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-1 dB insertion loss to 90 GHz ?

Gert Hohenwarter
GateWave Northern, Inc.

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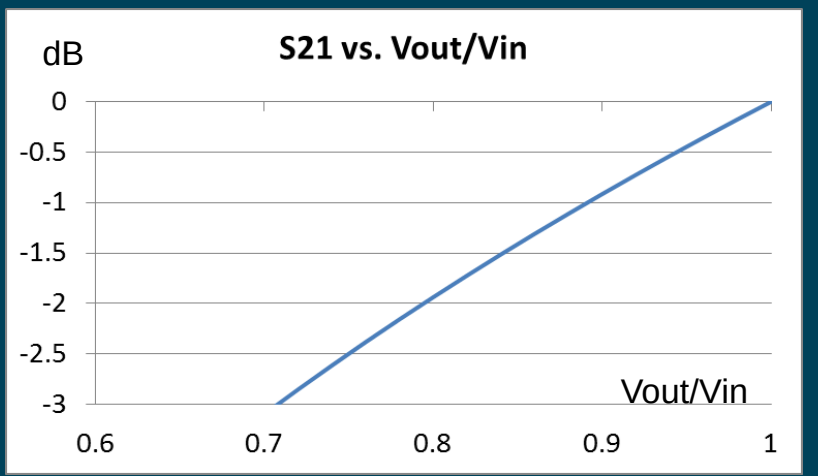
Objective

- Examine contact characteristics at elevated frequencies
- Identify key parameters for best performance
- Illuminate significance of these parameters
- Offer some insight why expectations are not always met

Approach

- Present existing -1 dB data
- Design experiments to identify insertion loss contributions
- Set up and run simulations that exemplify significance of individual contributors

– 1dB ?

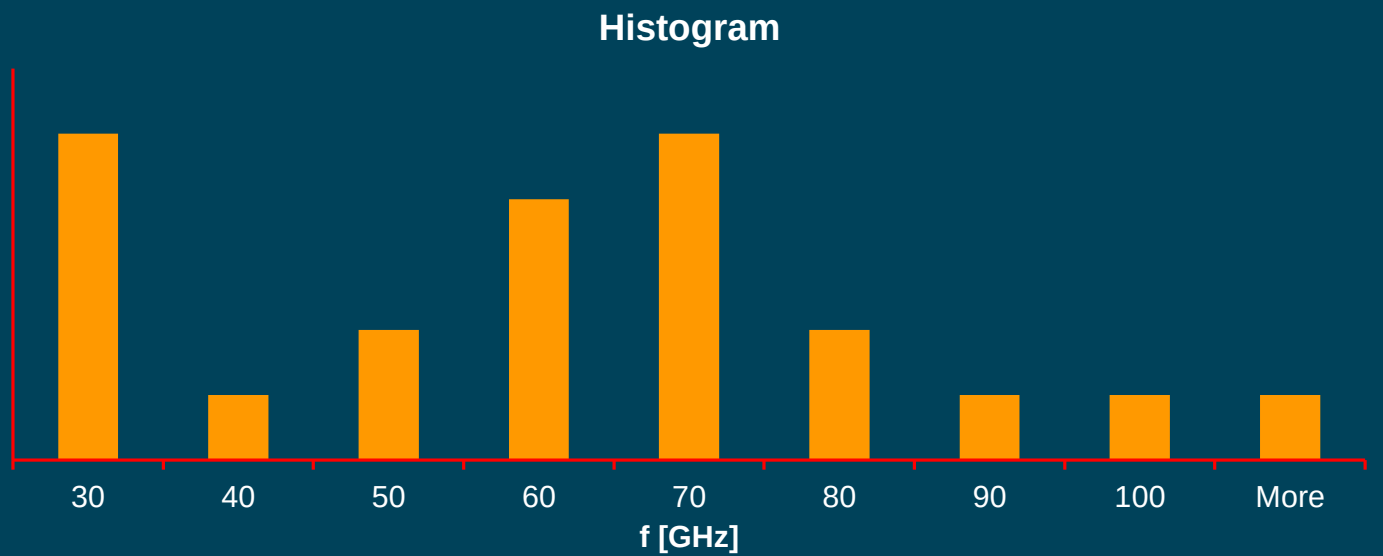


Insertion loss S21 is defined by ratio of output signal level
at port 2 vs. input signal level at port 1 of an interconnect/socket

$$S21=10*\log(Pout/Pin) =20*\log(Vout/Vin)$$

Measured -1 dB frequencies

(sockets for potential automotive radar applications – tested at GWN)

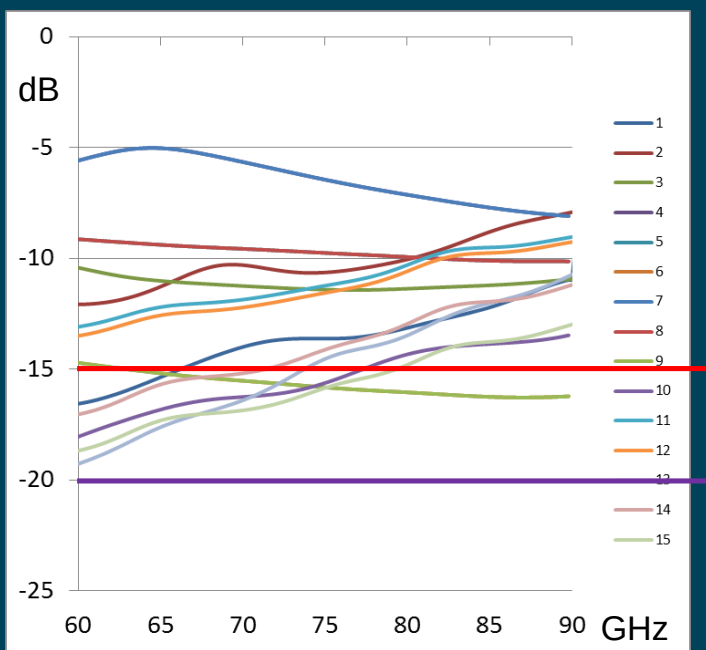


A collection of -1dB insertion loss points

-1 dB insertion loss to 90 GHz ?

Return loss examples

Return loss defined by ratio of source signal level vs. reflected amplitude level at port 1 (S11) or port 2 (S22)



-15 dB may be more suitable above 60 GHz

-20 dB is an often used metric at "lower" frequencies

From measurements - modified to make the actual response unidentifiable

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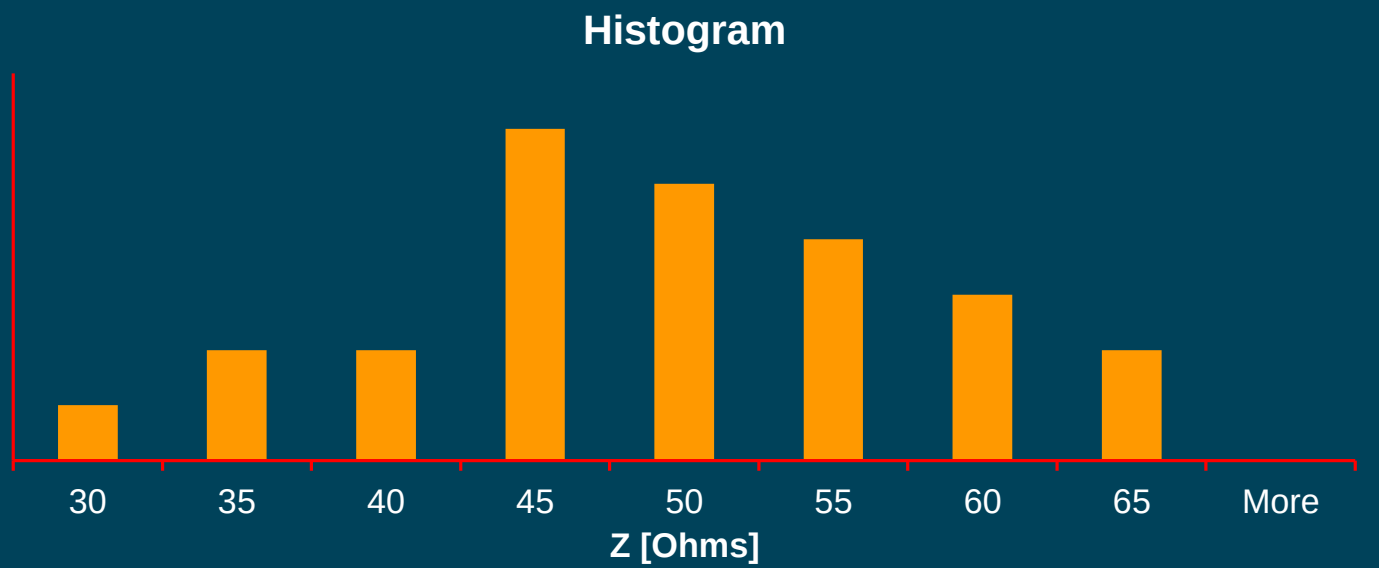
Measured impedance levels

(sockets for potential automotive radar applications – tested at GWN)



Characteristic impedance

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Parameters to be examined

- Impedance
- Pitch
- Contact length
- Contact materials, plating
- Surface roughness
- Dielectric materials / loss tangent

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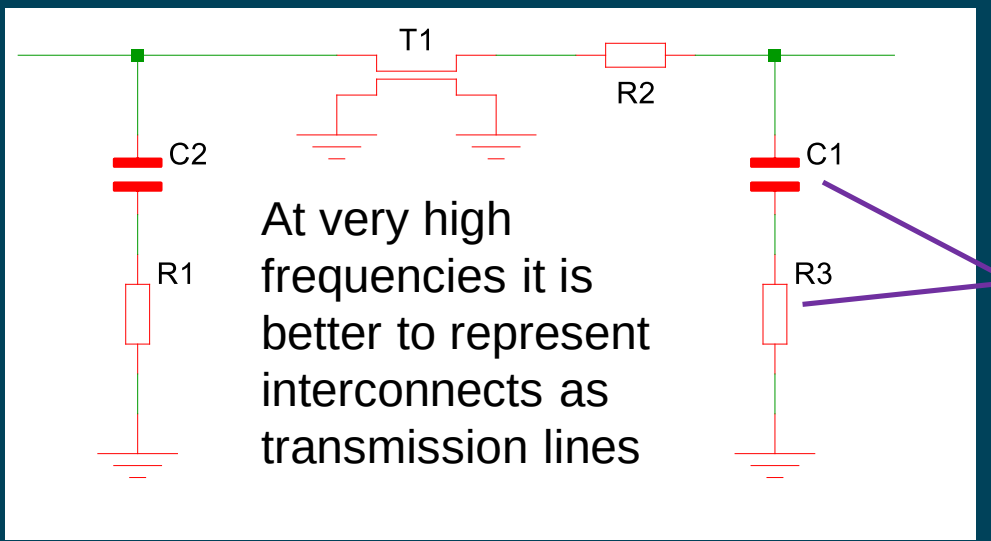
Line impedance impact



Simulation circuit (SPICE simulation for simplicity)

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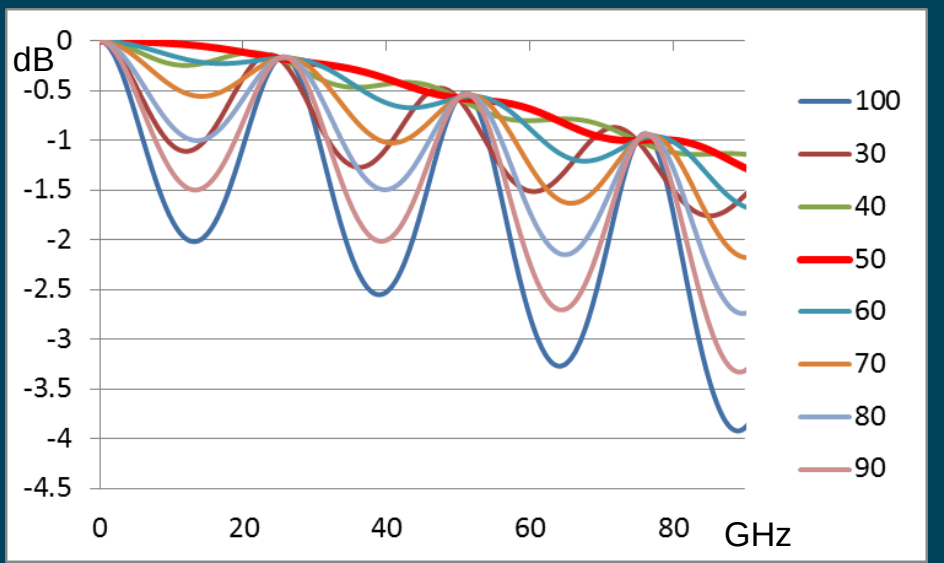
Line impedance impact



* Line length was fixed at 20 ps

Insertion loss for different line impedance levels

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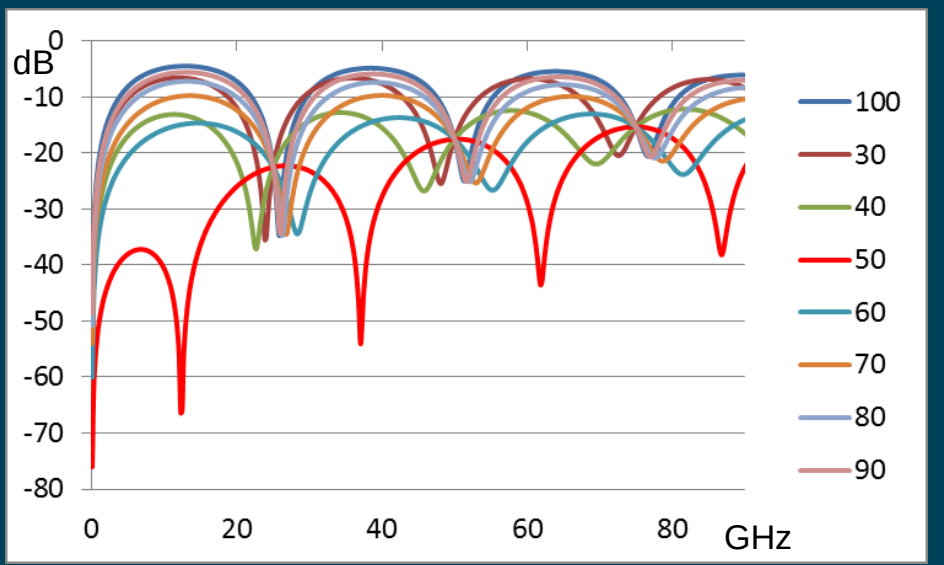
Line impedance impact



Return loss

Optimal results are achieved for a near 50 Ohm design

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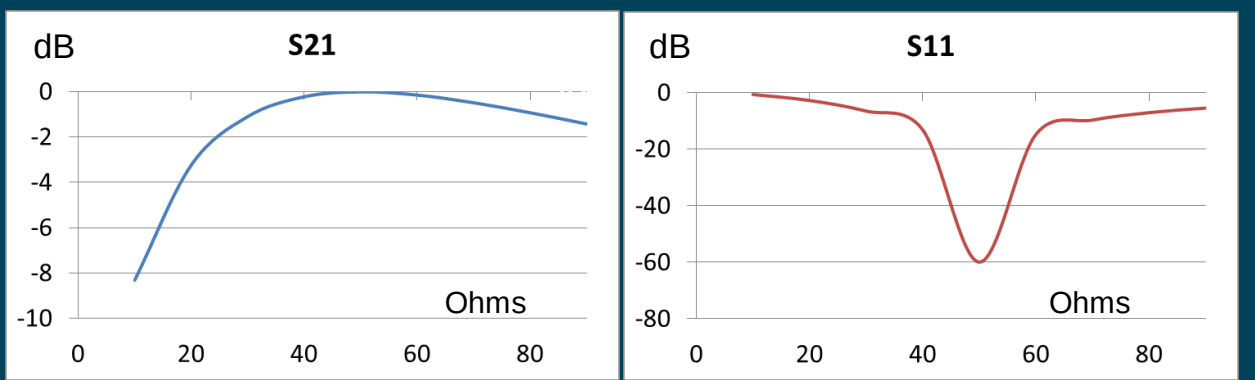
Line impedance impact



Peak insertion and return loss values as a function of line impedance

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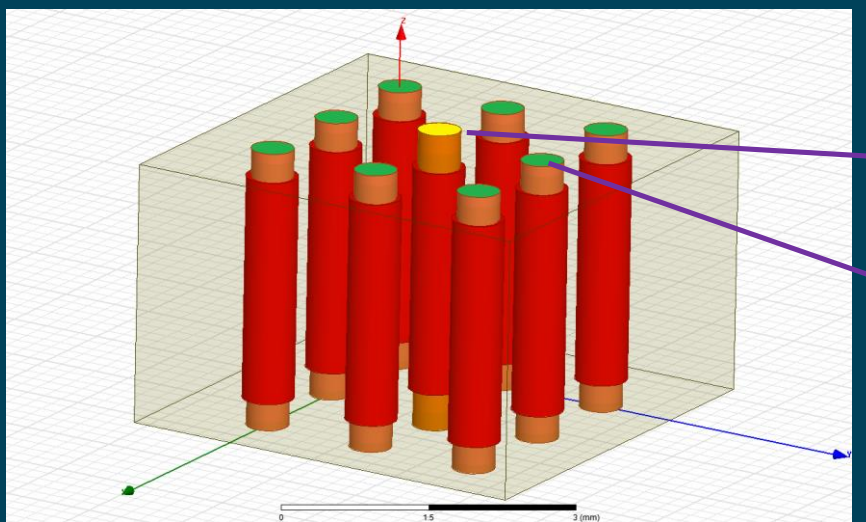
Basic simulation setup (3D HFSS models)

A 'field' configuration with grounded unused pins is chosen since that resembles applications



Simulation parameters and configurations oriented toward 'real-life'

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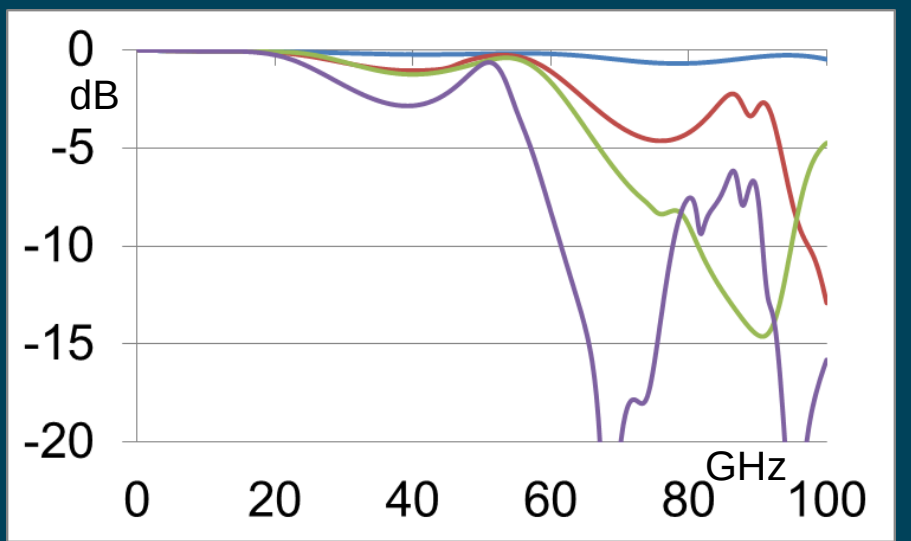
Pitch

A near 50 Ohm design was used in all cases



Insertion loss for different pitch arrangements

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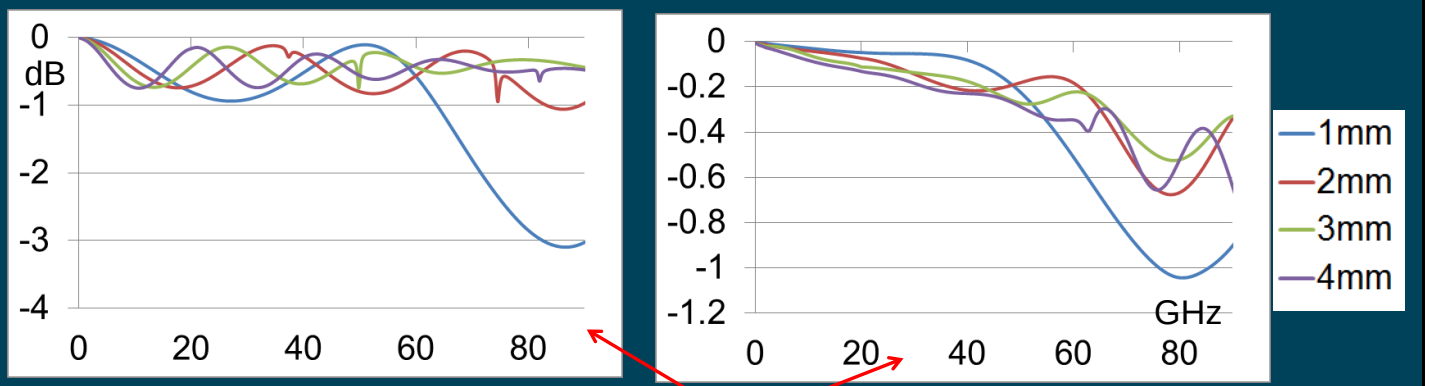
Line length impact



Line impedance was fixed at 35 and 48 Ohms

Insertion loss for different line lengths and impedance levels

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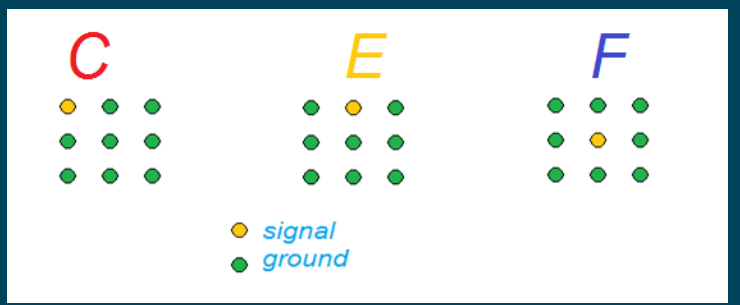
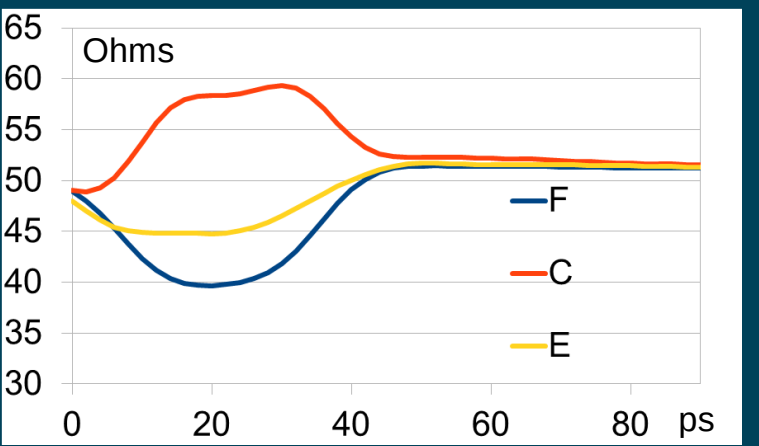
Signal and ground arrangement





Setup impact depends on which configuration gives closest Z to 50 Ohms

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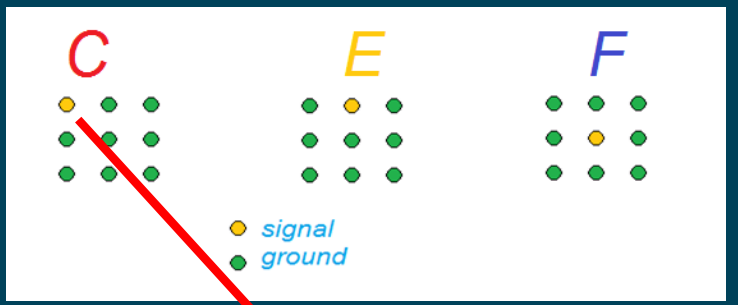
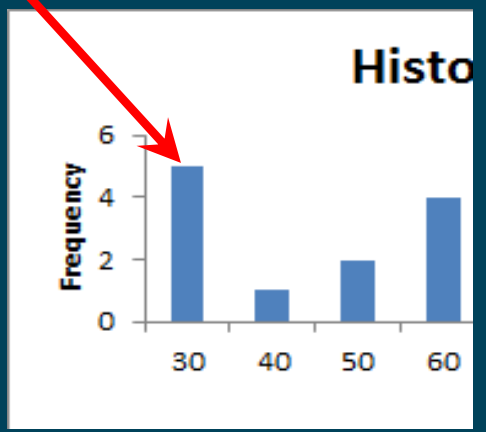
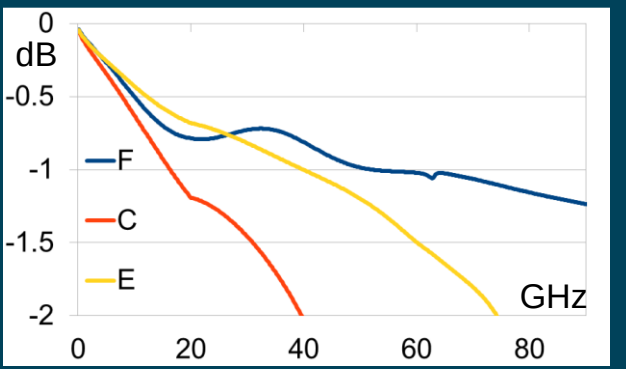
Signal and ground arrangement







Corner configuration often has lowest -1dB point

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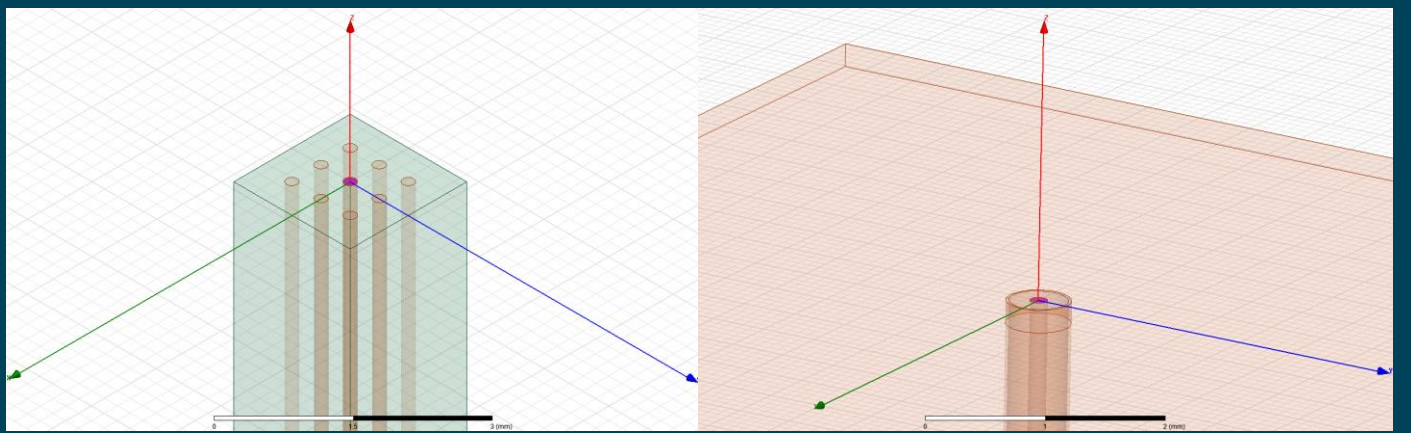
Models for different test configurations



LGA type feed will result in slightly different field configuration than coaxial feed

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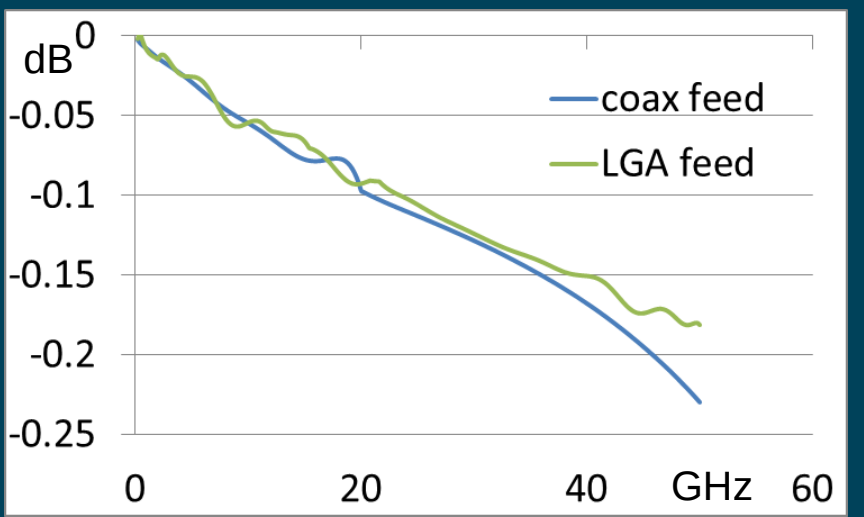
Test configuration



In this example there is relatively little difference in test results up to 40 GHz. This is not always the case.

Insertion loss difference example

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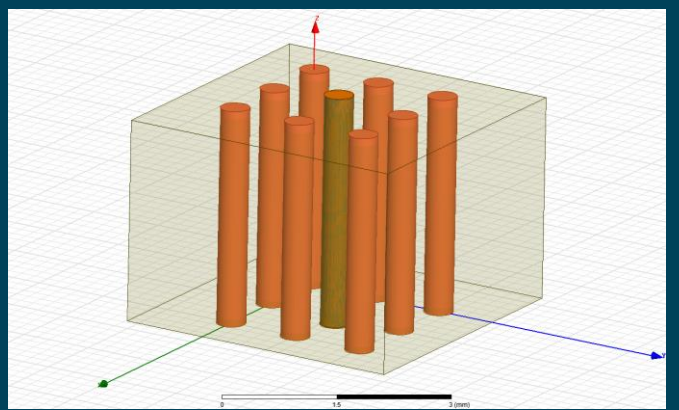
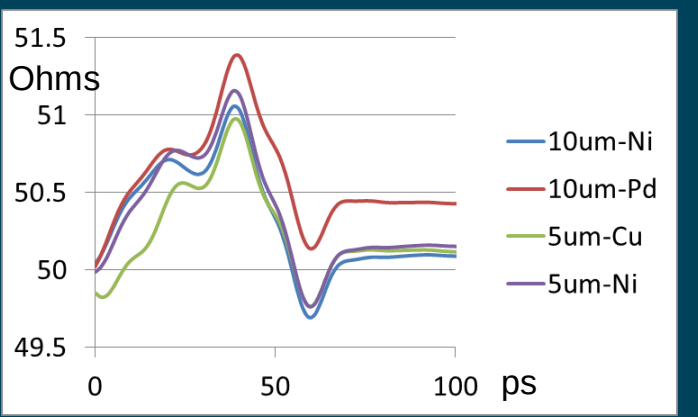
Plating

Simulation Setup:





Impedance as a function of time (i.e. distance)

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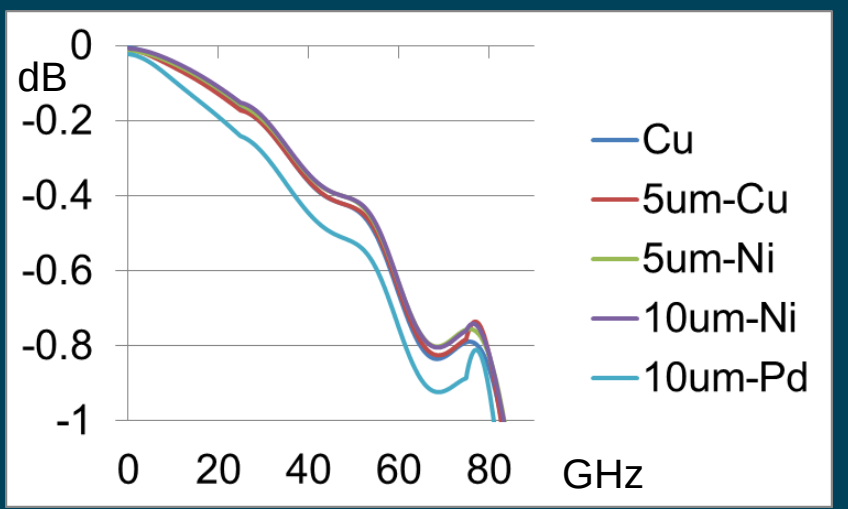
Plating

Au was not included since it is generally very thin and thus somewhat "transparent"



Insertion loss

For this near 50 Ohm design plating does not contribute significantly to loss.

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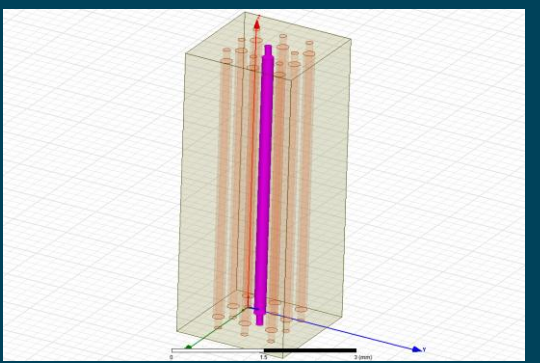
Roughness simulation

- Signal surrounded by ground assumed
- Only large diameter portion of pin was assigned a roughness



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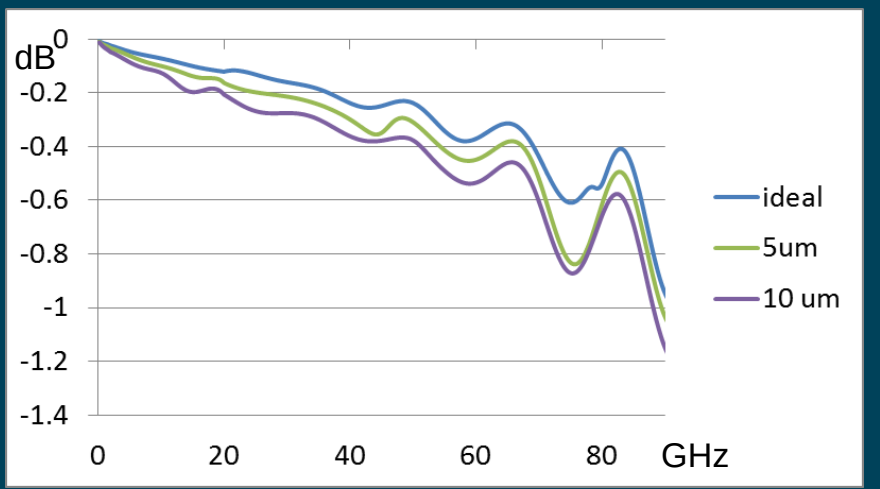
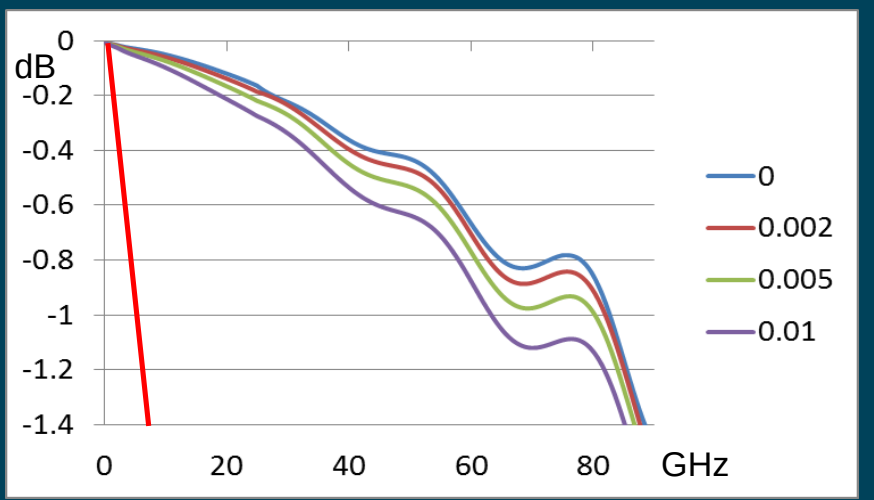
Roughness



Insertion loss as a function of frequency

-1 dB insertion loss to 90 GHz ?

Tangent Delta



Insertion loss as a function of loss tangent

-1 dB insertion loss to 90 GHz ?

Sensitivity of parameters

- Characteristic impedance is a major contributor to performance
- Pitch should be below 0.8 mm
- Line length can shift -1 dB point in frequency
- Roughness is not a major factor for short connections except for large variations
- Dielectric materials generally have only a small influence on performance
- Configuration for test and in application is important

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Conclusion

- Socket design should place a focus on interconnect impedance
- End user needs to consider signal/ground configuration
- Materials selection can contribute to loss
- Dielectric materials need to be properly characterized for simulations

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