Standardization of Electrical Specifications for Test Socket Contactors

Elec Seo

ISC & Prowell

TestConX한국 Korea

Incheon ▪ November 7, 2023

GLOBAL INNOVATION ISC PROWELL

Contents

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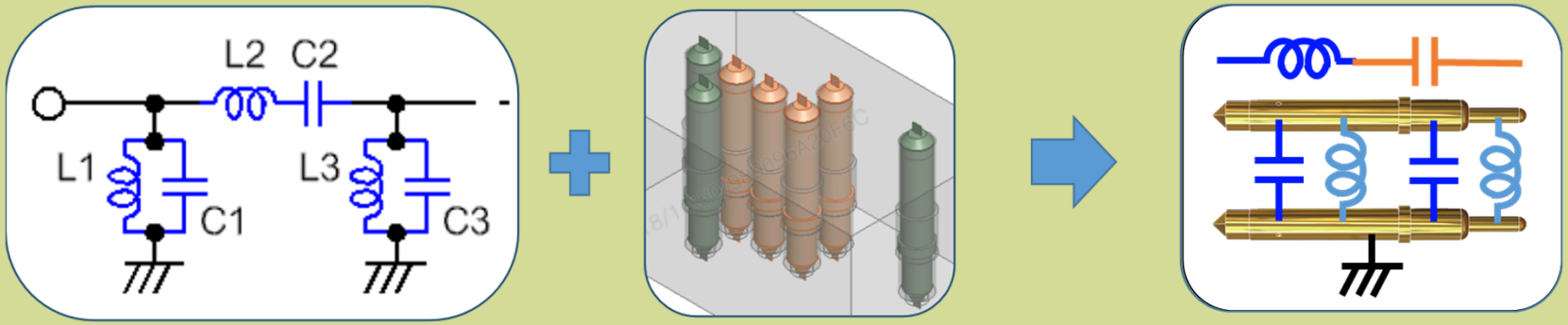
- Test socket & Contactor
- Problem of Data sheet
- Cause, Optimal conditions
- Need for standardization
- Discussion & Conclusion

In the Beginning...

- **Transmission speed**
  1.5Mbps ▶ 14Mbps ▶ 225Mbps ▶ **1Gbps** ▶ **20Gbps** ▶ **6G, 1Tbps**
- **Transmission line**
  Cable(Km~m) ▶ PCB(Cm~mm) ▶ **Connector/Socket(1~10mm)**
- **Equipment & Load BD'**
  Cable-Connector-**PCB(Load BD')**-Connector-Cable ▶ **m~Cm**
  DUT-**Test socket(0.1mm~10mm)** - PCB Pad & Trace
- **Requirement specification**
  SWR(1.5:1) ▶ Inductance(<1nH) ▶ **IL (-1dB)/RL(-10dB)/XT(-40dB)**

Test socket, Passive or Active Element?

- S-parameter requirements are also taken for granted in test sockets.
- Some customers require S-parameters just for contactors.
- However, S-Parameter cannot be analyzed using Contactor alone.
  - Must be a signal pin and at least one ground pin
  - Material of housing that makes it up also affects the S-parameter.



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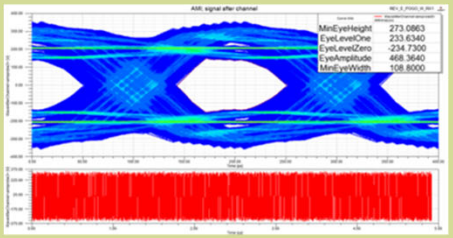
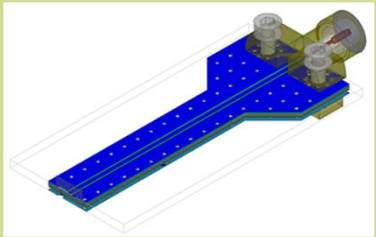
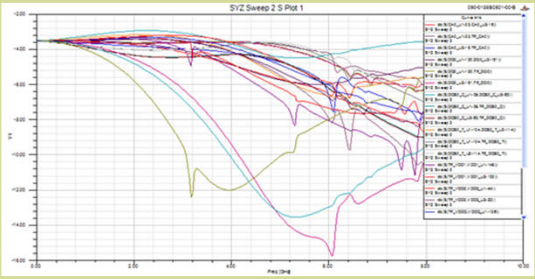
Test socket, Passive or Active Element?

- Fortunately, With the development of 3D FEA,
  - Even non-experts, to generate data without complex calculations.
- This presentation, I will explain through the 3D FEA case of POGO



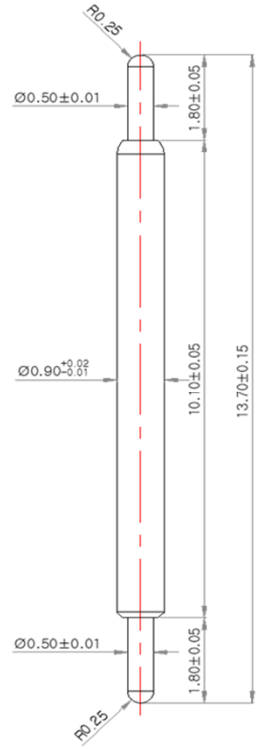




- The FEA tool used is Ansys HFSS,

: FEA detailed conditions apply ISC "RF Simulation STD Manual 2020 ver1.2".

Example Data sheet



Material and Plating

· Top Plunger	Hardened Beryllium copper / Au Plated
· Bottom Plunger	Hardened Beryllium copper / Au Plated
· Barrel	Brass / Au Plated
· Spring	Music Wire / Au Plated

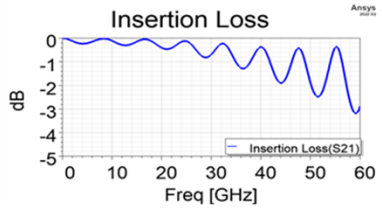
Mechanical Spec.

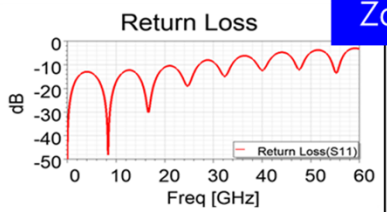
· Work Force	45.0gf @ 2.00mm (Recommended Travel
· Full Travel	63.9gf @ 3.00mm
· Working Temp.	-40 ~ 120℃

Electrical Spec. – 1.27p

ISC Std.

· Insertion Loss	34.93GHz @-1.0 dB
· Return Loss	27.08GHz @-10.0 dB
· Loop Inductance	3.02nH @1.0GHz
· Capacitance	1.80pF @1.0GHz
· Contact Resistance	<150mΩ
· Current Carrying Capability	2.0A (Continuous)





Note: Specification is ONLY for reference, possible to be changed for customer requirements. 2023.08.29

S-Parameter

S11(Return Loss)

S21(Insertion Loss)

Impedance

$L = -im\{1/Y(port1,port2)\}/(2\pi \cdot f)$

$C = -(1/im)\{Z(port1,port1)\}/(2\pi \cdot f)$

$Zo=\sqrt{L/C}$, (41Ω)

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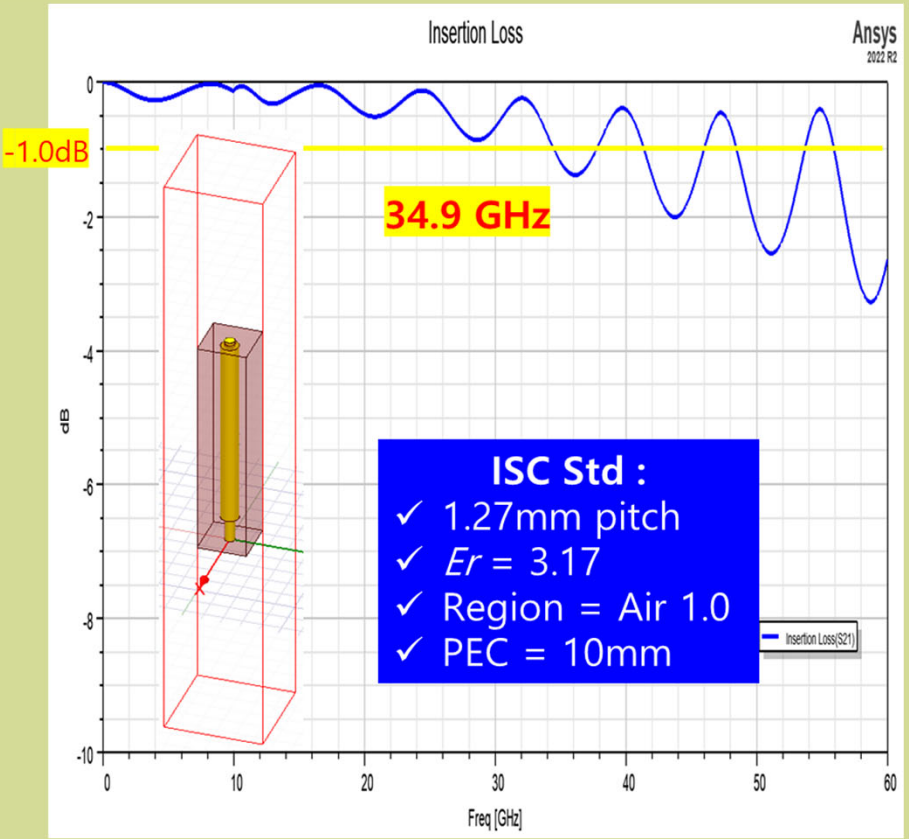
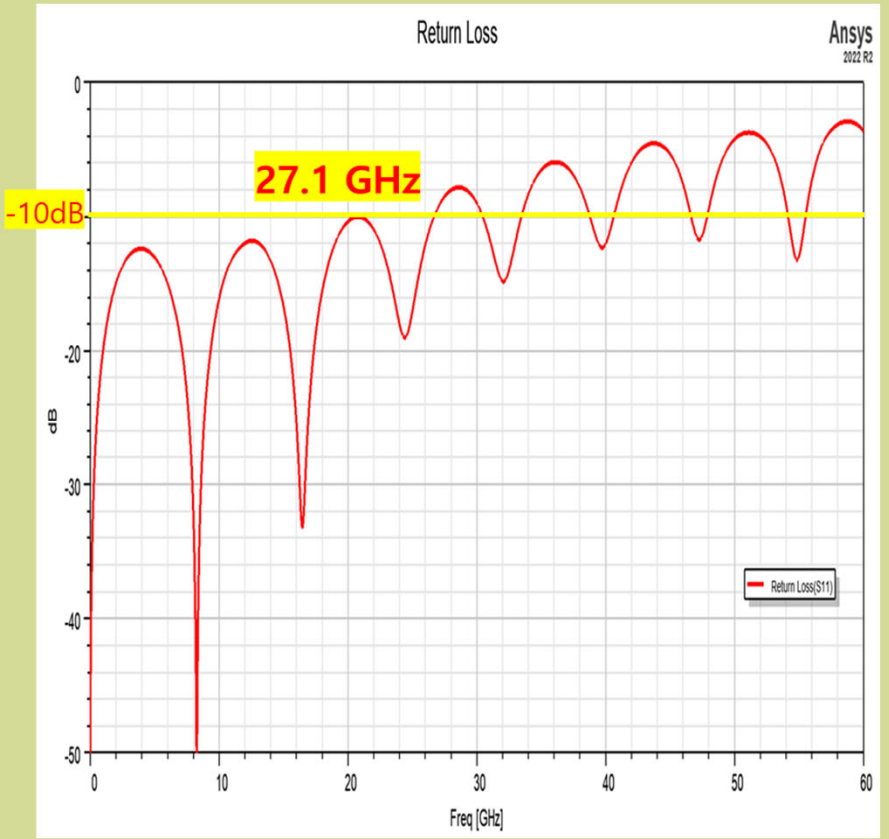
Example Data sheet





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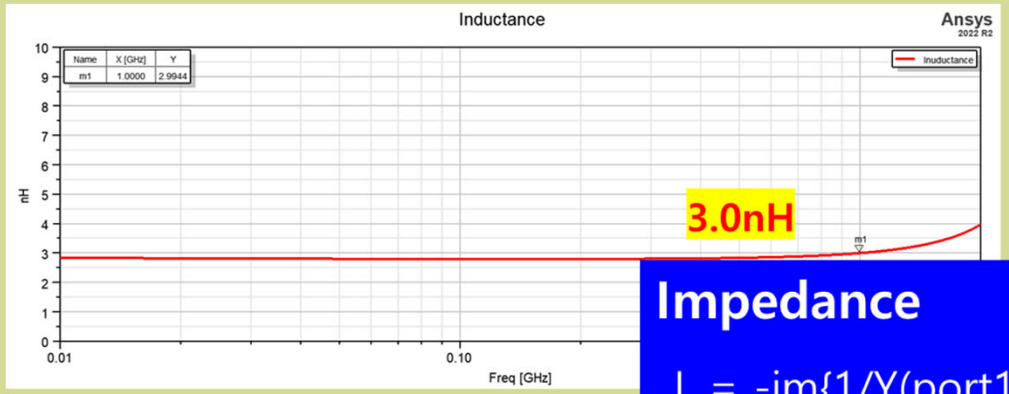
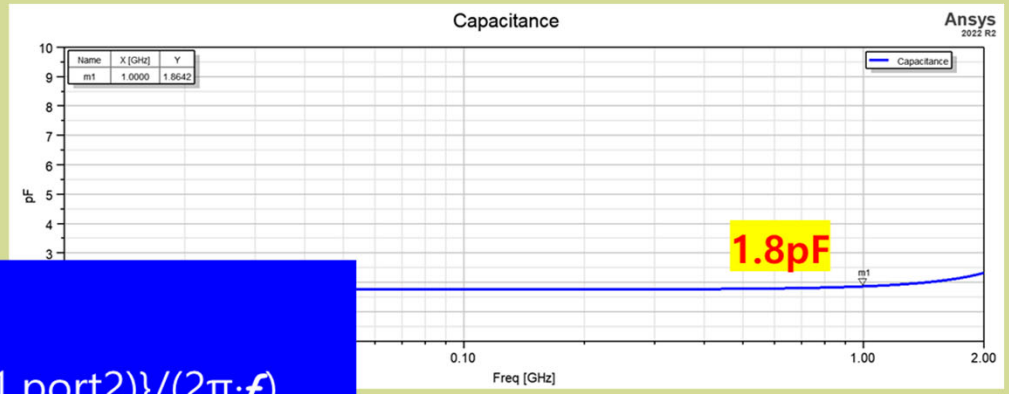
Example Data sheet



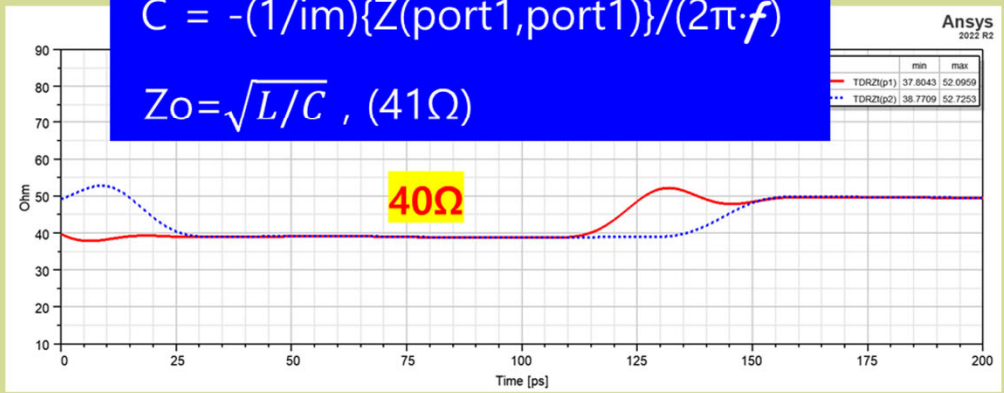


Impedance

L = -im{1/Y(port1,port2)}/(2π·*f*)

C = -(1/im){Z(port1,port1)}/(2π·*f*)

Zo=$\sqrt{L/C}$, (41Ω)



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Problem

Item		Vendor B		Remark
Dimension	OD0.9(0.5) * 13.7(1.8+10.1+1.8)mm			
Top Plunger	Hardened Beryllium copper / Au Plated			
Bottom Plunger	Hardened Beryllium copper / Au Plated			
Barrel	Brass / Au Plated			
Spring	Music Wire / Au Plated			
Work Force	45.0gf @ 2.00mm			
Full Travel	64.0gf @ 3.00mm			
Insertion loss (S21) @-1.0dB		**34.9 GHz**		
Return loss (S11) @-10.0dB		**27.1 GHz**		
Working Temp.	-40 ~ 120℃			

Problem

Item	Vendor A	Vendor B	Vendor C	Remark
Dimension	OD0.9(0.5) * 13.7(1.8+10.1+1.8)mm			all the same
Top Plunger	Hardened Beryllium copper / Au Plated			all the same
Bottom Plunger	Hardened Beryllium copper / Au Plated			all the same
Barrel	Brass / Au Plated			all the same
Spring	Music Wire / Au Plated			all the same
Work Force	45.0gf @ 2.00mm			all the same
Full Travel	64.0gf @ 3.00mm			all the same
Insertion loss (S21) @-1.0dB	**37.4 GHz**	**34.9 GHz**	**19.6 GHz**	**?**
Return loss (S11) @-10.0dB	**27.8 GHz**	**27.1 GHz**	**18.4 GHz**	**?**
Working Temp.	-40 ~ 120℃			all the same

Problem

Item	Vendor A	Vendor B	Vendor C	Remark
Insertion loss (S21)	37.4 GHz	34.9 GHz	19.6 GHz	
Return loss (S11)	26.5 GHz	27.1 GHz	18.4 GHz	

- Based on the data, Vendor A's value is the best.
- The pin length is 13mm. Is this 37.4GHz?
  Isn't FEA Simulation trick?
- But, choose Vendor A just by looking at the Numerical.
- Focus on competitively numeric, reducing trust in data!

Problem

- Customers require actual data

  - Is it possible to measure with general purpose measuring instruments (VNA, TDR, etc.) under the same conditions as actual use of ATE?

  - Is it possible to measure to obtain the same value as simulation?

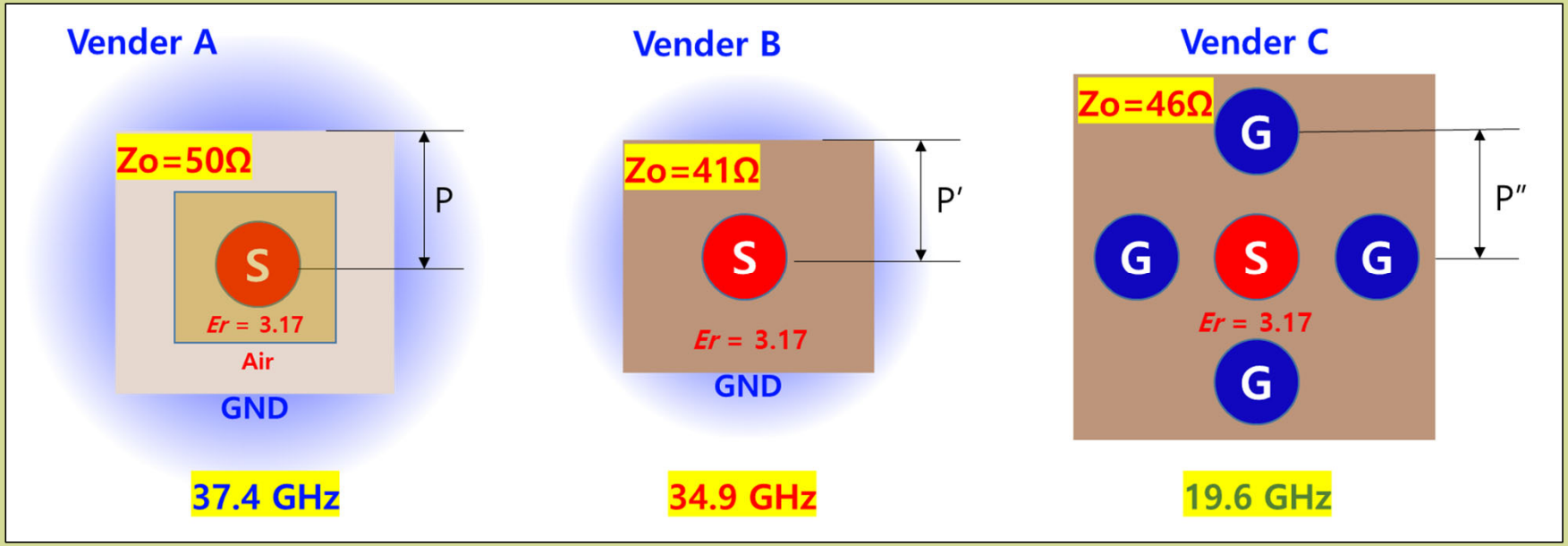
Cause, Optimal conditions

- Low Inductance : Signal length 11.7mm, Fixed
- Low Capacitance : Dielectric value of Housing & Pitch
- Impedance matching : 50Ω

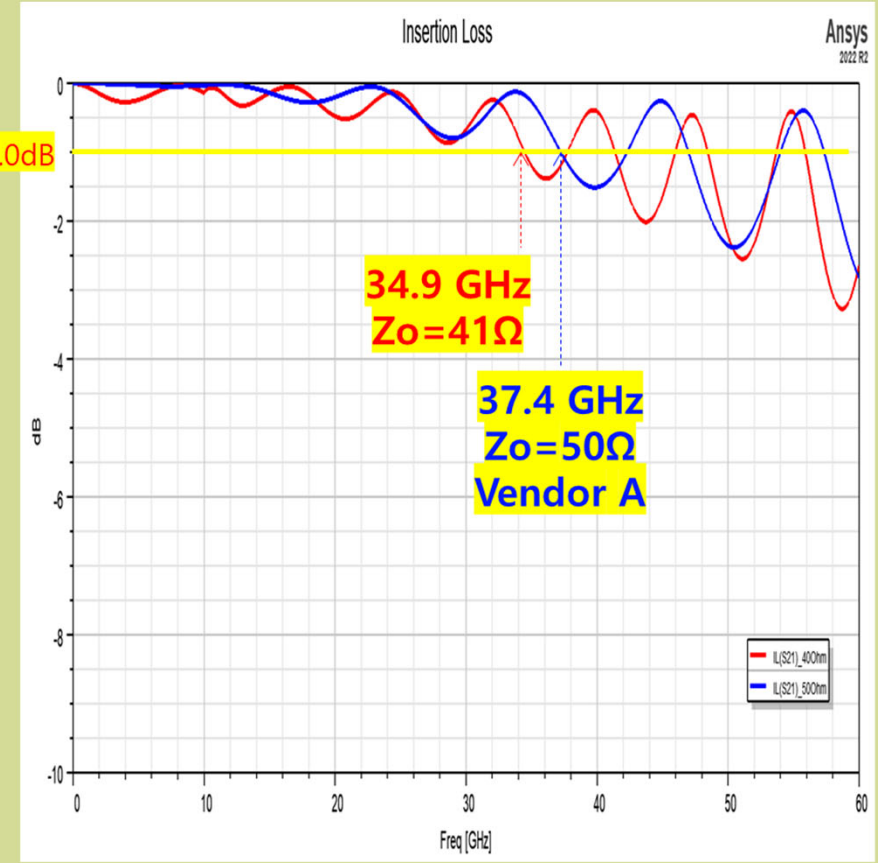
$$Zo(\Omega) = \frac{138}{\sqrt{Er}} log \frac{2P}{Pin\ O.D}$$

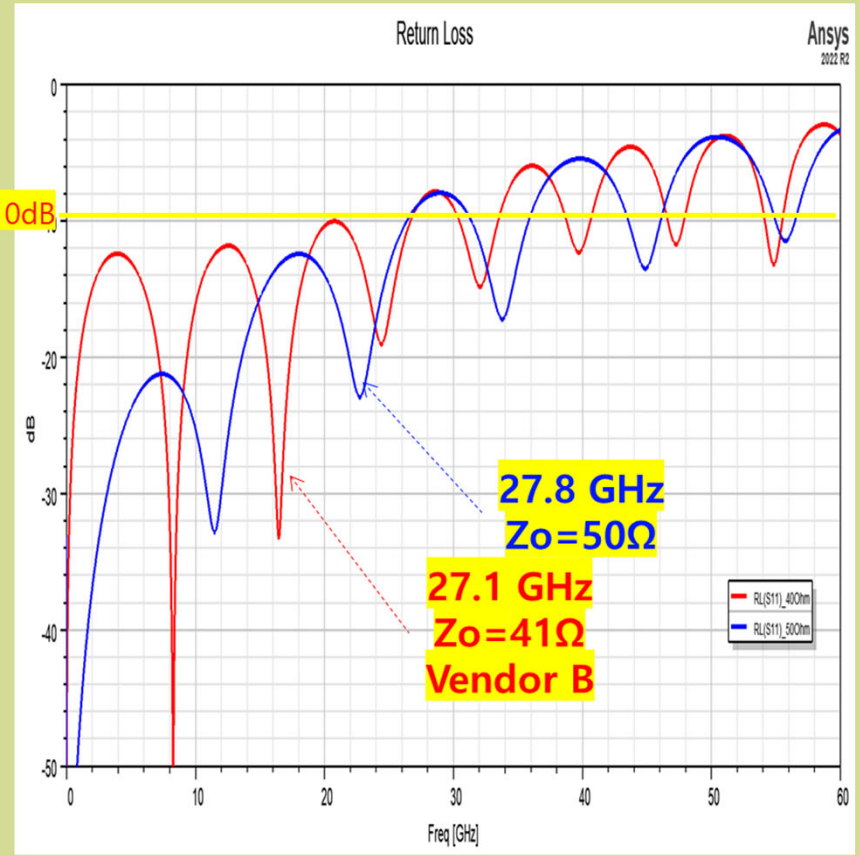
Cause, Optimal conditions

: Conditions are different when simulating for each vendor.



Comparative data between Vendor A and B





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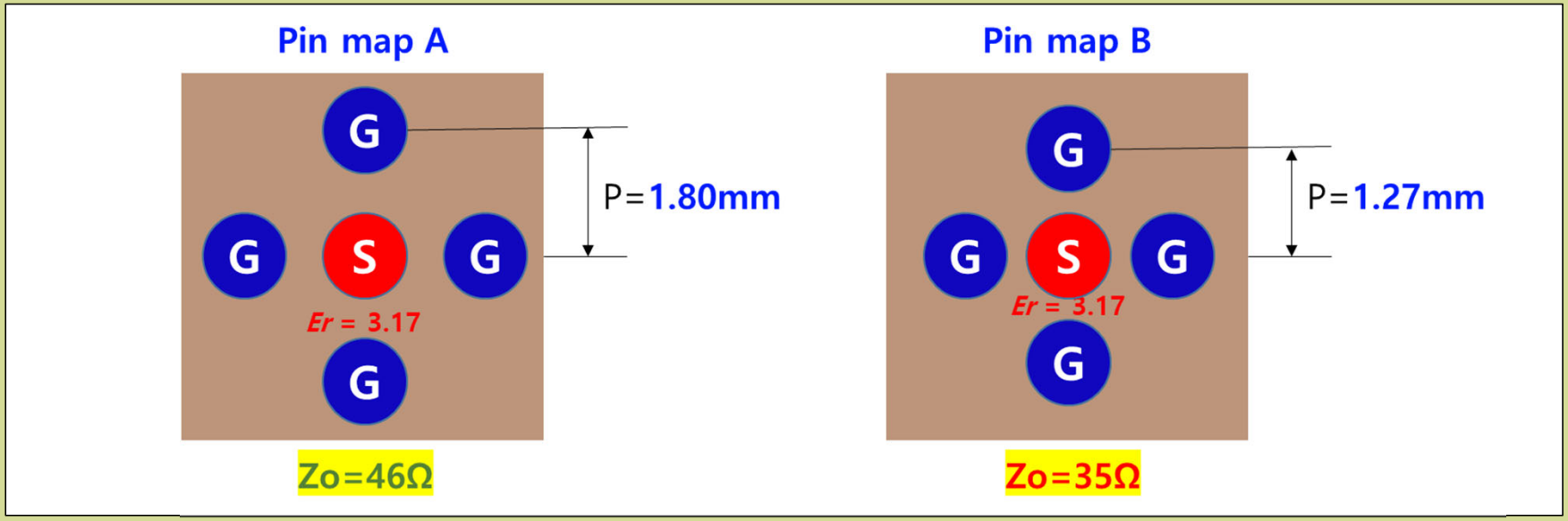
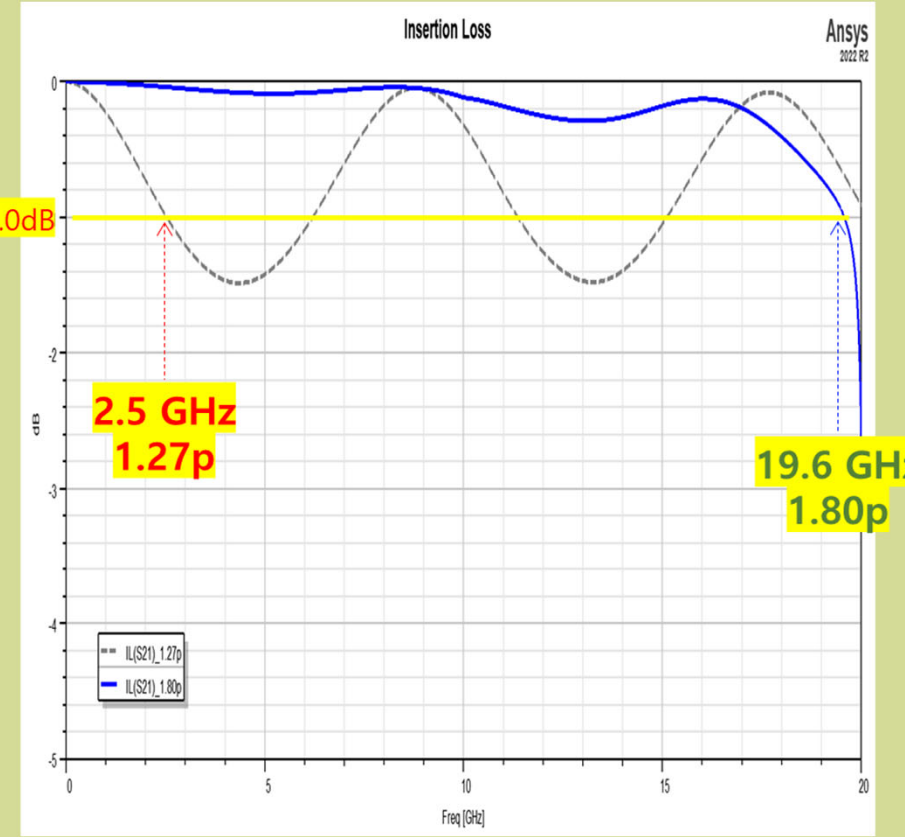
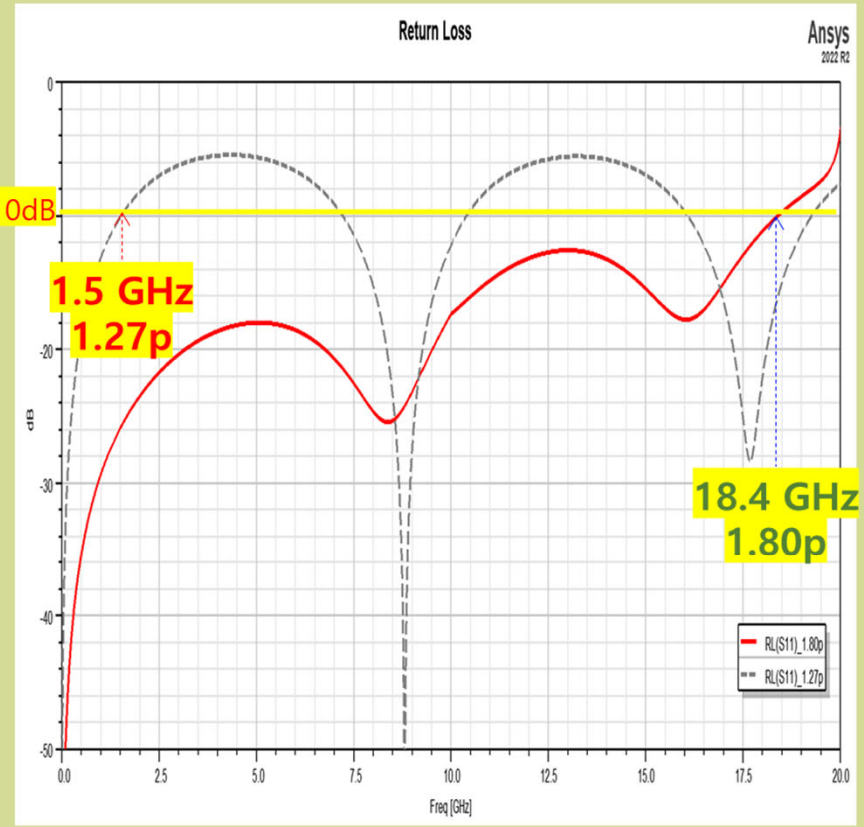
Cause, Optimal conditions

: Try changing the pitch in Vendor C's pin map.



Comparative data between Map A and B





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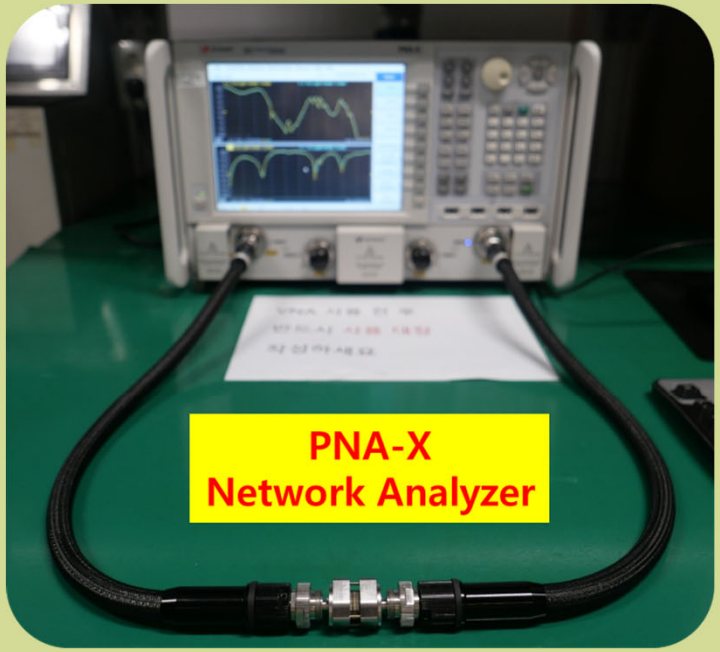
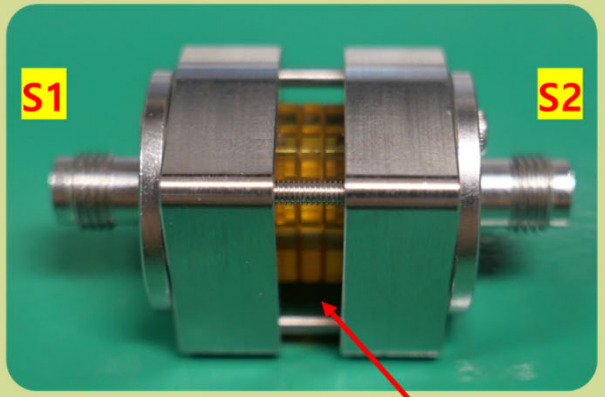
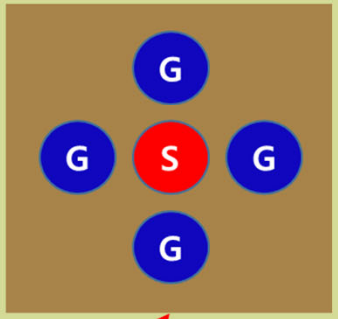
Cause, Optimal conditions

: Now, let's actually measure it!







Pogo Block
(Ultem1000)

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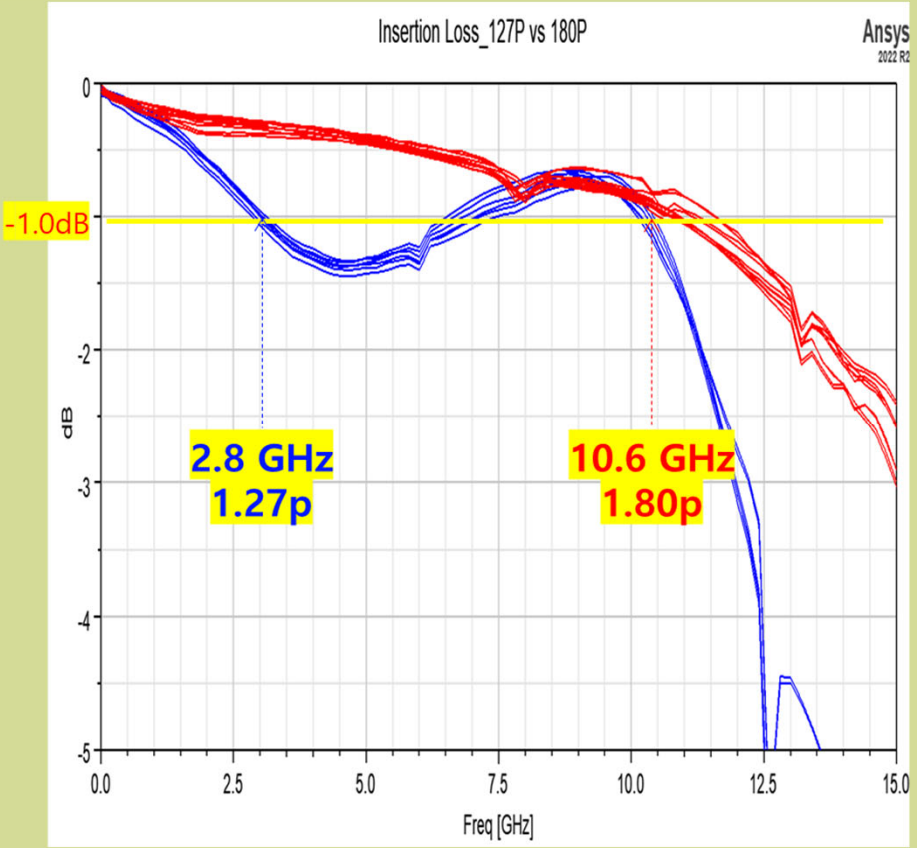
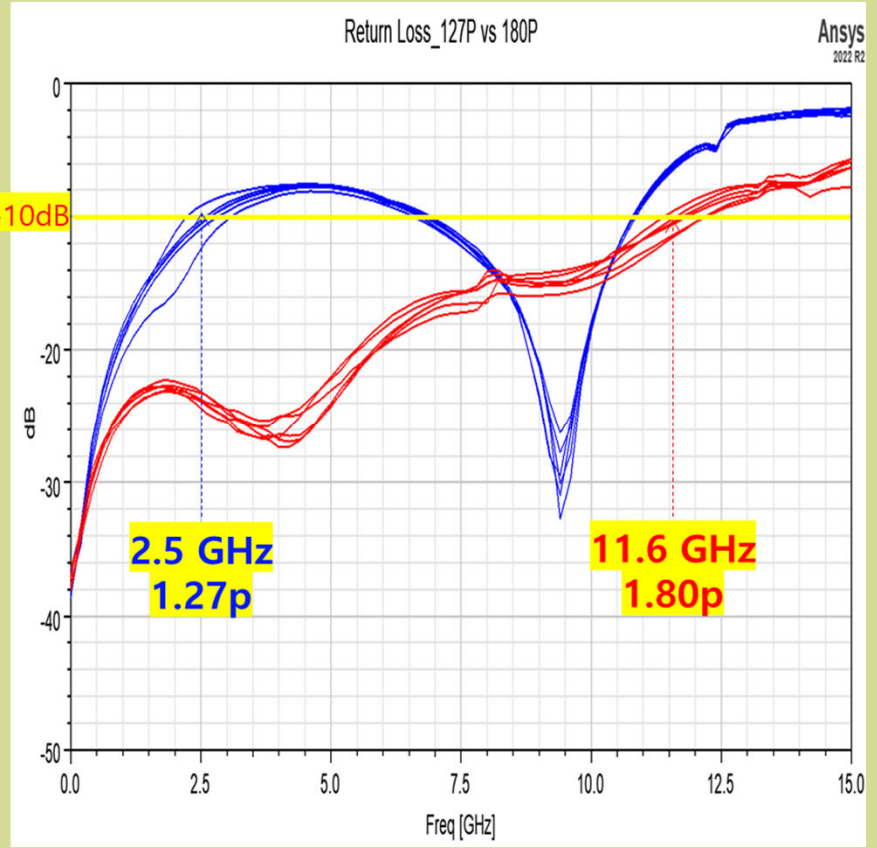
Measurement data (With In 2.4 Connector)





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Data summary

Case	Conditions	Insertion loss (S21) @-1.0dB	Return loss (S11) @-10.0dB	Remark
Vendor A	Force matching to Zo=50Ω	**37.4 GHz**	**27.8 GHz**	All same pogo Sample OD0.9*13.7L
Vendor B	Matching to pitch(ISC STD)	**34.9 GHz**	**27.1 GHz**	
Pin map A	Surround GND:1.80mm Pitch	**19.6 GHz**	**18.4 GHz**	
Pin map B	Surround GND:1.27mm Pitch	**2.5 GHz**	**1.5 GHz**	
Measure 1	JIG+2.4Conn:1.80mm Pitch	**10.6 GHz**	**11.6 GHz**	
Measure 2	JIG+2.4Conn:1.27mm Pitch	**2.8 GHz**	**2.5 GHz**	

Bandwidth is wide and diverse, from 1.5GHz to 37.4 GHz.

Need for standardization

- High-frequency characteristics cannot be determined solely by the contactor's appearance.
- Shorter contactors are good, but housing material matters.
- Match characteristic impedance; it's vital.
- **Therefore:**

  - Contactor-only suppliers, clarify data conditions.

  - Users, mind housing conditions, not just SP Numeric.

Discussion & Conclusion

- 13mm Pogo 37.4GHz, Isn't Simulation trick? : Not trick
- Is it possible to measure with VNA measuring instruments under the same conditions as actual use of ATE? : Challenging…
- Is it possible to measure to obtain the same value as simulation? : Possible
- Recognized international standardization for FEA and measurements is needed.

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