

# **200 Gb/s PAM4 Channel Sweep Designs for “Near Package Connector (NPC) KR Cabled Backplane” and “C2C with 1 Connector” Topologies**

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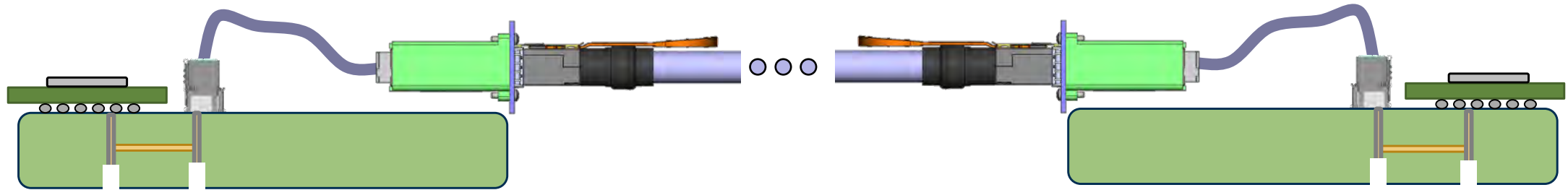
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- ❑ Modeling details
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- ❑ TP0-TP5 loss
- ❑ Die to Die (D2D) loss

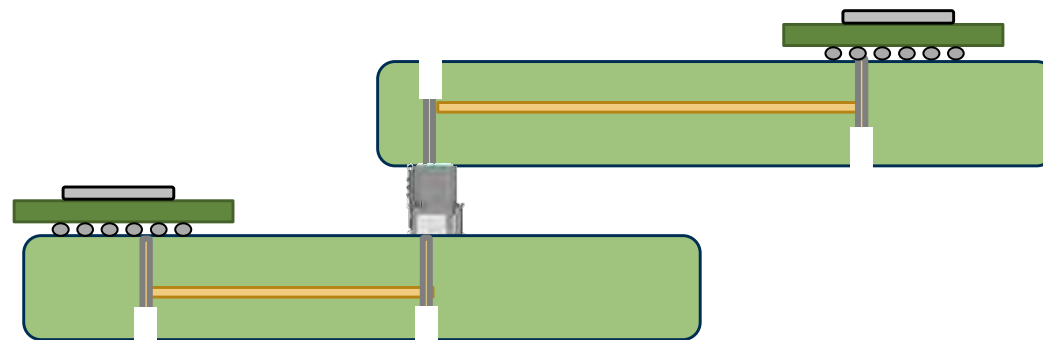
# 200 Gb/s PAM4 Channel Topologies

Length variations provide an amalgamation of products with a range of losses

## KR NPC Cabled Backplane

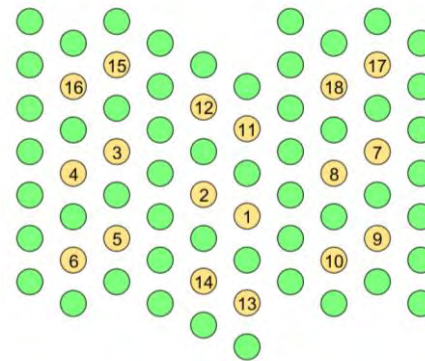
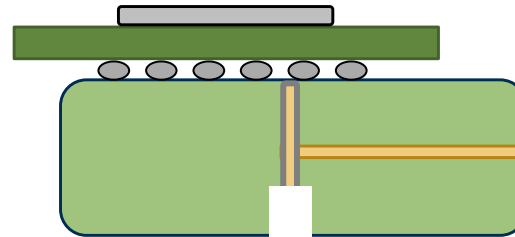


## Chip to Chip (C2C) Mezzanine



# BGA Ball Out\*

Used pin out for 224 G published at DesignCon 2022

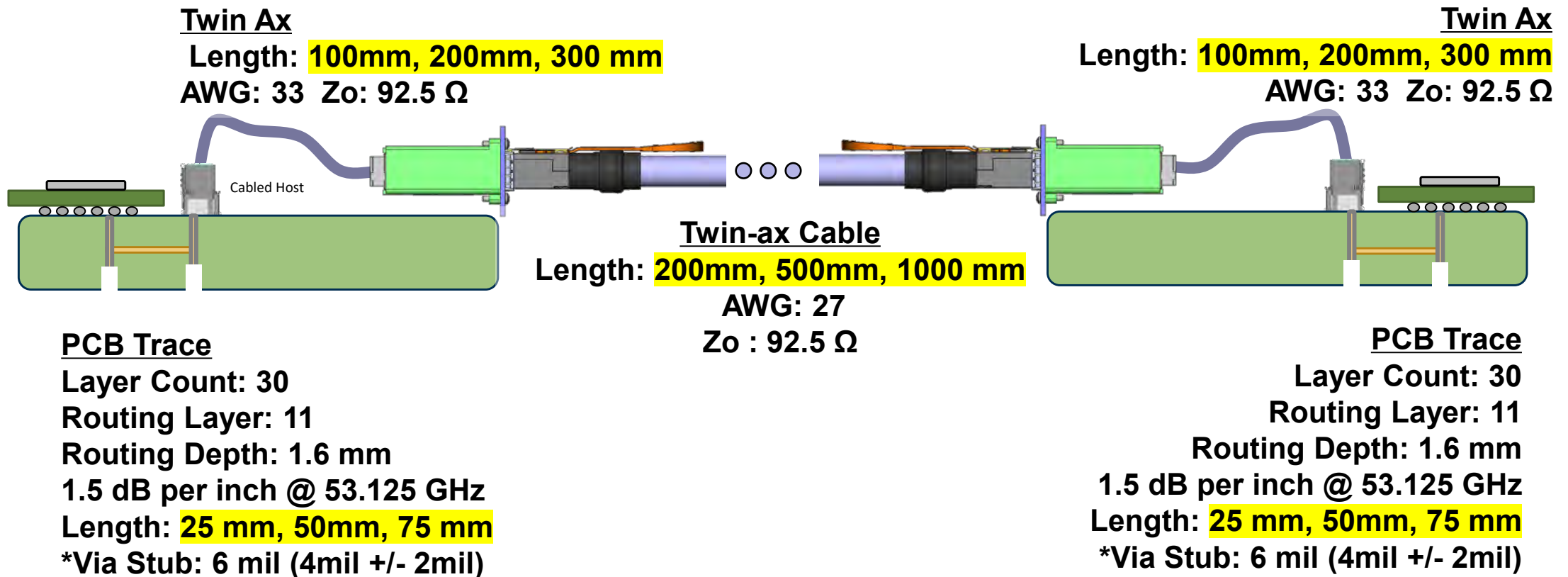


1 mm ball pitch

\* “ 224Gbps-PAM4 End-to-End Channel Solutions for High-Density Networking System ”  
J X Jiang, M P Li, E Milligan, Y L Ong, J Medina, Q Ding, H Wu, M Shimanouchi, K Aygun, S Litski, S Mada,  
DesignCon 2022, page 13

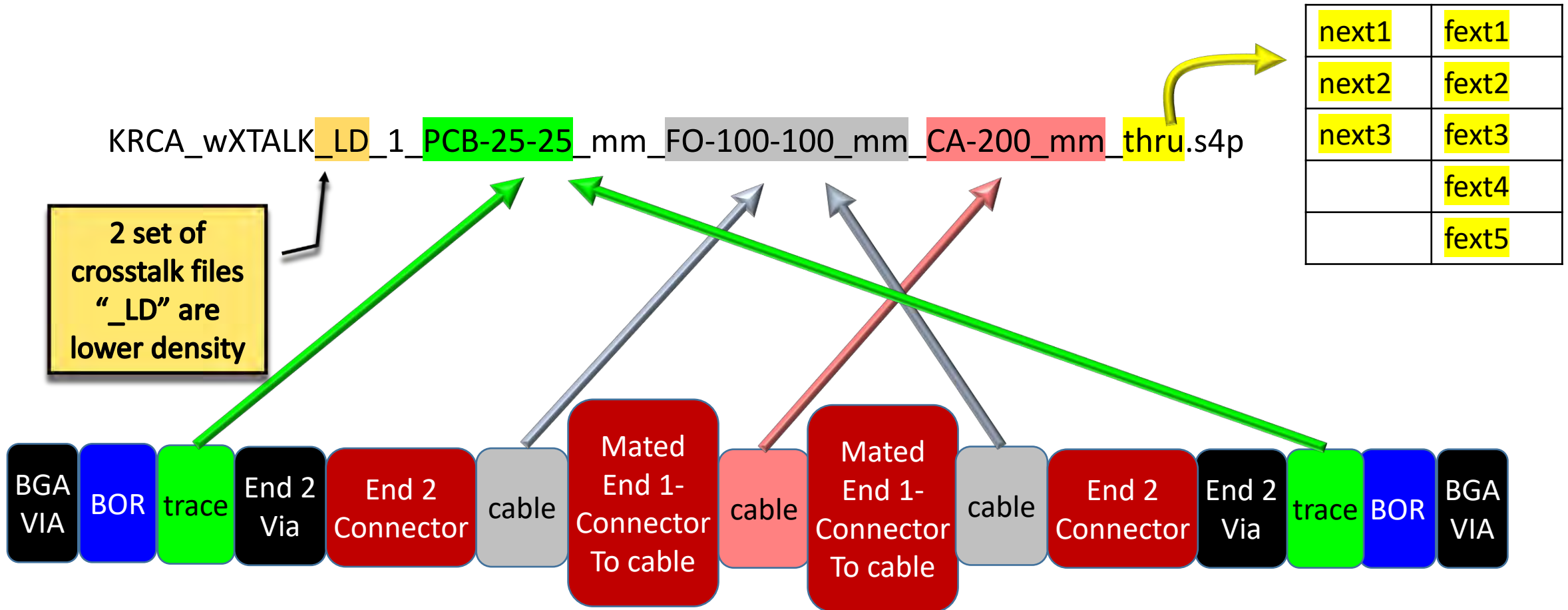
# KR Cabled TP0 to TP5 topology

Flyover Cabled Line Cards with Cabled Backplane



*\*Via structures include actual breakout and escape routing.*

# KR Channel List Key for Tp0-Tp5



# KR Channel List (thru) for Tp0-Tp5

KRCA\_wXTALK\_1\_PCB-25-25\_mm\_FO-100-100\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_2\_PCB-50-50\_mm\_FO-100-100\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_3\_PCB-75-75\_mm\_FO-100-100\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_4\_PCB-25-25\_mm\_FO-200-200\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_5\_PCB-50-50\_mm\_FO-200-200\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_6\_PCB-75-75\_mm\_FO-200-200\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_7\_PCB-25-25\_mm\_FO-300-300\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_8\_PCB-50-50\_mm\_FO-300-300\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_9\_PCB-75-75\_mm\_FO-300-300\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_10\_PCB-25-25\_mm\_FO-100-100\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_11\_PCB-50-50\_mm\_FO-100-100\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_12\_PCB-75-75\_mm\_FO-100-100\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_13\_PCB-25-25\_mm\_FO-200-200\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_14\_PCB-50-50\_mm\_FO-200-200\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_15\_PCB-75-75\_mm\_FO-200-200\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_16\_PCB-25-25\_mm\_FO-300-300\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_17\_PCB-50-50\_mm\_FO-300-300\_mm\_CA-500\_mm\_thru.s4p

KRCA\_wXTALK\_18\_PCB-75-75\_mm\_FO-300-300\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_19\_PCB-25-25\_mm\_FO-100-100\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_20\_PCB-50-50\_mm\_FO-100-100\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_21\_PCB-75-75\_mm\_FO-100-100\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_22\_PCB-25-25\_mm\_FO-200-200\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_23\_PCB-50-50\_mm\_FO-200-200\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_24\_PCB-75-75\_mm\_FO-200-200\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_25\_PCB-25-25\_mm\_FO-300-300\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_26\_PCB-50-50\_mm\_FO-300-300\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_27\_PCB-75-75\_mm\_FO-300-300\_mm\_CA-1000\_mm\_thru.s4p

# KR Channel List LD (thru) for Tp0-Tp5

## Crosstalk for a Lower Density

KRCA\_wXTALK\_LD\_1\_PCB-25-25\_mm\_FO-100-100\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_2\_PCB-50-50\_mm\_FO-100-100\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_3\_PCB-75-75\_mm\_FO-100-100\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_4\_PCB-25-25\_mm\_FO-200-200\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_5\_PCB-50-50\_mm\_FO-200-200\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_6\_PCB-75-75\_mm\_FO-200-200\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_7\_PCB-25-25\_mm\_FO-300-300\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_8\_PCB-50-50\_mm\_FO-300-300\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_9\_PCB-75-75\_mm\_FO-300-300\_mm\_CA-200\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_10\_PCB-25-25\_mm\_FO-100-100\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_11\_PCB-50-50\_mm\_FO-100-100\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_12\_PCB-75-75\_mm\_FO-100-100\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_13\_PCB-25-25\_mm\_FO-200-200\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_14\_PCB-50-50\_mm\_FO-200-200\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_15\_PCB-75-75\_mm\_FO-200-200\_mm\_CA-500\_mm\_thru.s4p

KRCA\_wXTALK\_LD\_16\_PCB-25-25\_mm\_FO-300-300\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_17\_PCB-50-50\_mm\_FO-300-300\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_18\_PCB-75-75\_mm\_FO-300-300\_mm\_CA-500\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_19\_PCB-25-25\_mm\_FO-100-100\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_20\_PCB-50-50\_mm\_FO-100-100\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_21\_PCB-75-75\_mm\_FO-100-100\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_22\_PCB-25-25\_mm\_FO-200-200\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_23\_PCB-50-50\_mm\_FO-200-200\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_24\_PCB-75-75\_mm\_FO-200-200\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_25\_PCB-25-25\_mm\_FO-300-300\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_26\_PCB-50-50\_mm\_FO-300-300\_mm\_CA-1000\_mm\_thru.s4p  
KRCA\_wXTALK\_LD\_27\_PCB-75-75\_mm\_FO-300-300\_mm\_CA-1000\_mm\_thru.s4p

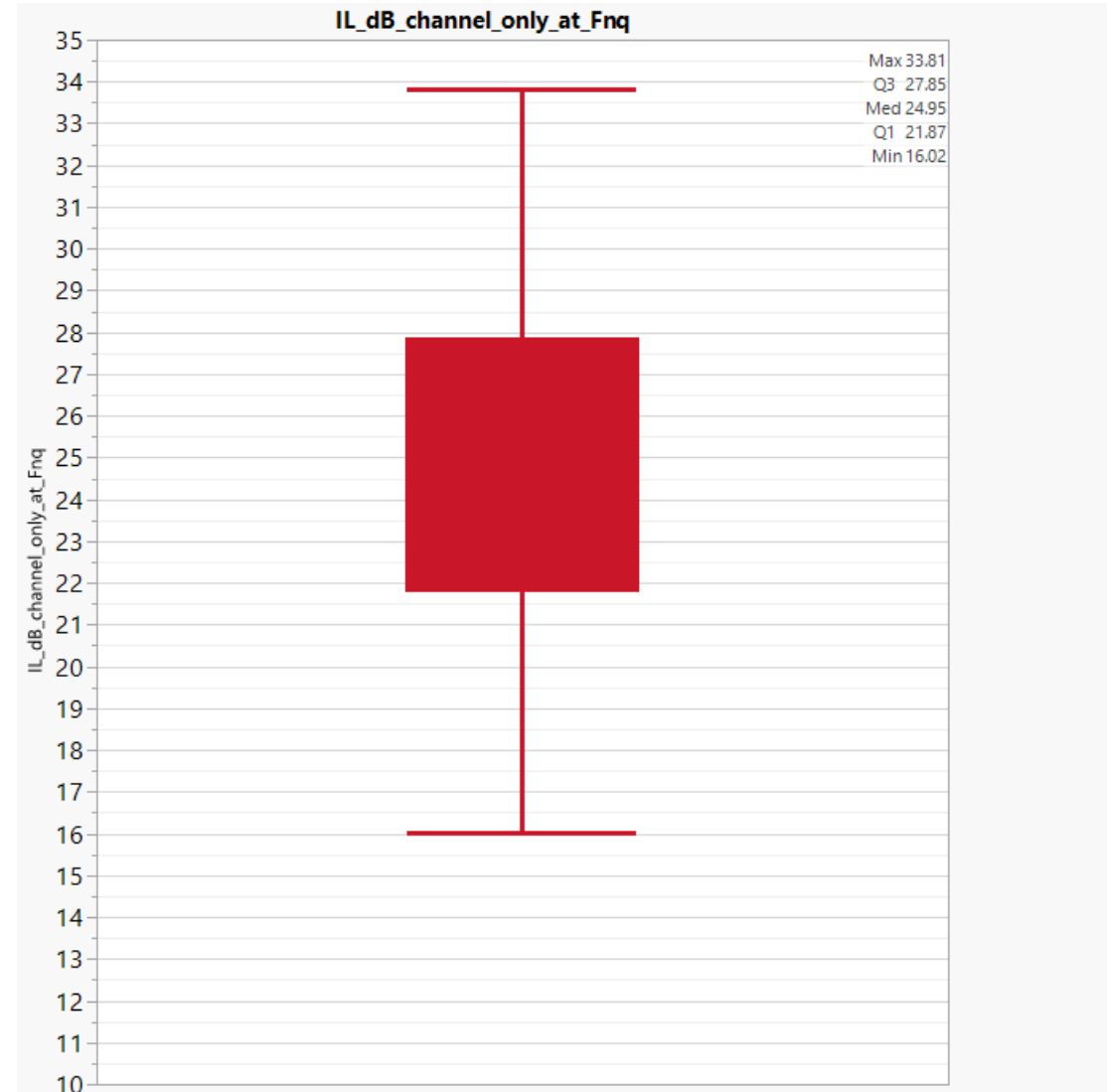
- Lower density (LD) are pin and path allocations
- All other geometries and IL thru loss are the same as previous page



# KR Cabled Backplane loss vs channel (TP0 - TP5)

IL Range: 16.2 dB to 33.8 dB

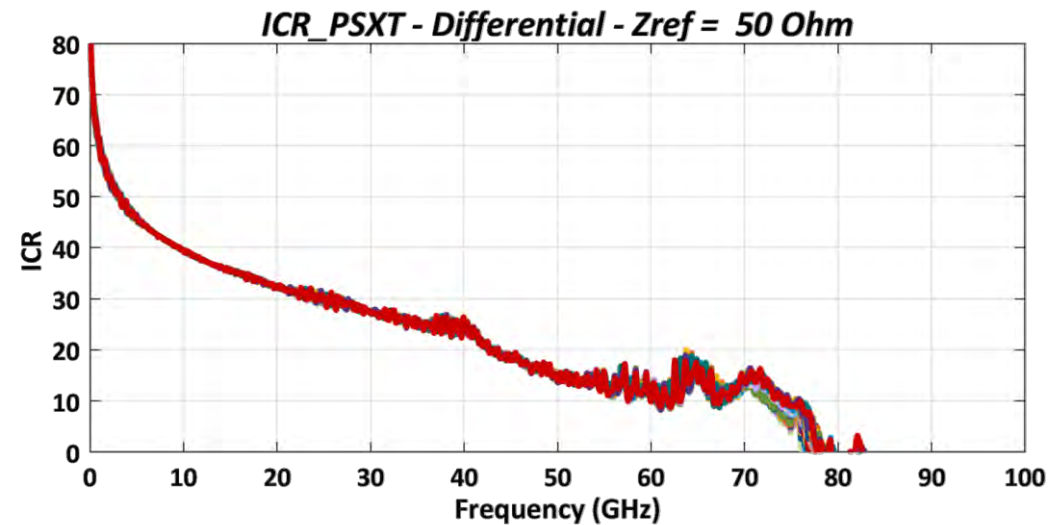
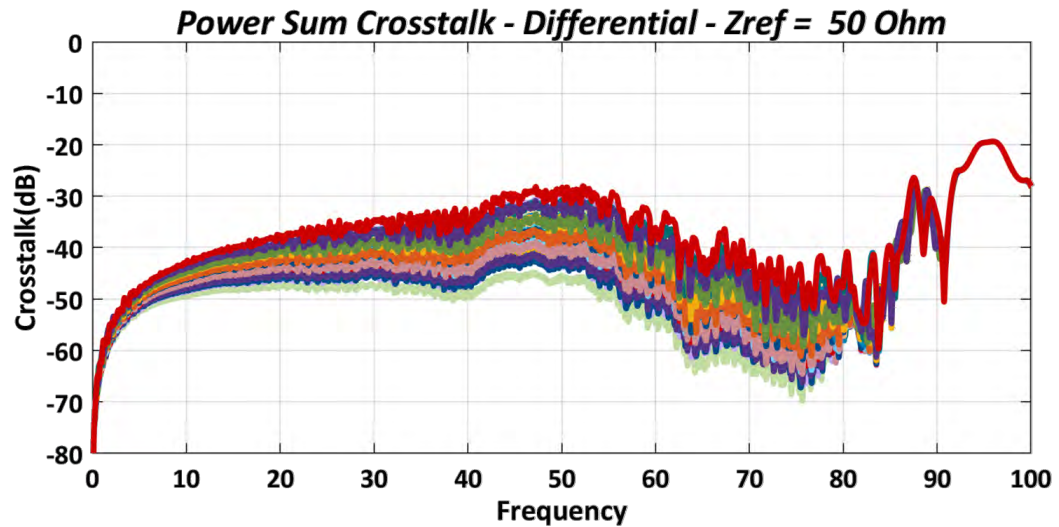
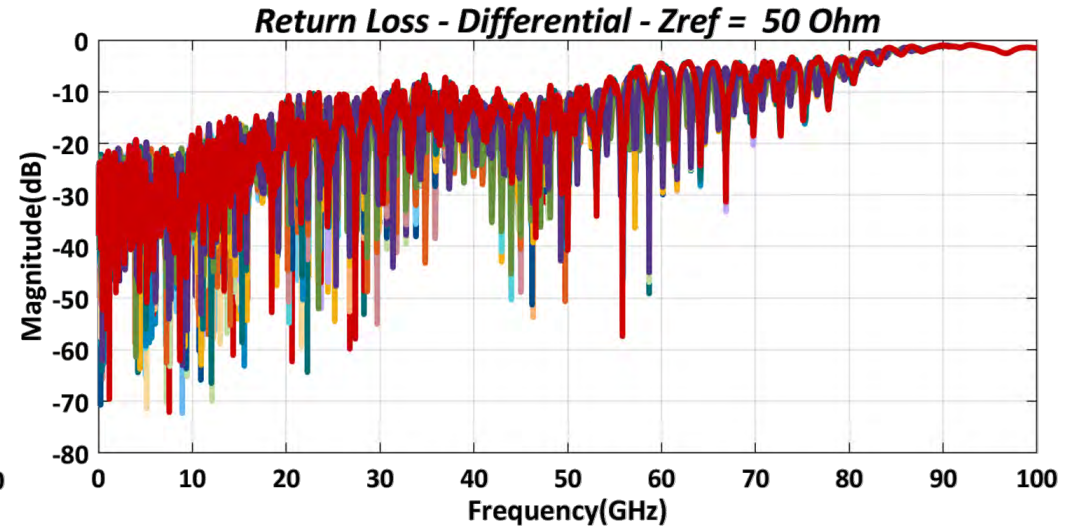
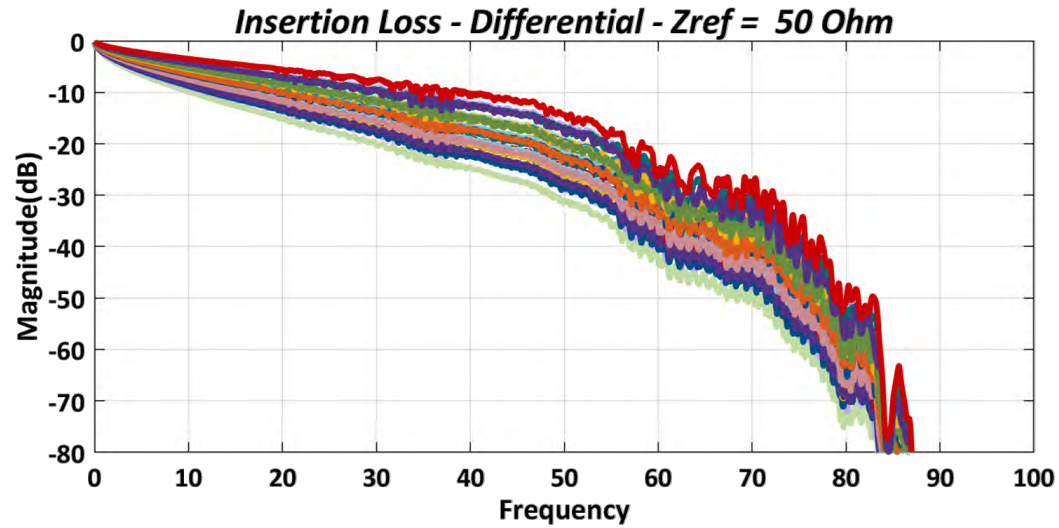
Channel	TP0-TP6 Loss (dB)
KRCA_wXTALK_1_PCB-25-25_mm_FO-100-100_mm_CA-200_mm_thru.s4p	16.02
KRCA_wXTALK_2_PCB-50-50_mm_FO-100-100_mm_CA-200_mm_thru.s4p	20.11
KRCA_wXTALK_3_PCB-75-75_mm_FO-100-100_mm_CA-200_mm_thru.s4p	22.81
KRCA_wXTALK_4_PCB-25-25_mm_FO-200-200_mm_CA-200_mm_thru.s4p	18.64
KRCA_wXTALK_5_PCB-50-50_mm_FO-200-200_mm_CA-200_mm_thru.s4p	22.38
KRCA_wXTALK_6_PCB-75-75_mm_FO-200-200_mm_CA-200_mm_thru.s4p	25.11
KRCA_wXTALK_7_PCB-25-25_mm_FO-300-300_mm_CA-200_mm_thru.s4p	21.27
KRCA_wXTALK_8_PCB-50-50_mm_FO-300-300_mm_CA-200_mm_thru.s4p	25.00
KRCA_wXTALK_9_PCB-75-75_mm_FO-300-300_mm_CA-200_mm_thru.s4p	27.85
KRCA_wXTALK_10_PCB-25-25_mm_FO-100-100_mm_CA-500_mm_thru.s4p	18.17
KRCA_wXTALK_11_PCB-50-50_mm_FO-100-100_mm_CA-500_mm_thru.s4p	22.19
KRCA_wXTALK_12_PCB-75-75_mm_FO-100-100_mm_CA-500_mm_thru.s4p	24.95
KRCA_wXTALK_13_PCB-25-25_mm_FO-200-200_mm_CA-500_mm_thru.s4p	20.82
KRCA_wXTALK_14_PCB-50-50_mm_FO-200-200_mm_CA-500_mm_thru.s4p	24.61
KRCA_wXTALK_15_PCB-75-75_mm_FO-200-200_mm_CA-500_mm_thru.s4p	27.34
KRCA_wXTALK_16_PCB-25-25_mm_FO-300-300_mm_CA-500_mm_thru.s4p	23.45
KRCA_wXTALK_17_PCB-50-50_mm_FO-300-300_mm_CA-500_mm_thru.s4p	27.20
KRCA_wXTALK_18_PCB-75-75_mm_FO-300-300_mm_CA-500_mm_thru.s4p	30.04
KRCA_wXTALK_19_PCB-25-25_mm_FO-100-100_mm_CA-1000_mm_thru.s4p	21.87
KRCA_wXTALK_20_PCB-50-50_mm_FO-100-100_mm_CA-1000_mm_thru.s4p	25.78
KRCA_wXTALK_21_PCB-75-75_mm_FO-100-100_mm_CA-1000_mm_thru.s4p	28.53
KRCA_wXTALK_22_PCB-25-25_mm_FO-200-200_mm_CA-1000_mm_thru.s4p	24.51
KRCA_wXTALK_23_PCB-50-50_mm_FO-200-200_mm_CA-1000_mm_thru.s4p	28.29
KRCA_wXTALK_24_PCB-75-75_mm_FO-200-200_mm_CA-1000_mm_thru.s4p	31.07
KRCA_wXTALK_25_PCB-25-25_mm_FO-300-300_mm_CA-1000_mm_thru.s4p	27.19
KRCA_wXTALK_26_PCB-50-50_mm_FO-300-300_mm_CA-1000_mm_thru.s4p	30.96
KRCA_wXTALK_27_PCB-75-75_mm_FO-300-300_mm_CA-1000_mm_thru.s4p	33.81



# KR Cabled Backplane

IL, RL, PST, ICR

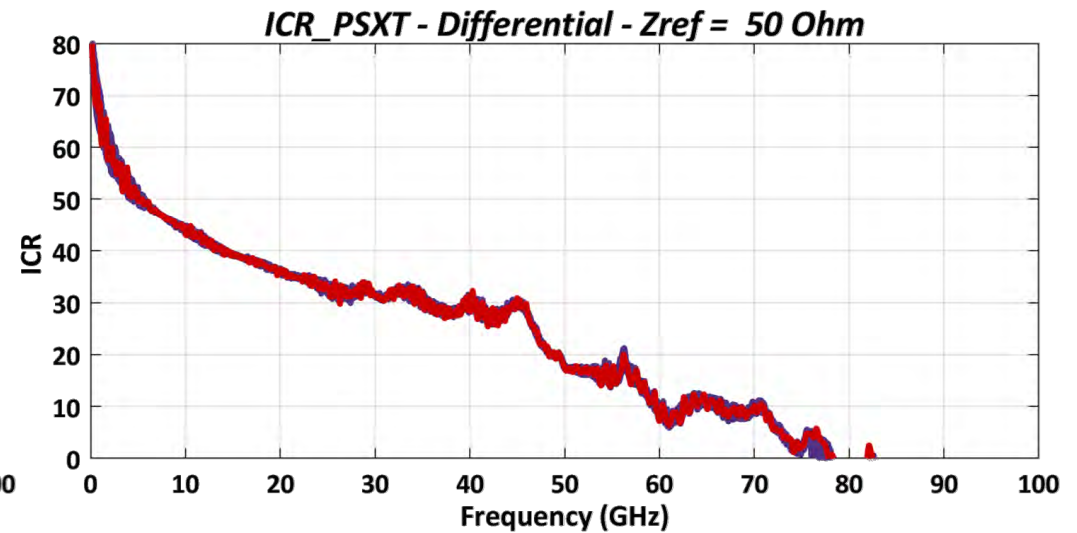
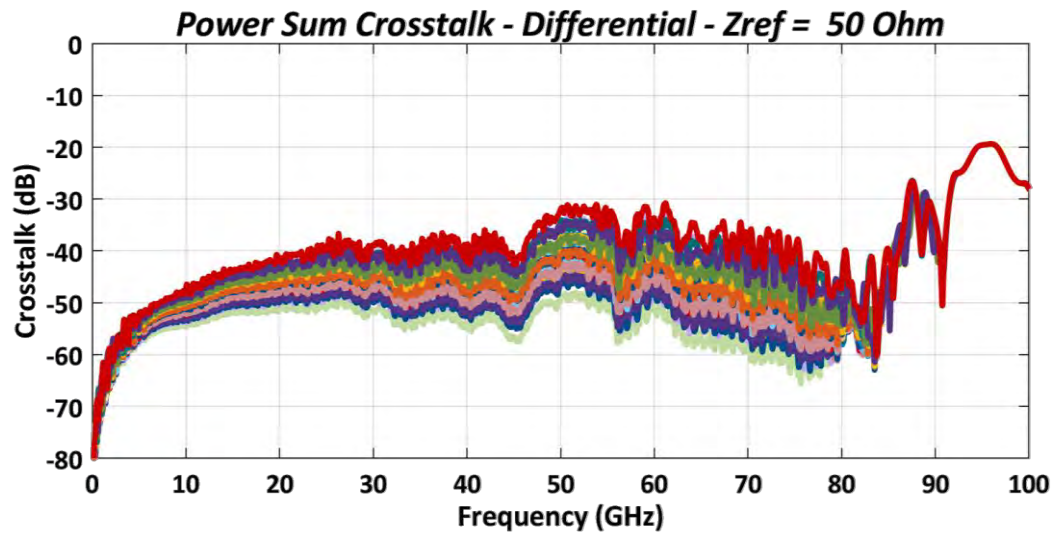
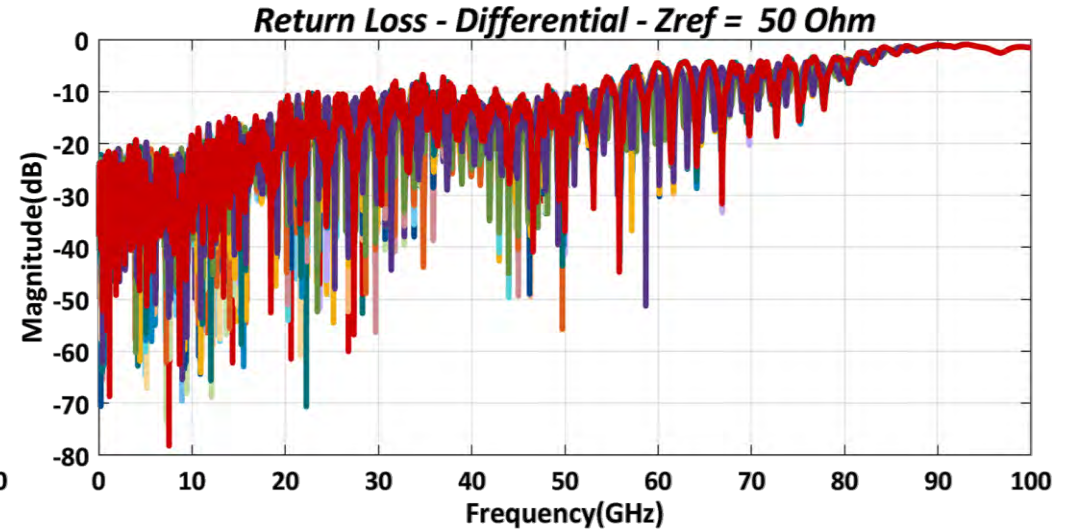
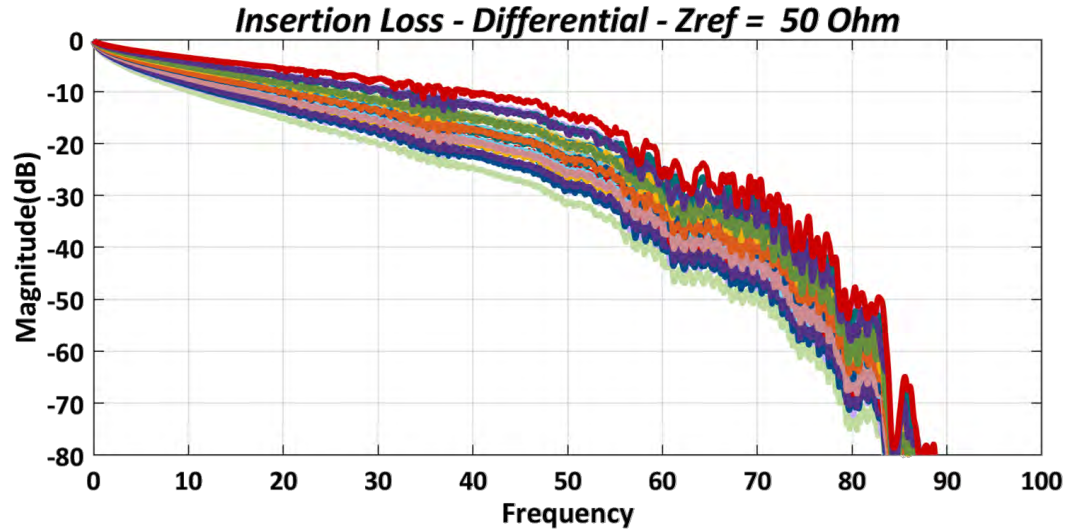
(KRCA\_wXTALK\_1\_PCB-##-##\_mm\_FO-##-##\_mm\_CA-##\_mm...)



# KR Cabled Backplane Lower Density

IL, RL, PST, ICR

(KRCA\_wXTALK\_LD\_x\_PCB-##-##\_mm\_FO-##-##\_mm\_CA-##\_mm...)



# Chip 2 Chip (C2C) Mezzanine

Only thru channels provided

## PCB Trace

Layer Count: 22

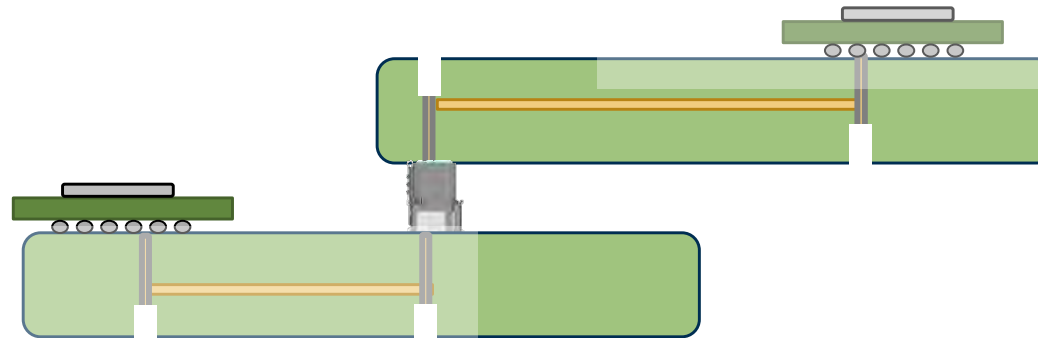
Routing Layer: 11

Routing Depth: 1.6 mm

1.5 dB per inch @ 53.125 GHz

Length: 25 mm, 60mm, 95 mm, 130 mm, 200 mm

\*Via Stub: 6 mil (4mil +/- 2mil)



## PCB Trace

Layer Count: 30

Routing Layer: 11

Routing Depth: 1.6 mm

1.5 dB per inch @ 53.125 GHz

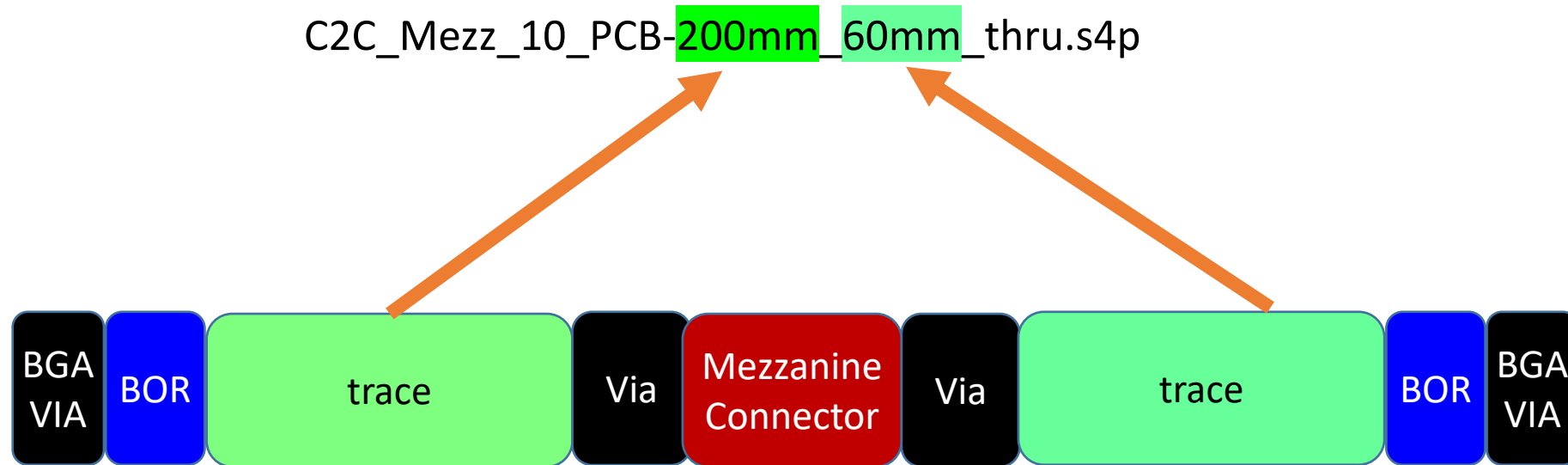
Length: 25 mm, 60mm, 95 mm, 130 mm, 200 mm

\*Via Stub: 6 mil (4mil +/- 2mil)

*\*Via structures include actual breakout and escape routing.*

# C2C File Syntax Key

Crosstalk will be provided in a later contribution



# C2C Channel List (thru) for Tp0-Tp5

C2C\_Mezz\_1\_PCB-25mm\_25mm\_thru.s4p  
C2C\_Mezz\_2\_PCB-60mm\_25mm\_thru.s4p  
C2C\_Mezz\_3\_PCB-95mm\_25mm\_thru.s4p  
C2C\_Mezz\_4\_PCB-130mm\_25mm\_thru.s4p  
C2C\_Mezz\_5\_PCB-200mm\_25mm\_thru.s4p  
C2C\_Mezz\_6\_PCB-25mm\_60mm\_thru.s4p  
C2C\_Mezz\_7\_PCB-60mm\_60mm\_thru.s4p  
C2C\_Mezz\_8\_PCB-95mm\_60mm\_thru.s4p  
C2C\_Mezz\_9\_PCB-130mm\_60mm\_thru.s4p  
C2C\_Mezz\_10\_PCB-200mm\_60mm\_thru.s4p  
C2C\_Mezz\_11\_PCB-25mm\_95mm\_thru.s4p  
C2C\_Mezz\_12\_PCB-60mm\_95mm\_thru.s4p  
C2C\_Mezz\_13\_PCB-95mm\_95mm\_thru.s4p

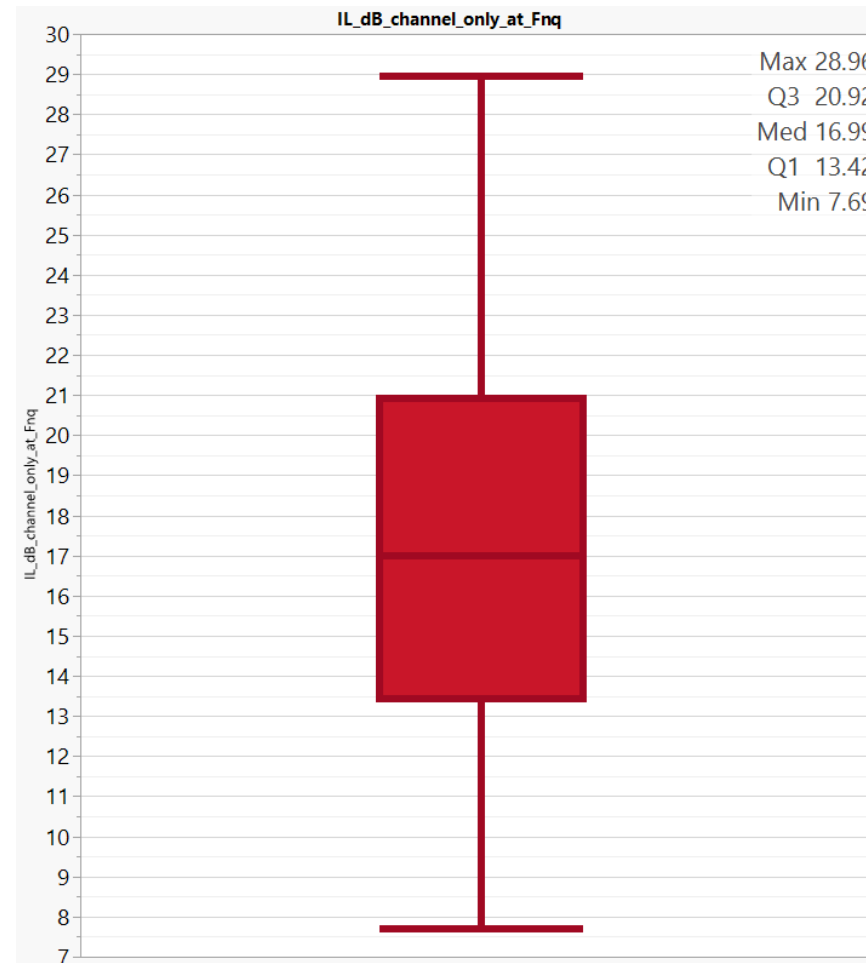
C2C\_Mezz\_14\_PCB-130mm\_95mm\_thru.s4p  
C2C\_Mezz\_15\_PCB-200mm\_95mm\_thru.s4p  
C2C\_Mezz\_16\_PCB-25mm\_130mm\_thru.s4p  
C2C\_Mezz\_17\_PCB-60mm\_130mm\_thru.s4p  
C2C\_Mezz\_18\_PCB-95mm\_130mm\_thru.s4p  
C2C\_Mezz\_19\_PCB-130mm\_130mm\_thru.s4p  
C2C\_Mezz\_20\_PCB-200mm\_130mm\_thru.s4p  
C2C\_Mezz\_21\_PCB-25mm\_200mm\_thru.s4p  
C2C\_Mezz\_22\_PCB-60mm\_200mm\_thru.s4p  
C2C\_Mezz\_23\_PCB-95mm\_200mm\_thru.s4p  
C2C\_Mezz\_24\_PCB-130mm\_200mm\_thru.s4p  
C2C\_Mezz\_25\_PCB-200mm\_200mm\_thru.s4p



# C2C Loss vs channel (TP0 TP5)

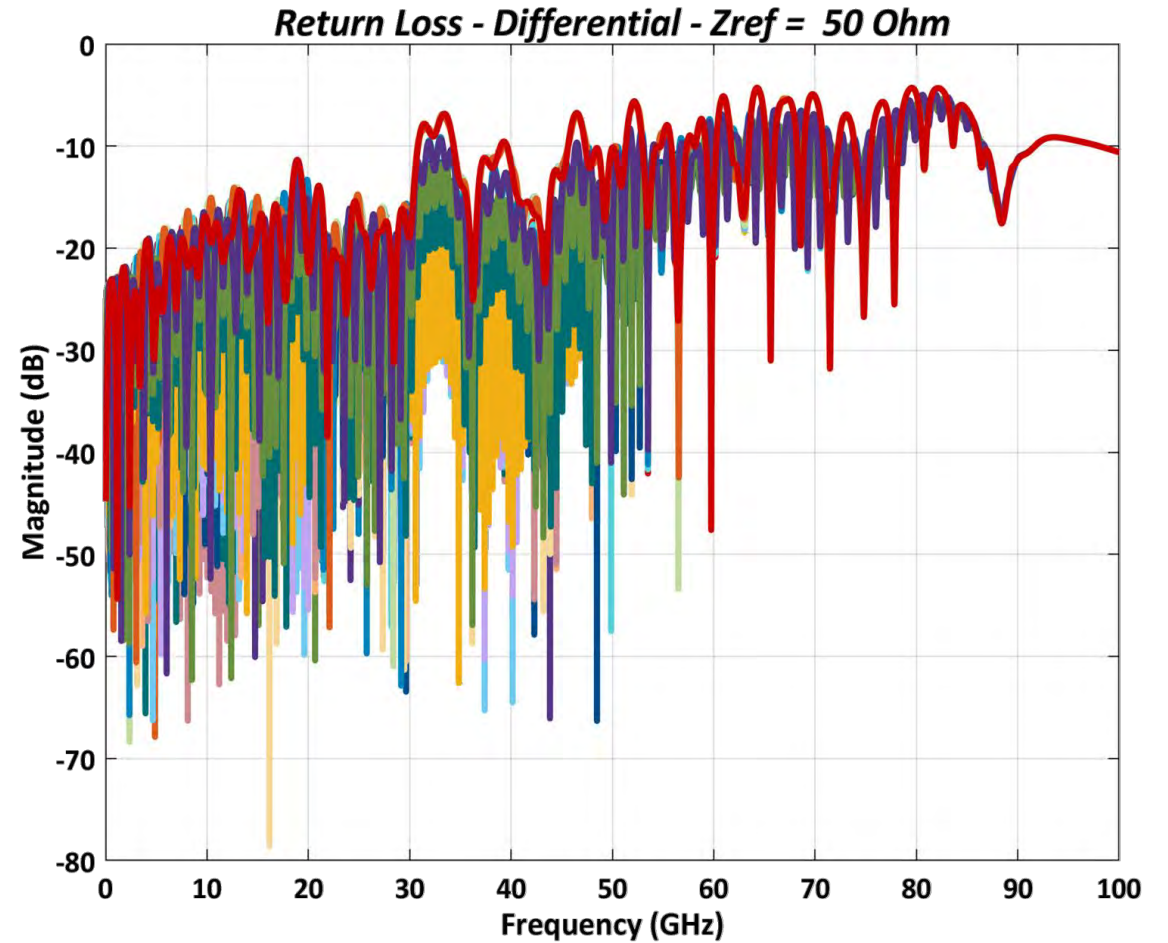
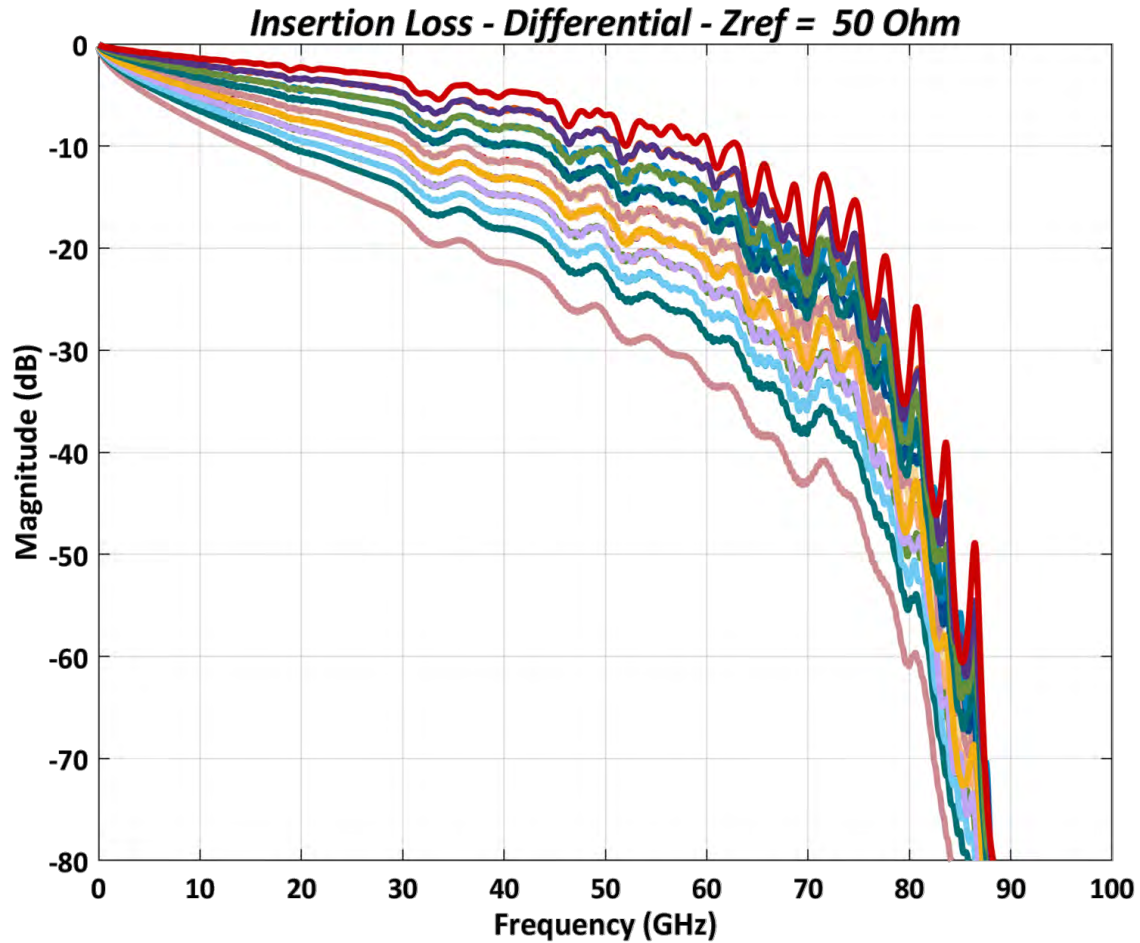
IL: 7.7 dB and 29 dB

Channel	TP0-TP5 Loss (dB)
C2C Mezz 1 PCB-25mm 25mm thru	7.69
C2C Mezz 2 PCB-60mm 25mm thru	10.16
C2C Mezz 3 PCB-95mm 25mm thru	12.34
C2C Mezz 4 PCB-130mm 25mm thru	14.32
C2C Mezz 5 PCB-200mm 25mm thru	18.30
C2C Mezz 6 PCB-25mm 60mm thru	10.04
C2C Mezz 7 PCB-60mm 60mm thru	12.52
C2C Mezz 8 PCB-95mm 60mm thru	14.73
C2C Mezz 9 PCB-130mm 60mm thru	16.71
C2C Mezz 10 PCB-200mm 60mm thru	20.68
C2C Mezz 11 PCB-25mm 95mm thru	12.28
C2C Mezz 12 PCB-60mm 95mm thru	14.78
C2C Mezz 13 PCB-95mm 95mm thru	16.99
C2C Mezz 14 PCB-130mm 95mm thru	18.97
C2C Mezz 15 PCB-200mm 95mm thru	22.94
C2C Mezz 16 PCB-25mm 130mm thru	14.33
C2C Mezz 17 PCB-60mm 130mm thru	16.84
C2C Mezz 18 PCB-95mm 130mm thru	19.05
C2C Mezz 19 PCB-130mm 130mm thru	21.02
C2C Mezz 20 PCB-200mm 130mm thru	24.98
C2C Mezz 21 PCB-25mm 200mm thru	18.31
C2C Mezz 22 PCB-60mm 200mm thru	20.81
C2C Mezz 23 PCB-95mm 200mm thru	23.02
C2C Mezz 24 PCB-130mm 200mm thru	24.99
C2C Mezz 25 PCB-200mm 200mm thru	28.96



# C2C channel (TP0 TP5)

RL, IL: C2C\_Mezz\_x\_PCB-##mm\_##mm\_thru.s4p





# Summary: KR & C2C Topologies

- ❑ Provide a wide range of losses
- ❑ KR NPC Cabled Backplane ... 27 channels
  - 16.2 dB to 33.8 dB @ 53.125 GHz
  - Two flavors of crosstalk
- ❑ Chip to Chip (C2C) Mezzanine ... 25 channels
  - 7.7 dB and 29 dB @ 53.125 GHz
  - Crosstalk not available yet

# Thank You!

# Back Up Extra

# Computation of Die-to-die (D2D) Losses

Range of packages derived from benartsi\_3df\_01a\_2211

Package parameters	Package 1	Package 2	Package3	Package 4
Pkg length ( mm)	6	18	30	45
Package loss (dB @ 53.125 GHz)	2.1	4.6	7.15	10.3
Pmax/Vf @ TP0 (with die load*)	0.6471	0.5730	0.5074	0.4378

**Tx**  
**Packages**

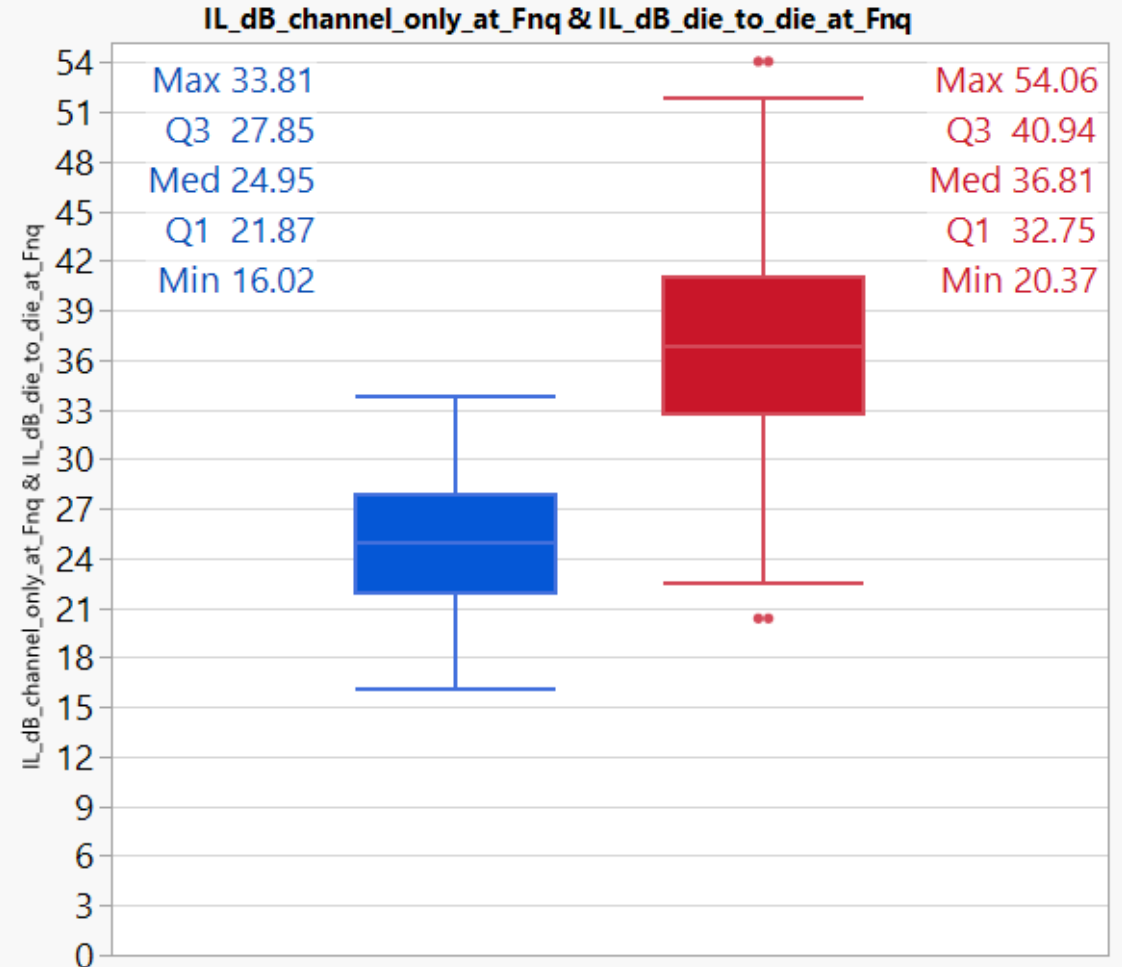
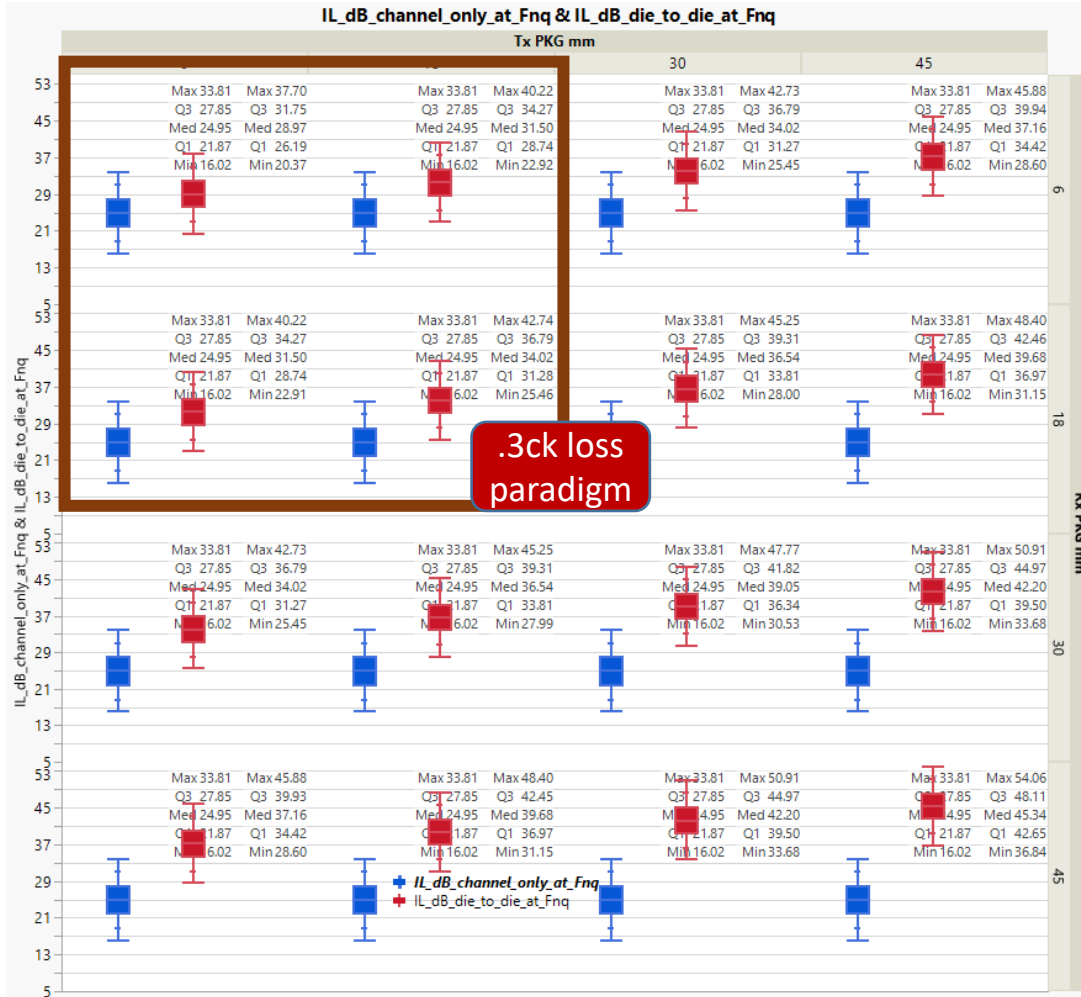
**TP0-TP5 Channels**

**Rx**  
**Packages**

\*mli\_3df\_02\_220316

# KR: D2D loss w/package & TP0-TP5 loss

TP0-TP5: 16 dB to 33.8 dB ; D2D: 20.4 dB to 54 dB



# C2C: D2D loss w/package & TP0-TP5 loss

TP0-TP5: 7.7 dB to 29 dB ; D2D: 12.5 dB to 49 dB

