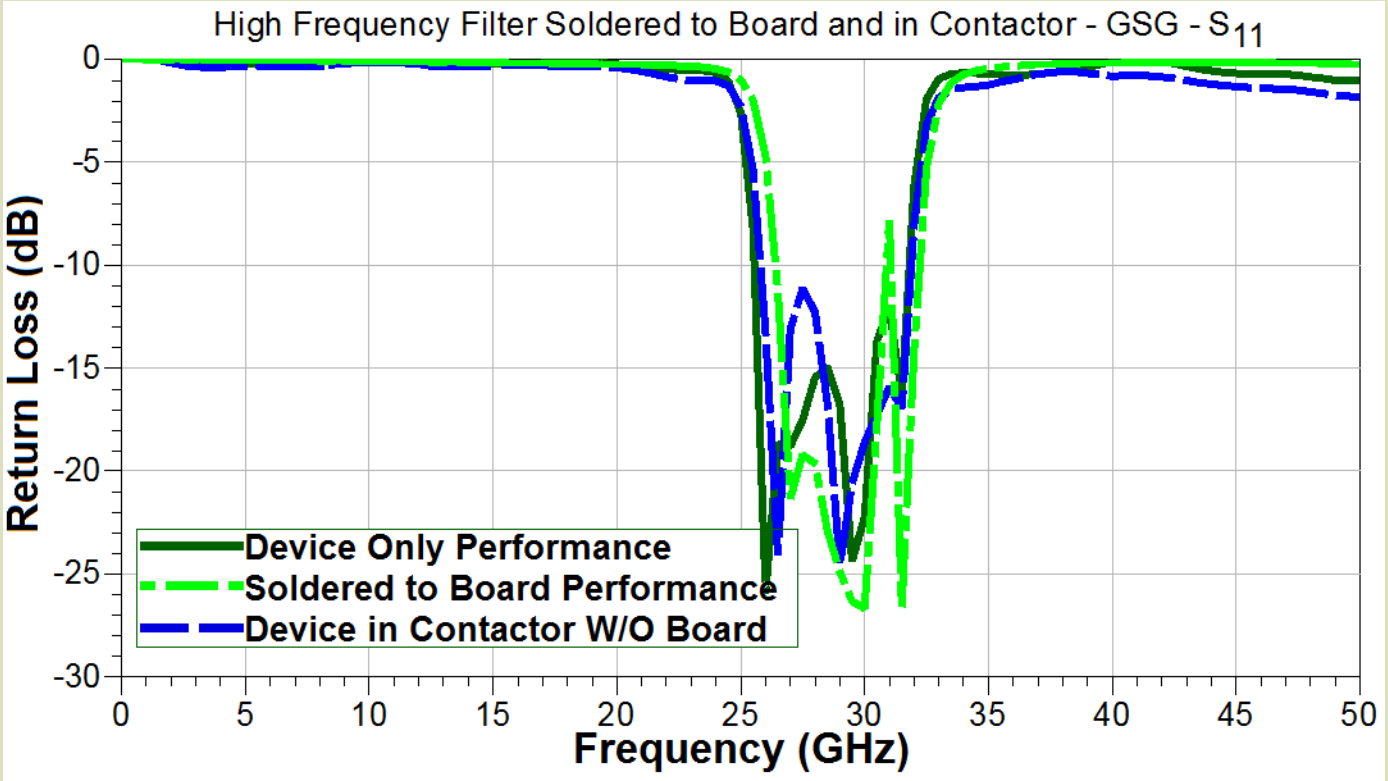
Contactor Design and Material Affects Performance by Changing Impedance

HFSS System Performance Comparing Device, Device Soldered to Board, And Device in Contactor – S_{21}



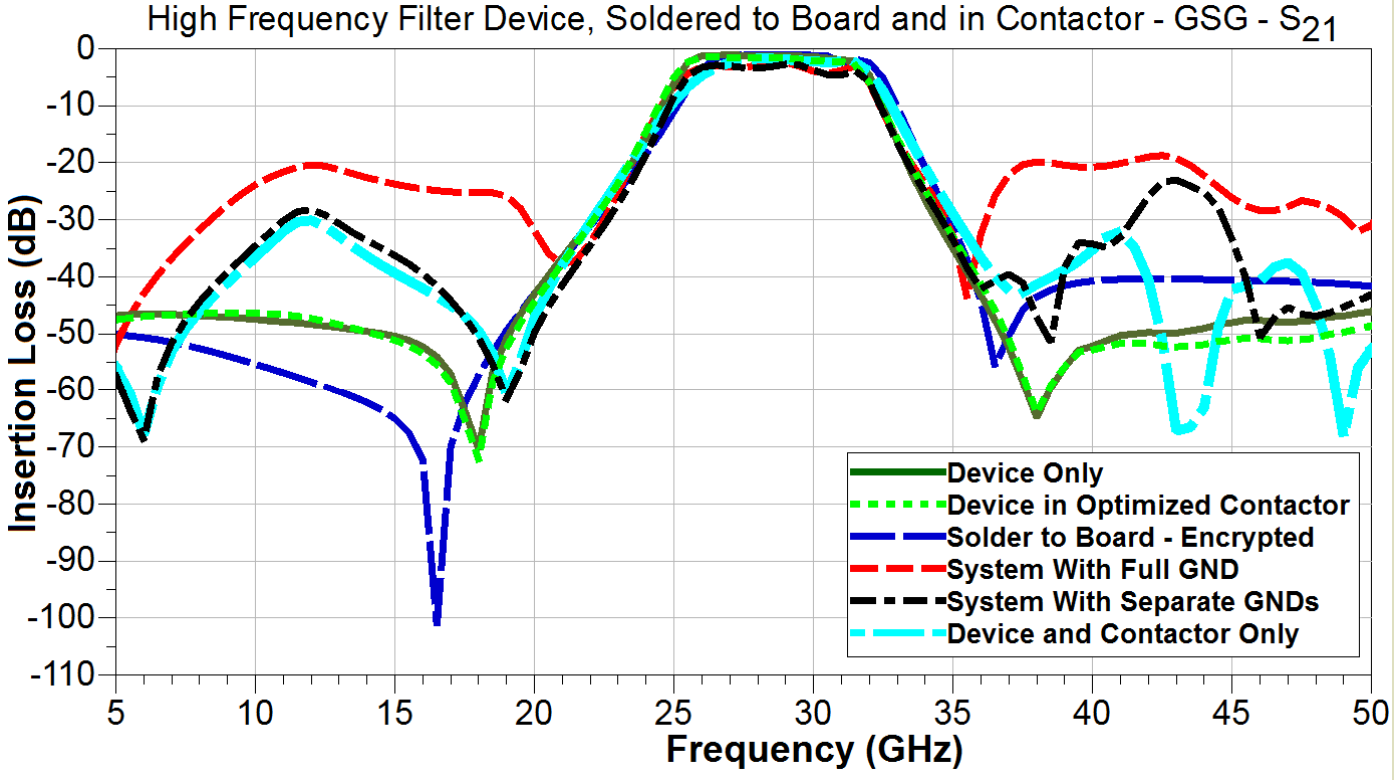
Load Board Grounding has Effects on Filter Out-of-Band Rejection

HFSS System Performance Comparing Device, Device Soldered to Board, And Device in Contactor – S_{11}



Load Board Grounding has Effects on Filter In-Band Return Loss

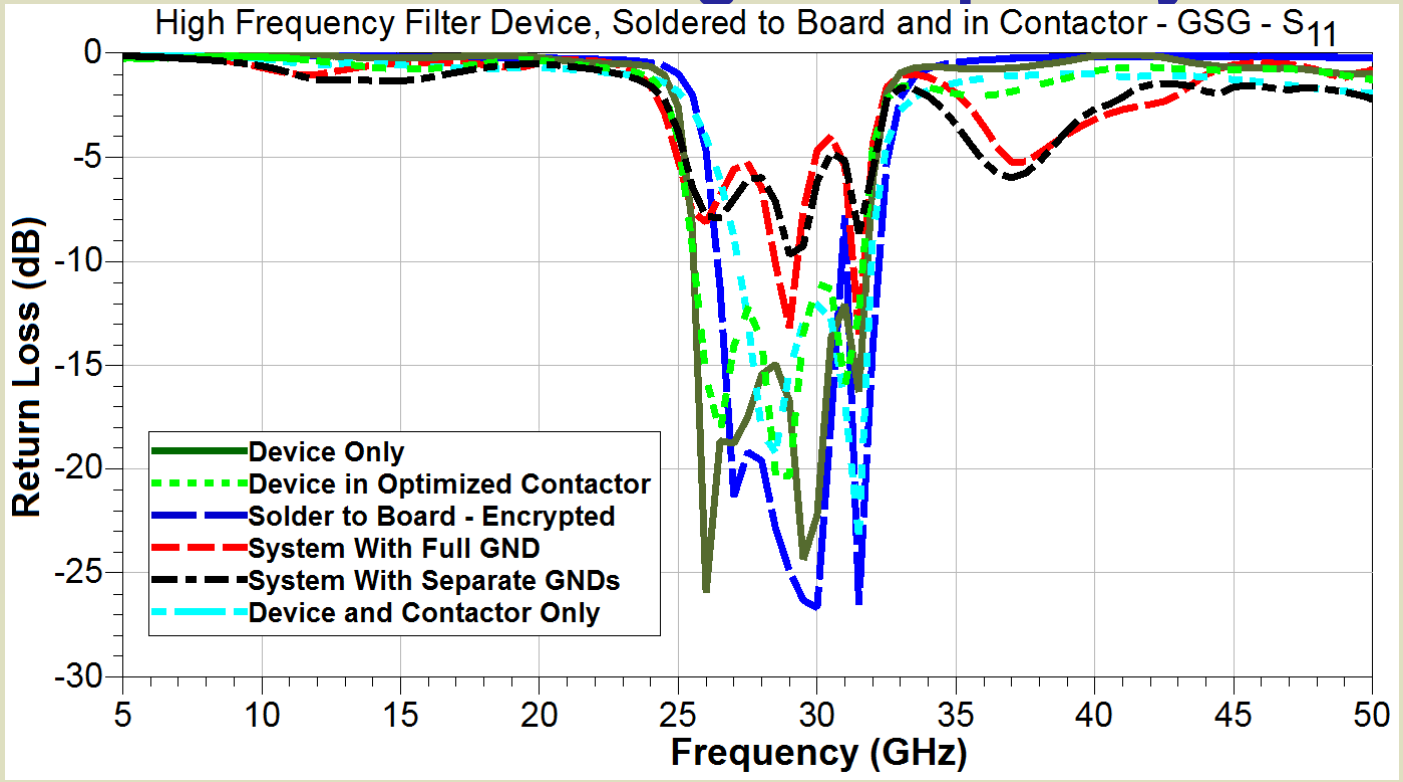
Encrypted File Simulations to Improve System Performance for High Frequency Filter Design – S_{21}



Used Highest Frequency Filter to Enhance Performance Changes

Load Board and Contactor Grounding has Effect on Filter Out-of-Band Rejection

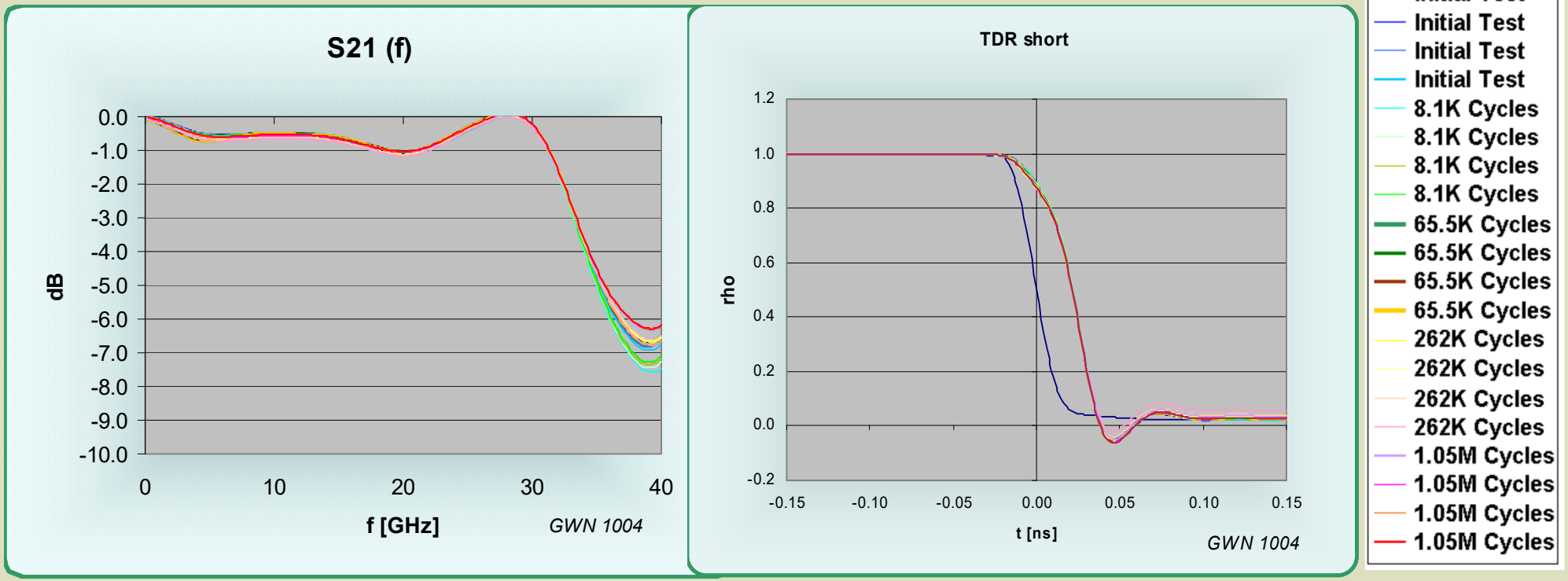
Encrypted File Simulations to Improve System Performance for High Frequency Filter Design – S_{11}



Used Highest Frequency Filter to Enhance Performance Changes

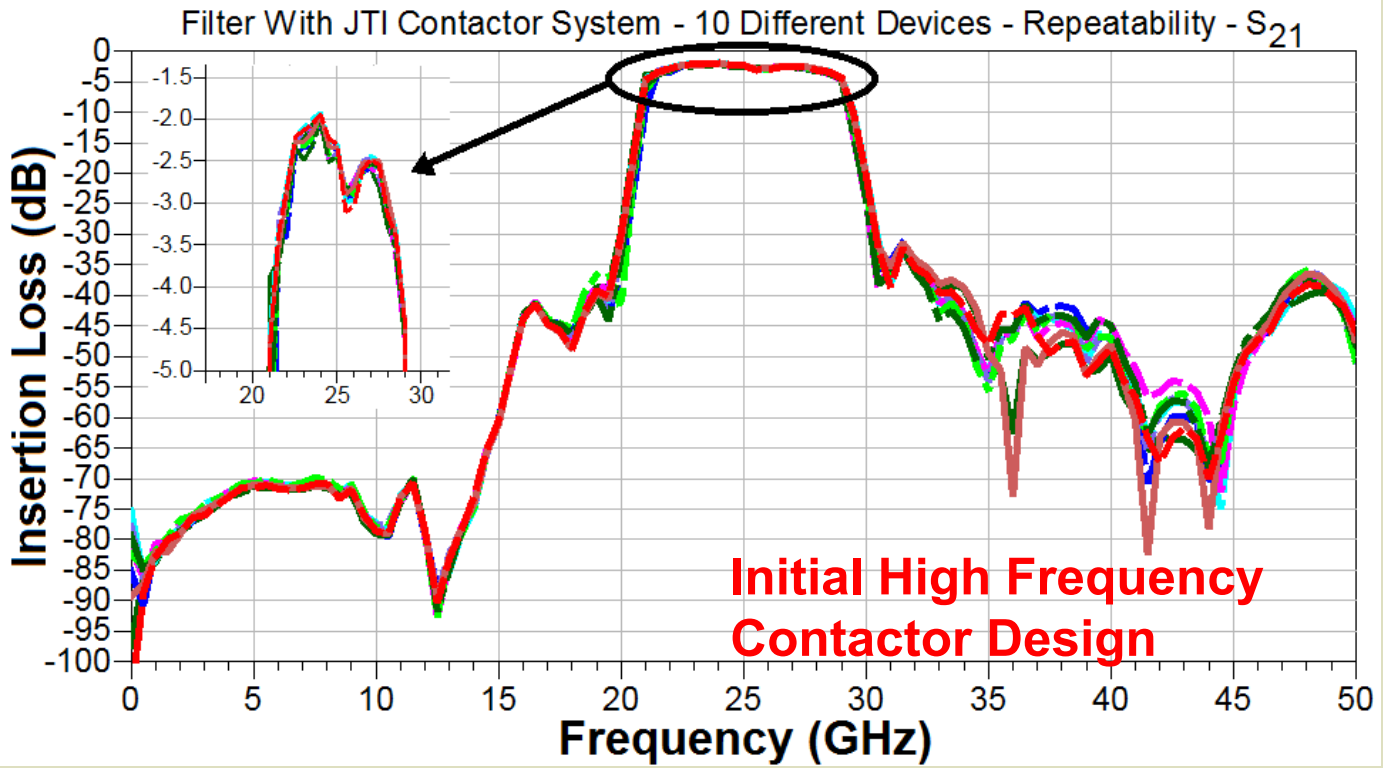
Load Board and Contactor Matching has Effect on Filter In-of-Band Return Loss

Contactor RF and Digital Repeatability – Rigid ROL Technology



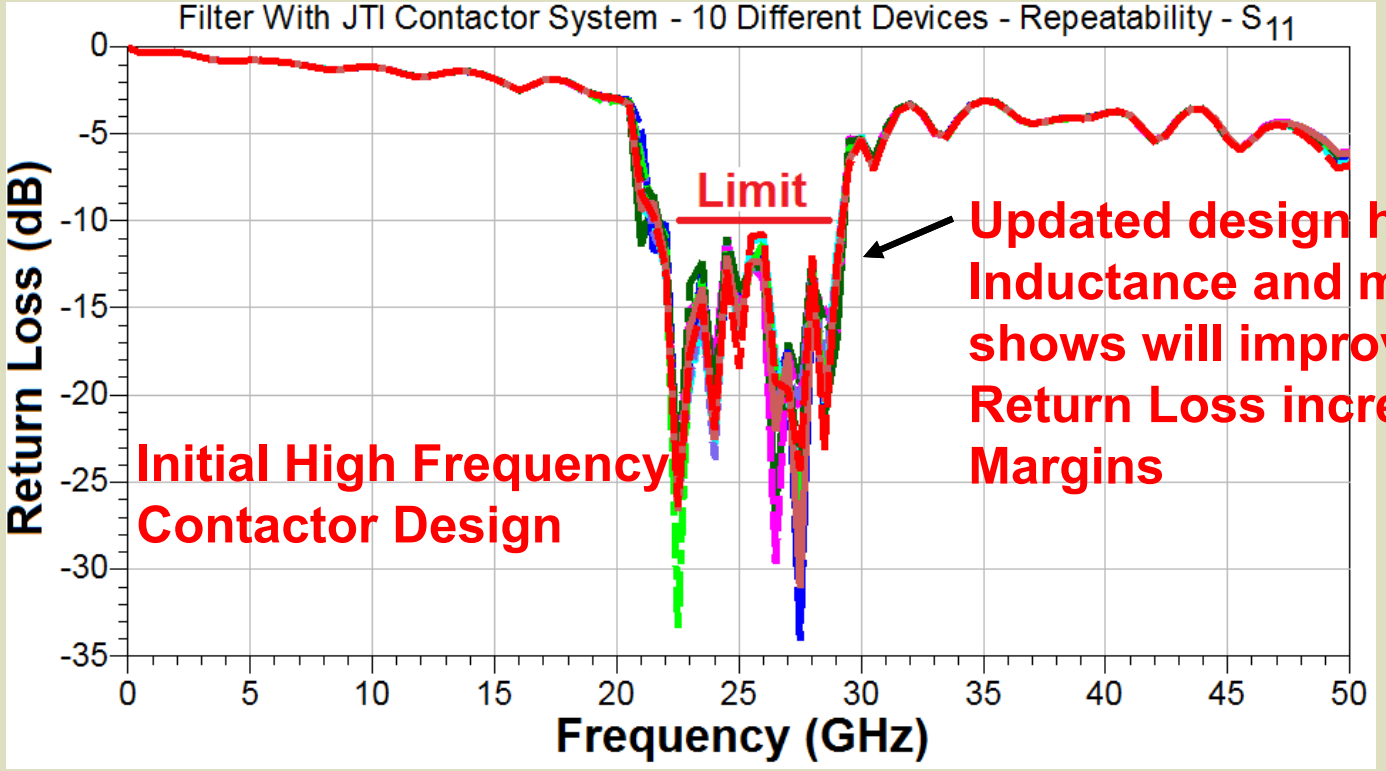
RF and Digital Repeatability is Important Across Life of Contactor

Repeatability of High-Frequency Filter in Contactor With 10 Different Devices – S_{21}



With Solid ROL®100 Technology Repeatability Between Devices is Good

Repeatability of High-Frequency Filter in Contactor With 10 Different Devices – S_{11}



With Solid ROL® 100 Technology Variability is Reduced Which Reduces False Failures

Conclusion

- Encrypted models can be used to fill in for missing parts of the system
- S-parameters of a device can be encrypted to get system performance
- For ground-sensitive parts, the GND inductance affects the performance
- Ground inductance becomes more important the higher the frequency of the device, the more gain the device exhibits, or in passive devices
- Device pads affect test technology and test performance
- With the same package, a high-frequency contactor can test multiple devices
- Repeatability of contacts can improve test results and reduce false failures

Special Thanks

- Engineers at Mini-Circuits that provided some data and encrypted models of High-Frequency filter