



High Frequency and High Speed Connector Design for 5G Applications

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- This work was supported in parts by [Harumoto Giken Co.](#)

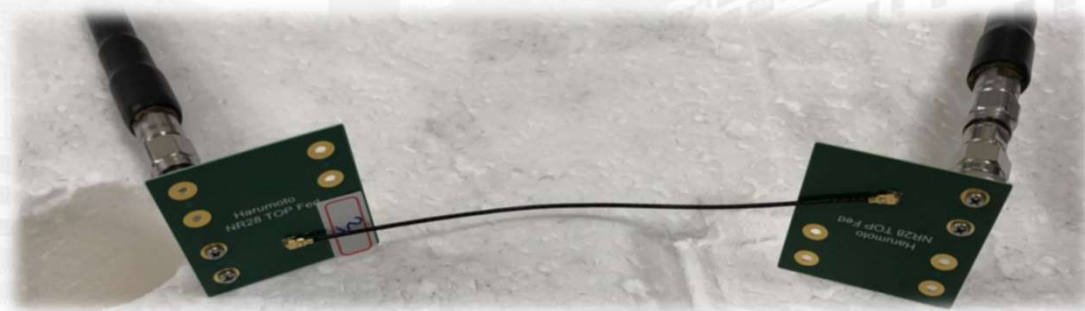
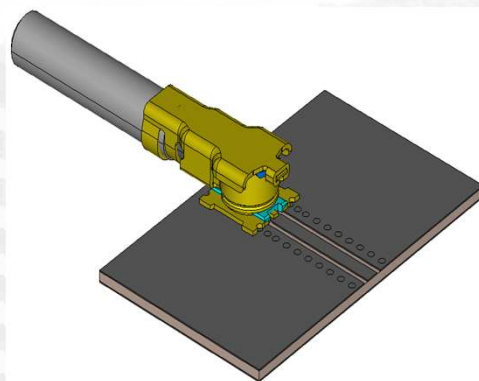


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High Frequency Connector Design

- One of the critical issues at mmWave frequencies is significant loss.
- A rotary type RF wire-to-board connector with an ultra-low loss cable is designed to provide low-loss jump wire solutions with a bandwidth from DC to 45GHz.



RF Jump Wire Applications

- This rotary RF jump wire may provide **ultra-low loss connection solutions** for 5G mobile and base station devices, radar systems, satellite modules, etc.



5G Mobile Device



NOKIA



Massive MIMO



60GHz Radar



Satellite Communications

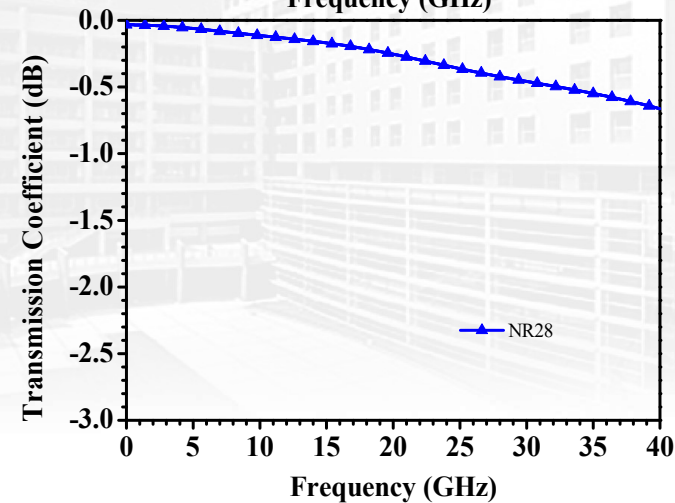
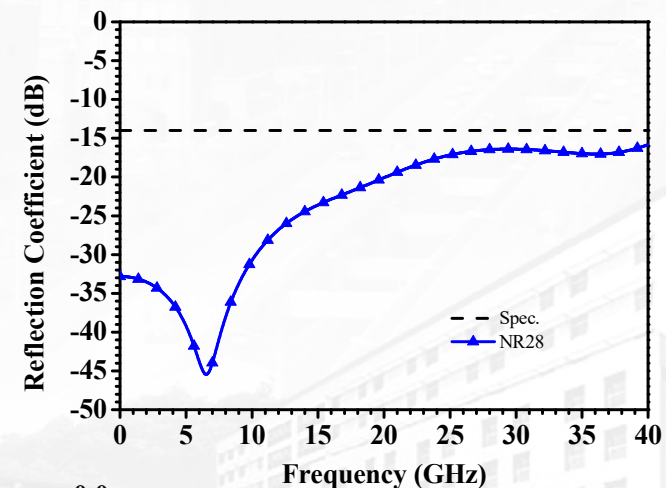
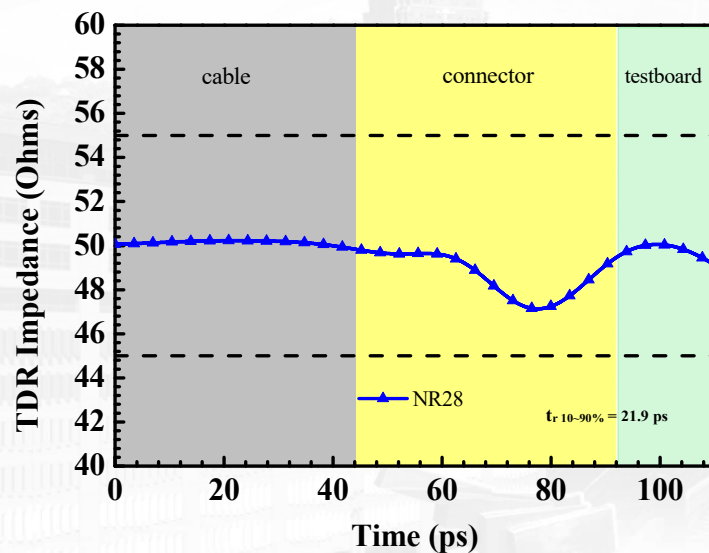
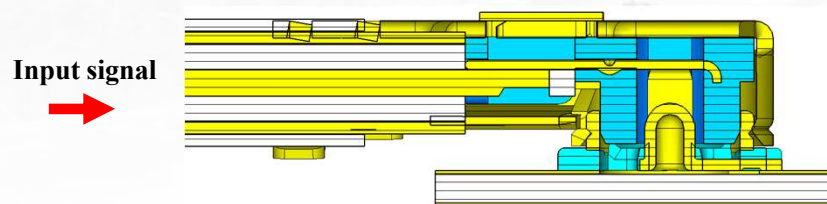


Starlink

<https://www.quora.com/How-does-Elon-Musks-Starlink-work-Will-I-be-able-to-have-service-and-wifi-anywhere>

RFIT 2021 NR28 Rotary Wire-to-Board RF Connector

● Simulated NR28 jump wire connectors



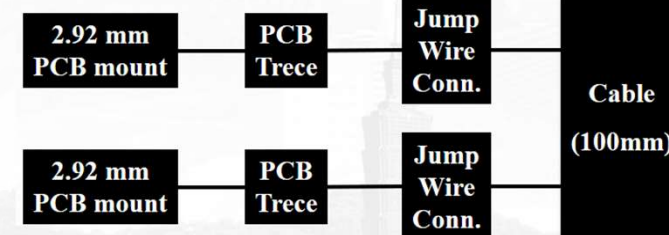
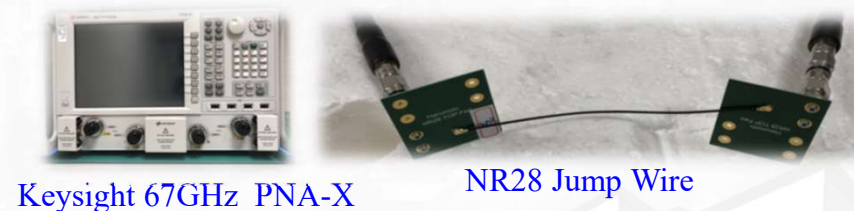
➤ NR28 RF jump wire for Ka band applications.

Jump Wire Measurements (1/2)

● Measurements of the jump wire:

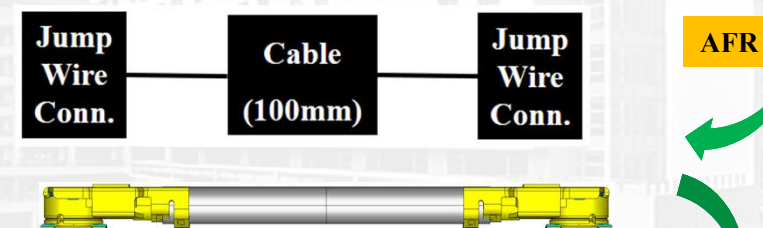
Step 1 – Measure with 67GHz Network Analyzer

- ✓ Include a pair of the NR28 RF connectors with the PCB, a pair of the 2.92mm PCB mount connectors and a 10cm long cable with an outer diameter of 0.81mm.



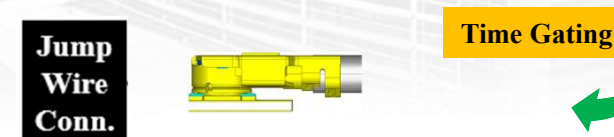
Step 2 – Process with PLTS AFR

- ✓ Use Keysight PLTS Automatic Fixture Removal (AFR) to remove the effects of the test boards and 2.92mm PCB mount connectors.



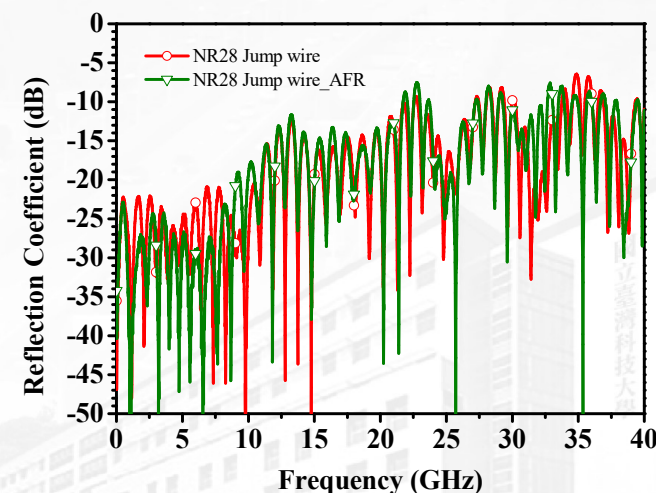
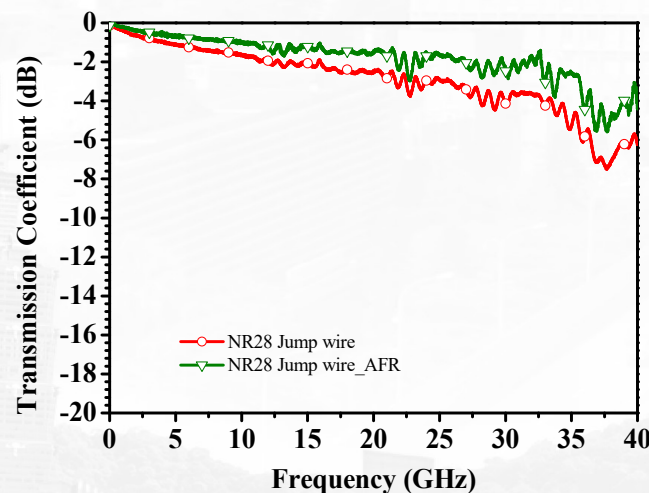
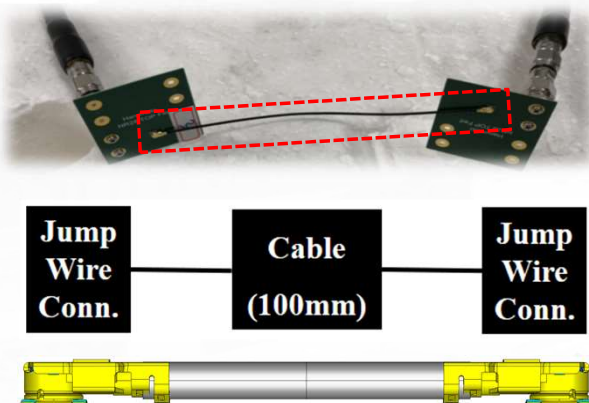
Step 3 – Process with PLTS Time Gating

- ✓ Apply Keysight PLTS Time Gating to extract results for a single RF connector.



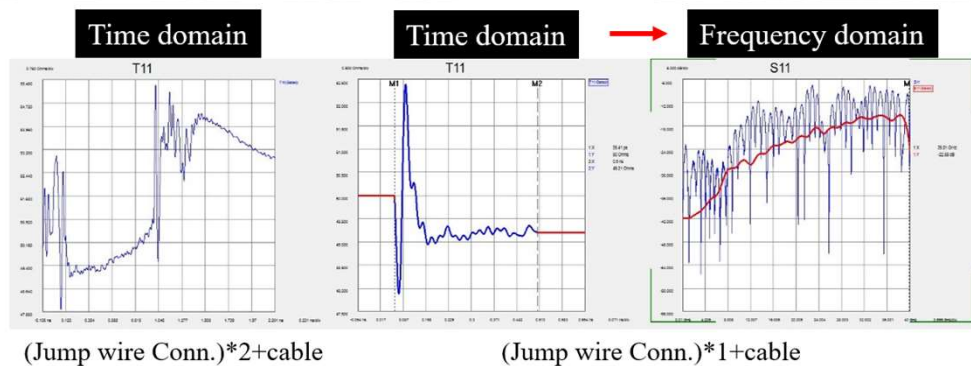
Jump Wire Measurements (2/2)

AFR

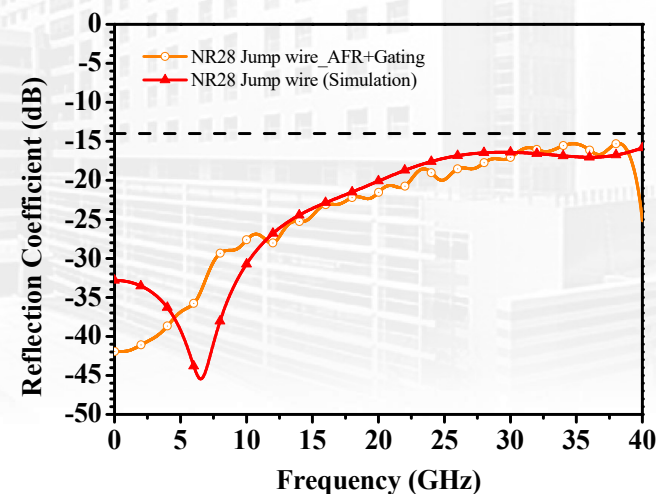
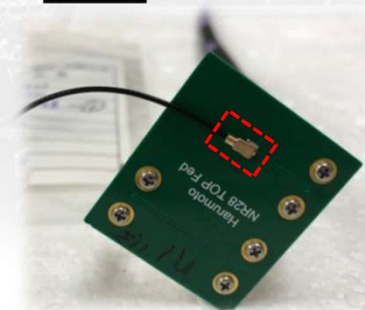
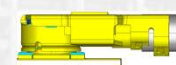


- NR28 jump wire with a 10cm long cable having an outer diameter of 0.81mm.

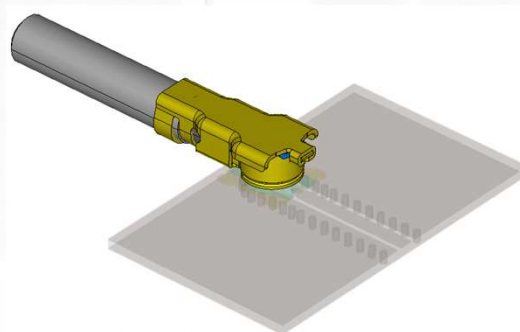
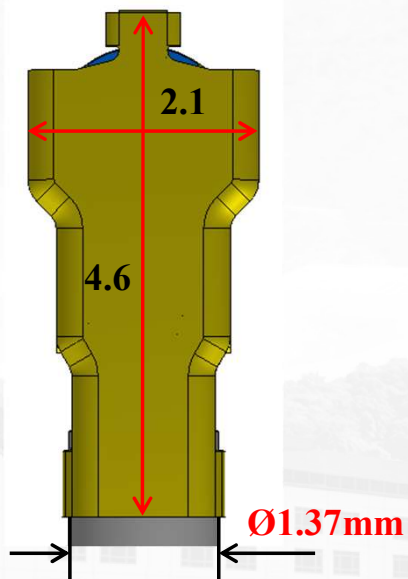
Time Gating



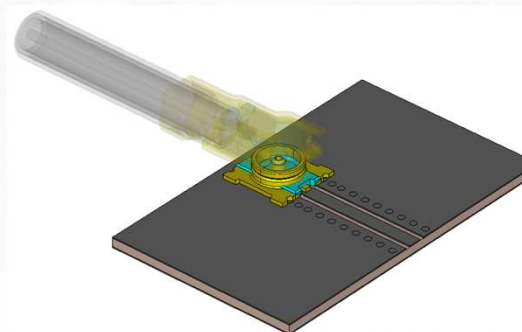
Jump Wire Conn.



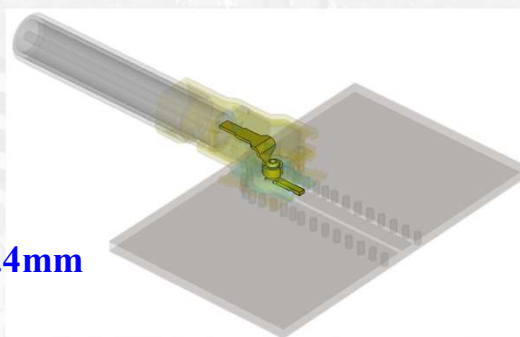
NR45 Rotary Wire-to-Board RF Connector (1/2)



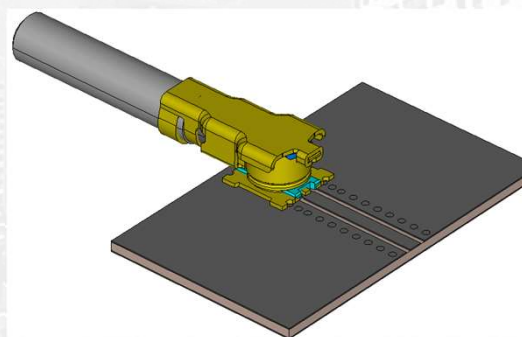
(a) Plug



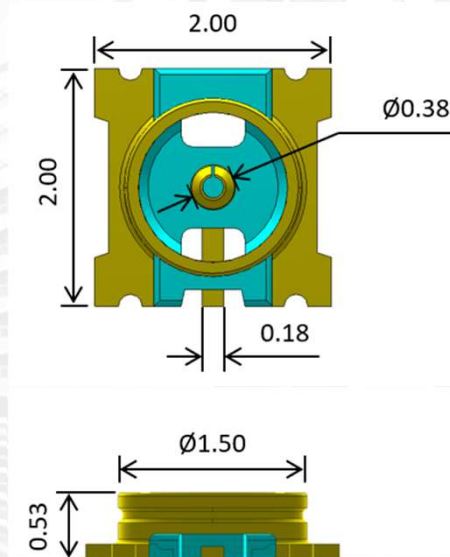
(b) Receptacle



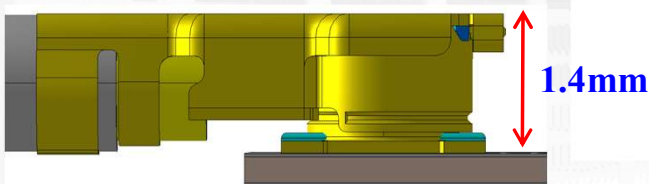
(c) Rotary joint



(d) Plug in



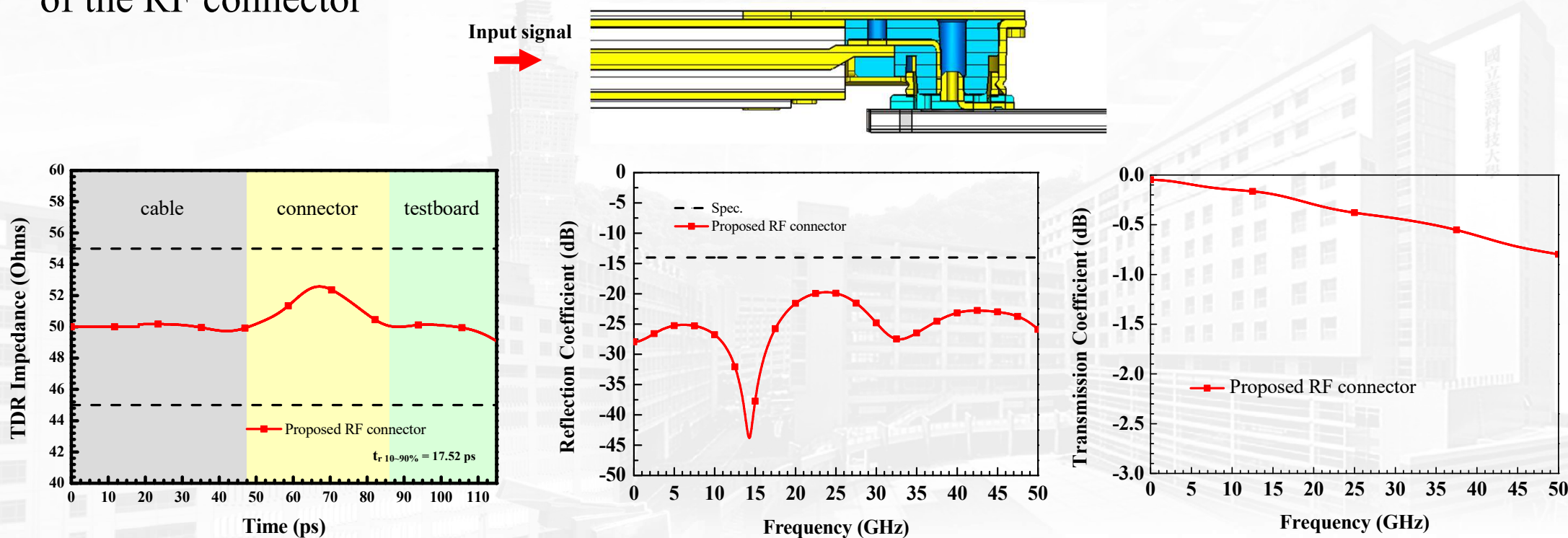
unit : mm



$4.6(L) \times 2.1(W) \times 1.4(T) \text{ mm}^3$

RFIT 2021 NR45 Rotary Wire-to-Board RF Connector (2/2)

- Simulated TDR impedance, reflection and transmission coefficients of the RF connector

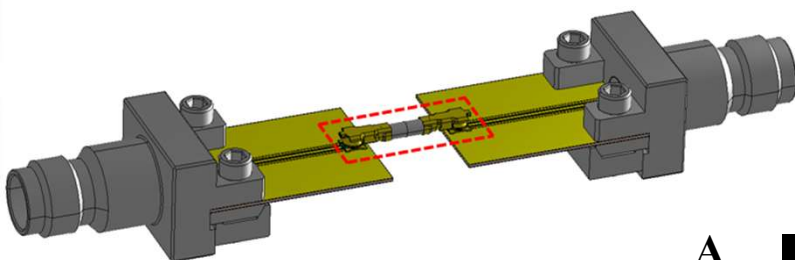


➤ Some samples will be manufactured and measured for verifications in this September.

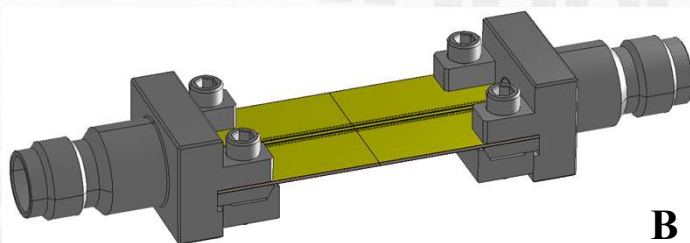
NR45 Jump Wire v.s. PCB Lines

✓ Path Loss

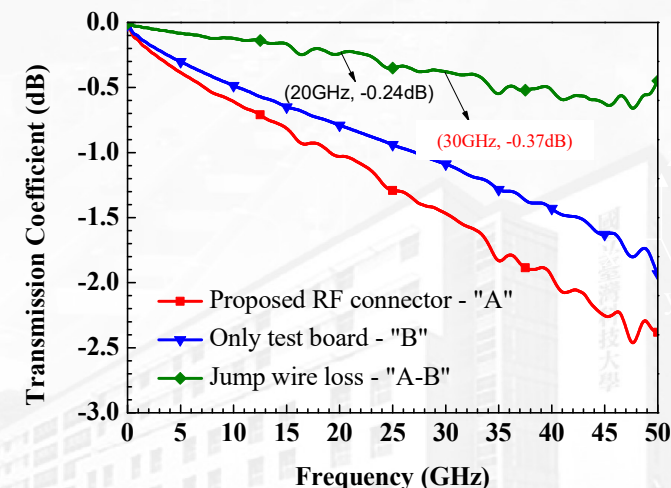
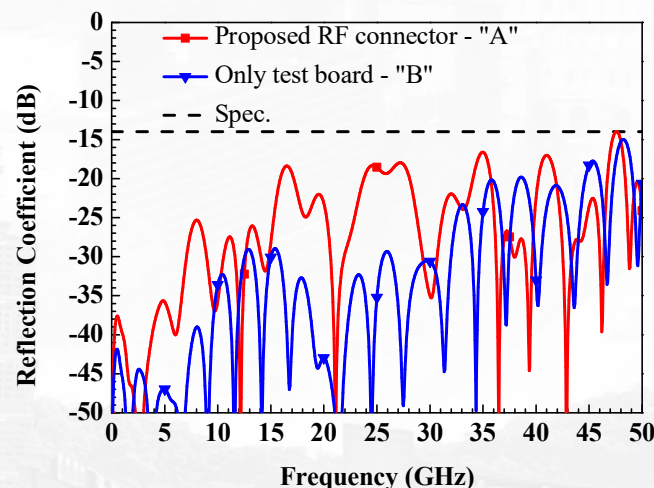
$$\approx \text{Conn. Loss(dB)} + \text{Cable Loss(dB/cm)} \times \text{Length(cm)}$$



(a) Jump wire with a test board



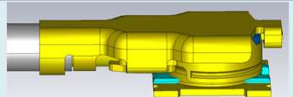
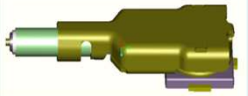
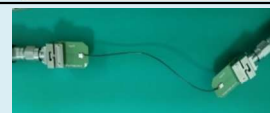
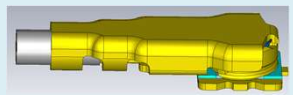
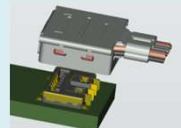
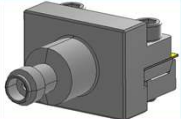
(b) Only the test board



OD1.37mm Cable Loss	
Frequency	Measured Insertion Loss
10 GHz	0.040 dB/cm
20 GHz	0.057 dB/cm
26.5 GHz	0.069 dB/cm
30 GHz	0.073 dB/cm
35 GHz	0.082 dB/cm
40 GHz	0.088 dB/cm
45 GHz	0.096 dB/cm
50 GHz	0.102 dB/cm

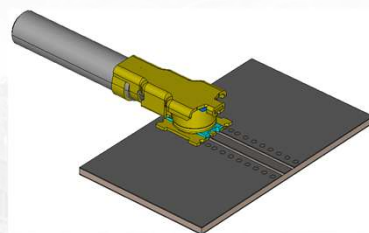
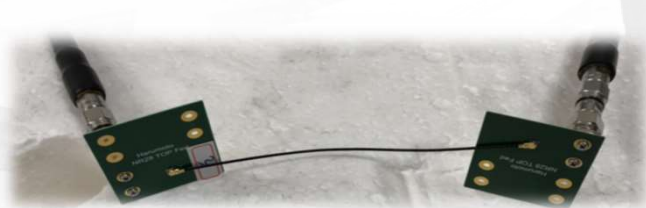
Connection	20 GHz	30 GHz
NR45 Jump Wire (Simulations)	0.81 dB/10cm	1.10 dB/10cm
Stripline (Simulations)	1.83 dB/10cm	2.44 dB/10cm
Microstrip Line with ENIG (Measurements) [3]	4.18 dB/10cm	5.41 dB/10cm
GCPW with ENIG (Measurements) [3]	6.02 dB/10cm	7.75 dB/10cm

RF Connectors for mmWave and Sub-Terahertz Applications

Connector Type	Frequency	Note
 NR15/28/45 Rotary Type RF Connectors	25/40/60GHz	Mating Height = 1.40mm
 NR80 Rotary Type RF Connector	90GHz	Mating Height = 1.00mm
 C100 Clamshell Type RF Connector	67/100GHz	Mating Height = 0.70mm
 NR150 RF Connector	150GHz	Mating Height = 0.70mm
 RF WTB Connector P0.35 / H1.6mm	20~67GHz	Working Space 4.4x5.3x1.6 Mating High = 1.7mm
 RF Probe	45/90GHz	For RF PCBA Tester
 2.92/2.4/1.85/1.0mm End-Launch Connectors	40/50/67/110GHz	Robust, Reusable and Repairable

ACKNOWLEDGEMENTS

- The ultra-low loss rotary type RF wire-to-board connector design was supported in parts by Harumoto Giken Co., Taipei, Taiwan.
- 本報告僅保留春源部分，他廠的篇幅由於未獲得發表許可，故予以刪除。



Thank You