

# Mated Board and Host Specifications

IEEE 802.3bj Task Force

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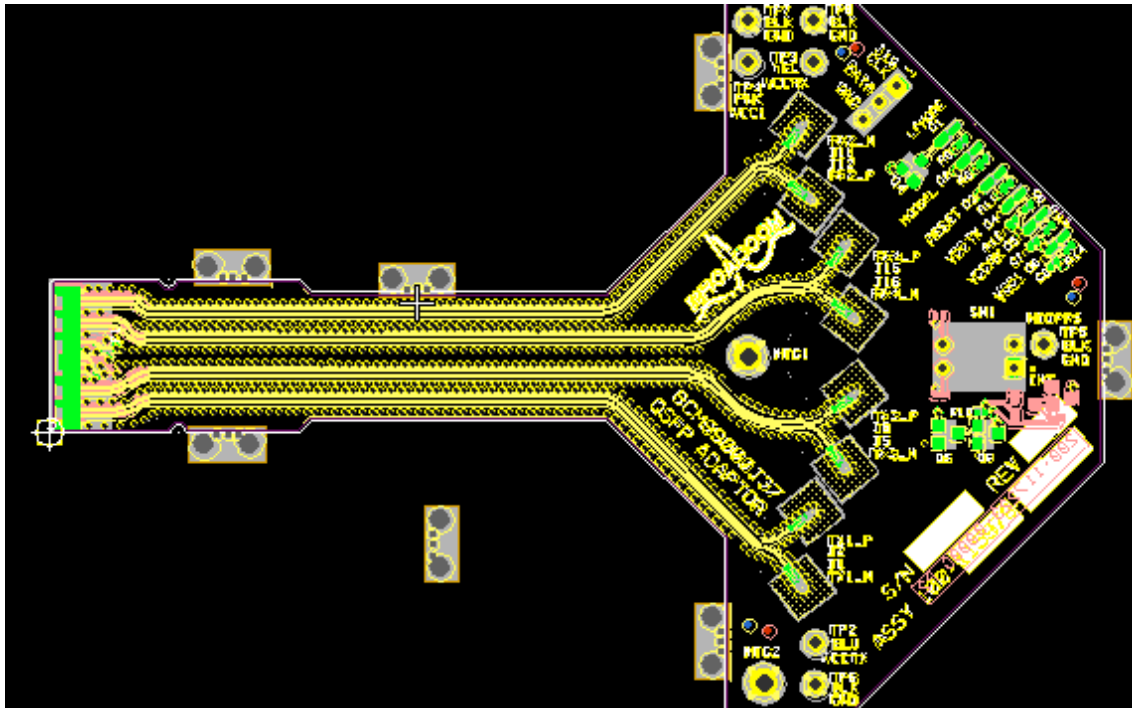
Geneva

# Overview

- Addressing following comments
  - 308/311 – Transmitter/Host RL
  - 309 – Channel Loss
  - 316 – MCB loss
  - 317 – HCB loss
  - 319 – MCB-HCB mated RL

# QSFP+ HCB Microstrip Construction

- Based on 12-12-12 mils differential microstrip with 20 mils ground shield separation with loss of 5.6 dB@14 GHz
  - Substrate material Rogers 4350B
  - Signals are routed on top and bottom
  - Trace length 3.4"
  - To meet target loss of 1.75 dB, RO3003 with rolled Cu will be needed instead of RO4350B with ED

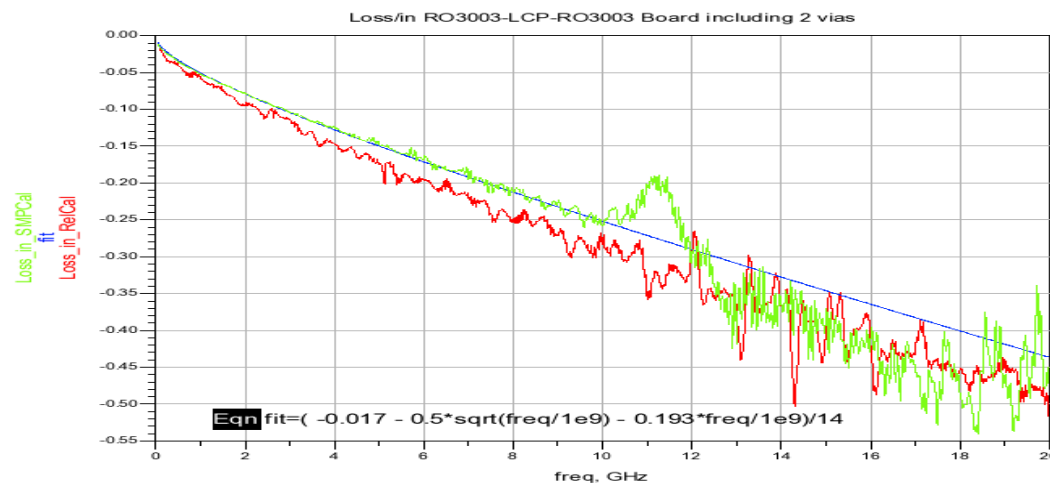
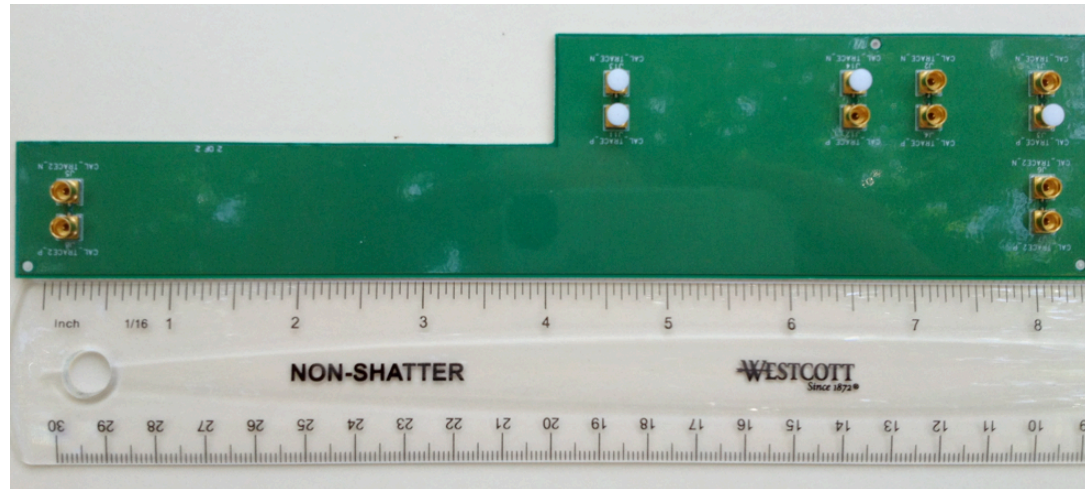


# Strip-line HCB Construction

- CFP HCB traces are 7.5" long with max loss of 2.1 dB at 5.5 GHz
- To minimize losses
  - Used Rogers 3003
  - Stripline construction of 12-13-12 mils was used
  - Roger 3003 laminates were bonded with Roger 3850 LCP material (does require high temperature press)
  - To keep the surface roughness losses low rolled Cu was used
- Based on the above construction one may build a HCB meeting max loss of 1.75 dB at 14 GHz with stripline
  - In the case of QSFP28, max PCB thickness of 1mm (0.040"), a single routing layer or embedded microstrip would need to be used
- Alternatively we could increase HCB loss to 2 dB giving little more implementation flexibility but small enough not requiring open other parameters.

# RO3003 Stripline Losses

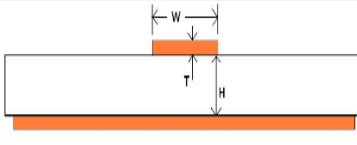
- Loss per inch calculated two different method
  - Some of the noise is due to SMP connector and the cal kit



# HCB loss Moving from RO4350B to RO30003

- Loss for 12 mil single-ended trace
  - Using Rogers Corp calculator (free download but require registration)  
<https://www.rogerscorp.com/acm/technology/index.aspx>
  - Loss/in at 14 GHz will improve from 0.66dB/in to 0.50 dB/in
  - Current HCB

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Microstrip

Transmission Line Information

Conventional Microstrip  
Using .005 inch RO3003™ circuit materials.  
Conductor width = 0.011 in.

Impedance = 49.53 ohms  
Effective dk = 2.2873

Dielectric Loss is = 0.0537 dB/in  
Conductor loss is = 0.4430 dB/in  
Total loss is = 0.4967 dB/in

Dielectric Q Factor is 911.1  
Conductor Q Factor is 110.5  
Total Q Factor for transmission line is 98.54

Phase Velocity = 7.679e+007 meters/sec.  
or 3.023e+009 in/sec.  
Open Single End Fringing = 0.0021 inches  
Wavelength in transmission line = 0.557 in.

☒ Display results of only one calculation

Material Name	dk	df	TC dk	Therm Cond.
RT/duroid 5870	2.33	0.0012	-115	0.22
RT/duroid 5880	2.2	0.0009	-125	0.2
RT/duroid 5880 LZ	1.96	0.0019	22	0.2
RT/duroid 6002	2.94	0.0012	12	0.6
RT/duroid 6006	6.45	0.0027	-410	0.48
RT/duroid 6010LM	10.7	0.0023	-425	0.78
RT/duroid 6035HTC	3.6	0.0013	-66	1.44
RT/duroid 6202	2.9	0.0015	13	0.68
TMM3	3.39	0.002	37	0.7
TMM4	4.5	0.002	-15.3	0.7
TMM6	6	0.0023	-11	0.72
TMM10	9.56	0.0022	-38	0.76
TMM10i	9.96	0.002	-43	0.76
ULTRALAM 3850	2.9	0.0024	100	0.2
RO3003	3	0.0013	13	0.5
RO3003	3	0.0013	13	0.5

ROGERS CORPORATION  
www.rogerscorp.com

Application Specific

Frequency 14 GHz RF Power 1 Watt

Material Properties

Material RO3003 Thickness (H) .005 in.

Circuit Parameters

Conductor Width (W) 0.011 in. Space (S) 0.009 in. Length 1 in.

Dk 3 Df .0013 Thermal Cond. .5 W/K·m

Copper Thickness (T) 0.0026 in. Copper Roughness RMS 0.5 microns Copper Conductivity 5.813 X 10<sup>7</sup> S/m

Conductor conductivity is considered a bulk value

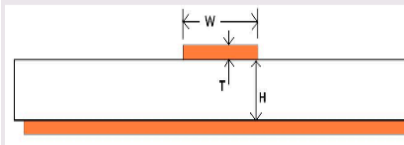
Calculate Impedance 50 Ohms

Generate Tables and Files None

Units English Metric

Freq. Range 10 to 30 GHz

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Microstrip

Transmission Line Information

Conventional Microstrip  
Using .0066 inch RO4350B™ circuit materials.  
Conductor width = 0.012 in.

Impedance = 51.61 ohms  
Effective dk = 2.6766

Dielectric Loss is = 0.1688 dB/in  
Conductor loss is = 0.4931 dB/in  
Total loss is = 0.6620 dB/in

Dielectric Q Factor is 313.5  
Conductor Q Factor is 107.3  
Total Q Factor for transmission line is 79.98

Phase Velocity = 8.641e+007 meters/sec.  
or 3.402e+009 in/sec.  
Open Single End Fringing = 0.0026 inches  
Wavelength in transmission line = 0.515 in.

☒ Display results of only one calculation

Material Name	dk	df	TC dk	Therm Cond.
RO3003	3	0.0013	13	0.5
RO3006	6.5	0.002	-160	0.72
RO3010	11.2	0.0023	-280	0.95
RO3035	3.6	0.0018	-34	0.5
RO3203	3.02	0.0016	13	0.5
RO3206	6.6	0.0027	-212	0.63
RO3210	10.8	0.0027	-459	0.81
RO3730	3	0.0016	-22	0.45
RO4003	3.55	0.0027	40	0.64
RO4003 LoPro	3.5	0.0027	40	0.64
RO4350	3.66	0.0037	50	0.62
RO4350 LoPro	3.55	0.0037	50	0.62
RO4360	6.6	0.0038	-120	0.8
RO4730	3	0.0033	23	0.52
XT/duroid 8000	3.34	0.0035	7	0.35
RO4350	3.66	0.0037	50	0.62

ROGERS CORPORATION  
www.rogerscorp.com

Application Specific

Frequency 14 GHz RF Power 1 Watt

Material Properties

Material RO4350 Thickness (H) .0066 in.

Circuit Parameters

Conductor Width (W) 0.012 in. Space (S) 0.009 in. Length 1 in.

Dk 3.66 Df .0037 Thermal Cond. .62 W/K·m

Copper Thickness (T) 0.0026 in. Copper Roughness RMS 2.8 microns Copper Conductivity 5.813 X 10<sup>7</sup> S/m

Conductor conductivity is considered a bulk value

Calculate Impedance 50 Ohms

Generate Tables and Files None

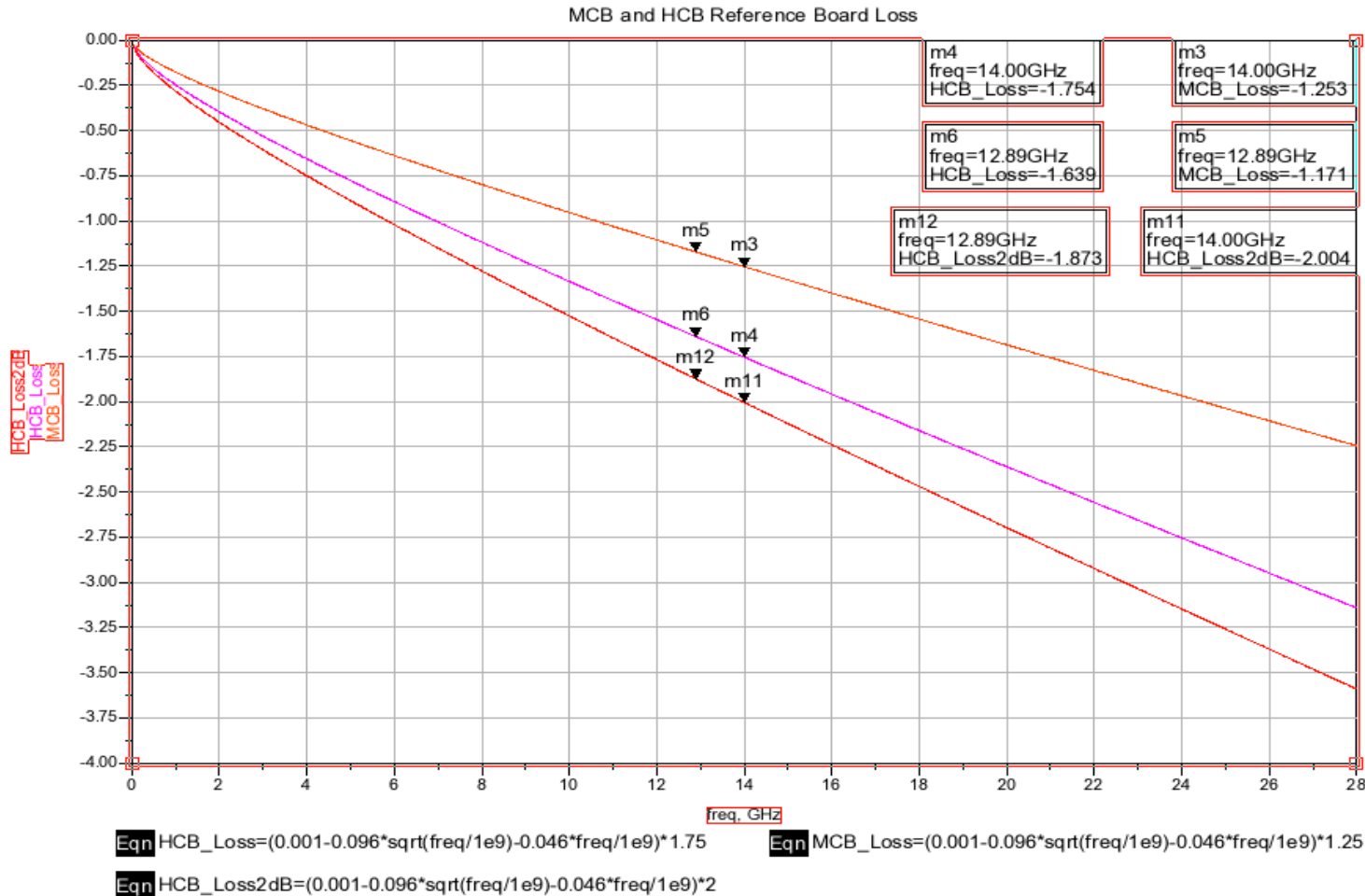
Units English Metric

Freq. Range 10 to 30 GHz



# MCB and HCB Loss Profile

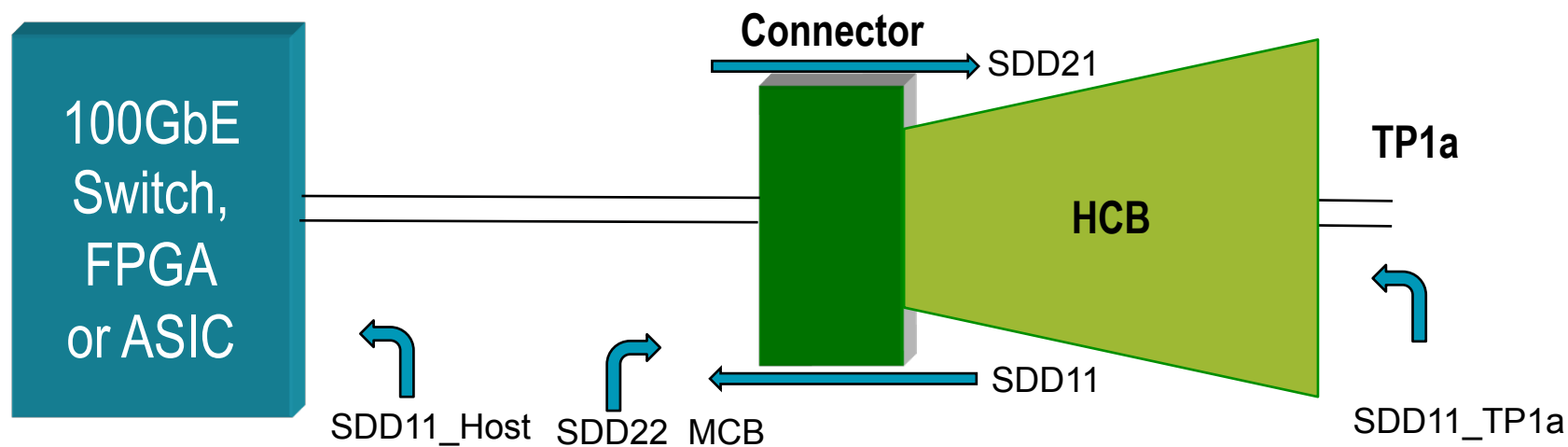
- Addressing comment 316/317
  - 2 dB HCB loss will make it more manufacturable



# Host Aggregate Return Loss

- Host aggregate return loss can be written as
  - SDD21/SDD12 is the through loss
  - When the host PCB loss is the identical to MCB loss then one may approximate SDD21/SDD12 to unity

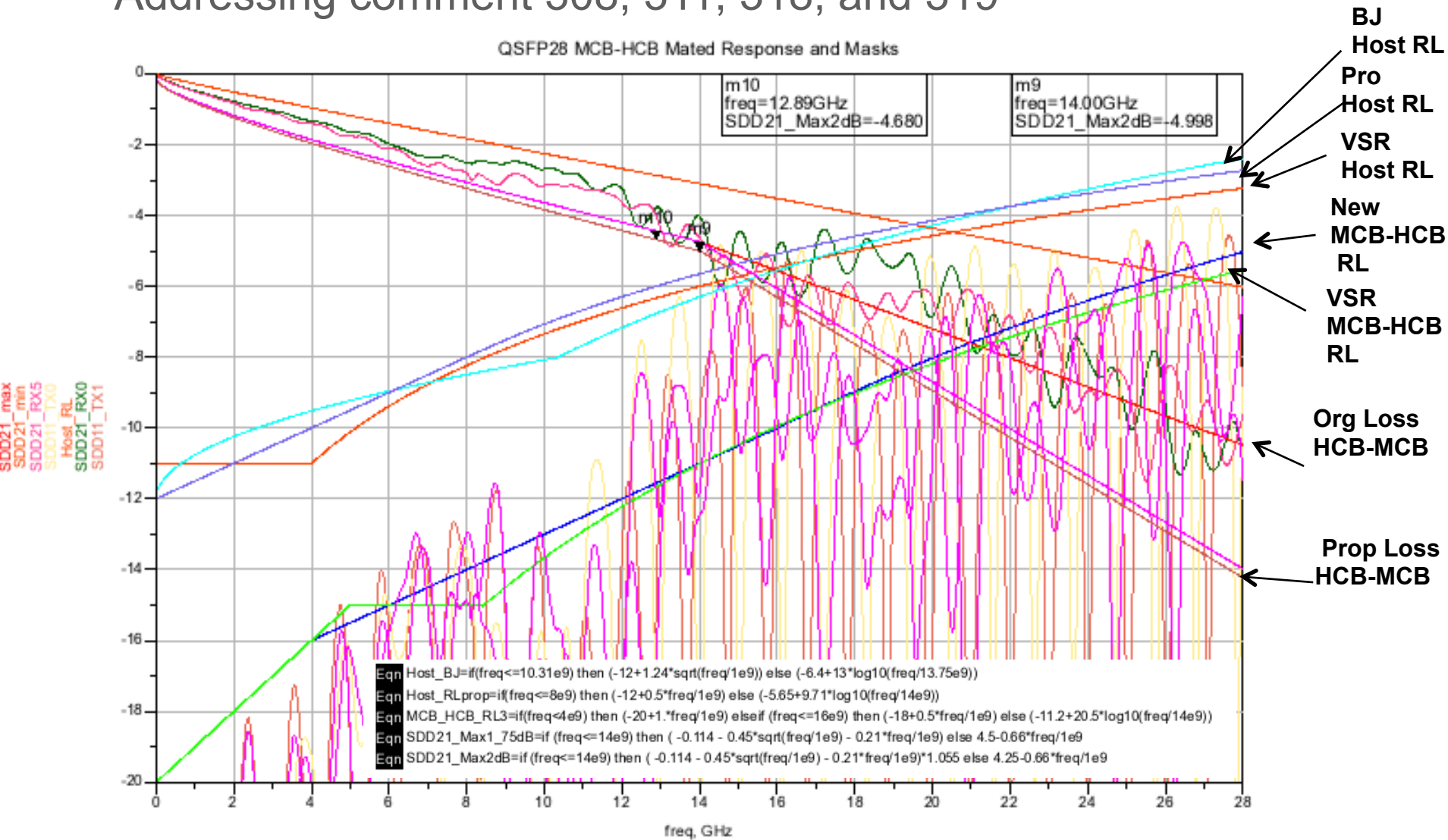
$$SDD11\_TP1a = SDD11\_Host + SDD21 \cdot SDD12 \cdot \left( \frac{SDD11\_Host}{1 - SDD22\_MCB \cdot SDD11\_Host} \right)$$





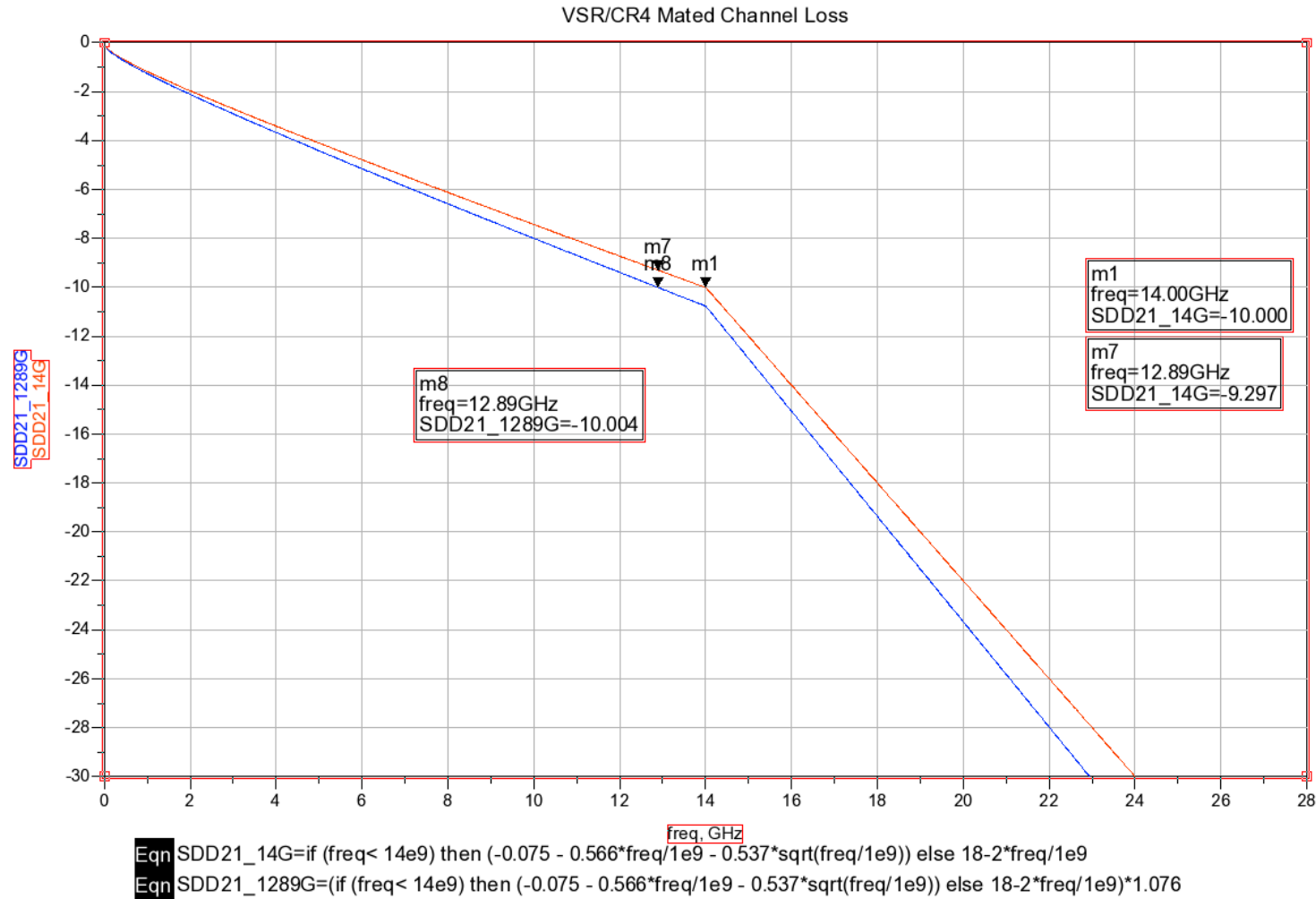
# Mated Board and Host Return Loss and Return Loss at TP1a

- Addressing comment 308, 311, 318, and 319



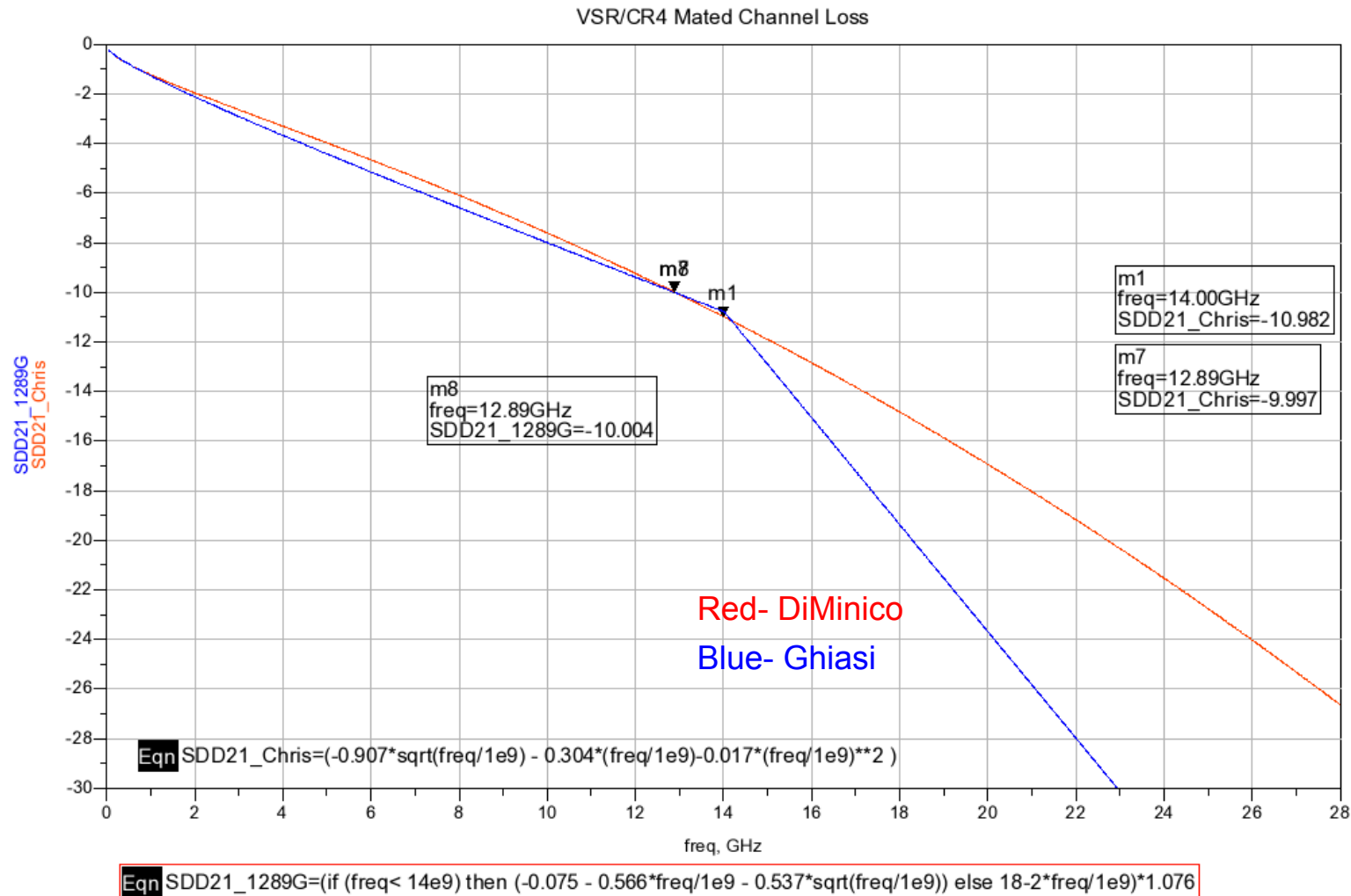
# CR4 Host Mated Channel Loss

- Comment 309, equation shown is for SDD21 not loss



# Proposed Ghiasi and DiMinico Loss Overlaid

- Comment 309, equation shown is for SDD21 not loss



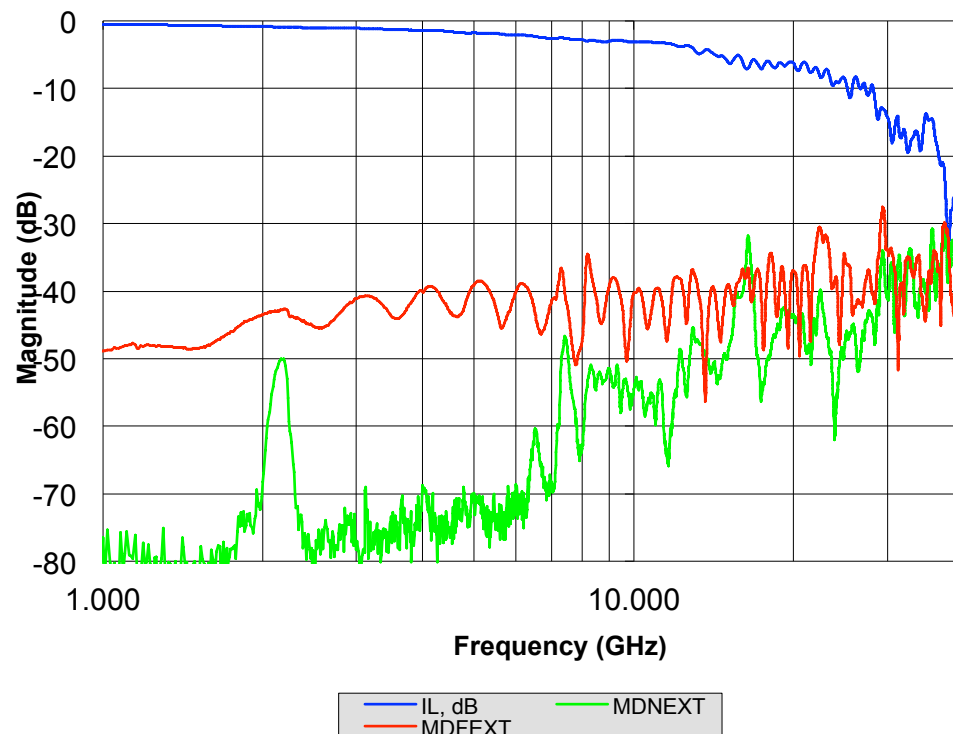
# Issue of Relaxing Mated Board Return loss

- As the frequency has increased and board loss reduced any board or connector imperfection shows up as insertion loss and ILD
  - Increasing MCB/HCB loss is the best way to hide a problem than can exist in real system where IC are placed 0.5" from the connector
- If we relax the mated board return loss without relaxing the host then realistic host will not meet the RL
- If we relax the mated board and host then there will be some signal integrity penalty
- We should relax the return loss at last resort and while understanding the implications.

# QSFP28 MCB-HCB Crosstalk

- Include 4 NEXTs and 3 FEXTs
  - As the board loss has gone down crosstalk has increased

MCB-HCB Crosstalk	10.3125 GBd ICN (mV)	25.78 GBd ICN (mV)	28.0 GBd ICN (mV)
Rise Time 20-80% (ps)	24.000	9.600	8.840
MDNEXT	0.323	1.390	1.612
MDFEXT	3.593	4.562	4.673
ICN	3.607	4.769	4.943



# Summary

- Current HCB loss of 1.75 dB at 14 GHz can be met if superior material and construction is used
  - To facilitate more flexible implementation HCB loss could be relaxed to 2 dB without material impacting or need to adjust other specifications
- If the HCB board loss is increased to 3.75 dB one may be able to correct for signal at TP1a with software CTLE having 2 dB additional but no longer host return loss can be measured
  - When HCB has loss of 3.75 dB even a short at connector just due to the board loss could read RL of -7.5 dB!
- Mated board return loss shown here are based on early boards with SMA on MCB and SMP on the HCB impacting the RL and require further upgrade for 25G operation
- HCB and MCB are functional instrument for signal measurements and host return loss measurement requiring very careful construction otherwise the whole concept is useless!



**Thank You**