Baseline Proposal
Cable assembly, Host, MTF, and Channel Insertion Loss

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Purpose

- **Baseline proposal for cable assembly, Host, MTF, and Channel Insertion loss budgets**

Contributors

- Scott Sommers, Tom Plalkert, Alex Haser – Molex
- Jane Lim, Upen Reddy – Cisco
- Samuel Kocsis, Greg Mcsorley - Amphenol
- Nathan Tracy – TE
- Rich Mellitz - Samtec

Supporters

- Scott Sommers, Tom Plalkert, Alex Haser – Molex
- Jane Lim, Pirooz Tooyserkani – Cisco
- Samuel Kocsis, Greg Mcsorley – Amphenol
- Nathan Tracy – TE
- Rick Rabinovich – Keysight

Supporting presentations

- Cable assembly - palkert_3ck_01a_0519.pdf
- Host - lim_3ck_CR_0303.pdf
- Baseline specifications - diminico_3ck_01a_0319.pdf
- MTF - diminico_3ck_01_0519.pdf

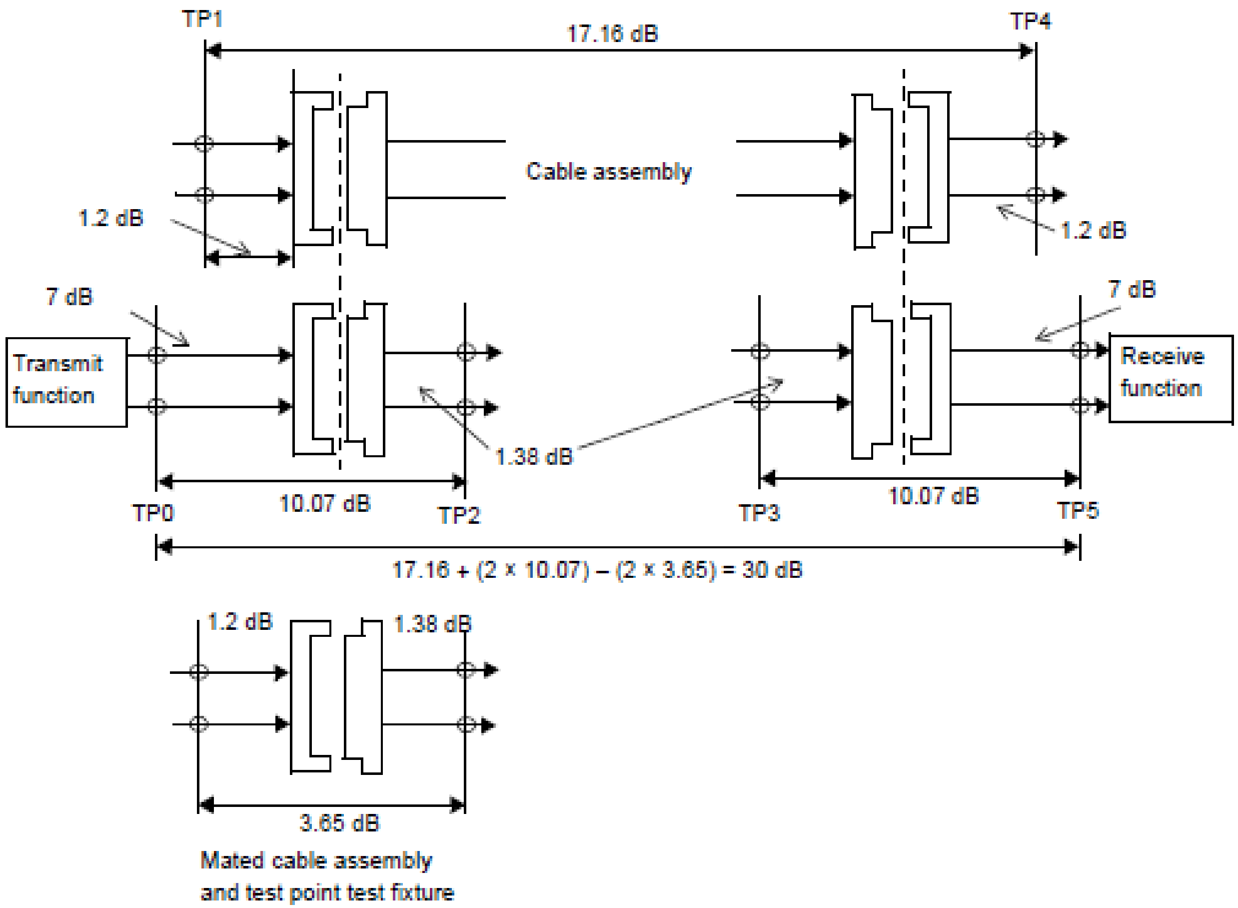
Overview

Component	802.3cd Insertion Loss dB @ 13.28 GHz	802.3ck Insertion Loss dB @ 26.56 GHz (proposed)	Comment
Module Compliance Board (MCB) PCB	1.2	2.3	
Host Compliance Board (HCB) PCB	1.38	2.5	
Host	7	7	cd-The 7 dB did not include explicit allowances for BGA and connector footprint ck-The 7 dB includes allowance of 1.34 dB for BGA (0.73) via and connector footprint via (0.61)
Host Connector	1.07+0.62	1.6	cd-The host connector is allocated 0.62 dB of additional margin ck- The host connector mating interface is allocated 0.3 dB variation allowance (not including via)
Mated Test Fixture (MTF)	3.65	6.6	
MTF connector	1.07	1.8	ck-includes 0.2 dB via allowance
Bulk cable and wire attachment	12.62	11.8	cd(3m), ck(2m)
Channel	30	29	

- Host and Mated test fixture connector mating interfaces are the same >>1.3 dB + variation 0.3 dB = 1.6 dB.
- Variation is to account for multiple MDIs and other factors other than implementation or margin.

MTF IL = 2.3(MCB PCB)+1.6(conn)+0.2(via)+2.5(HCB PCB) =6.6 dB
Host Channel IL =7(Host PCB and via's)+1.6(conn)+2.5(HCB PCB) = 11.1 dB
Channel IL =2*7(Host PCB and via's)+2*1.6(conn)+11.8(cable and wire termination) = 29 dB

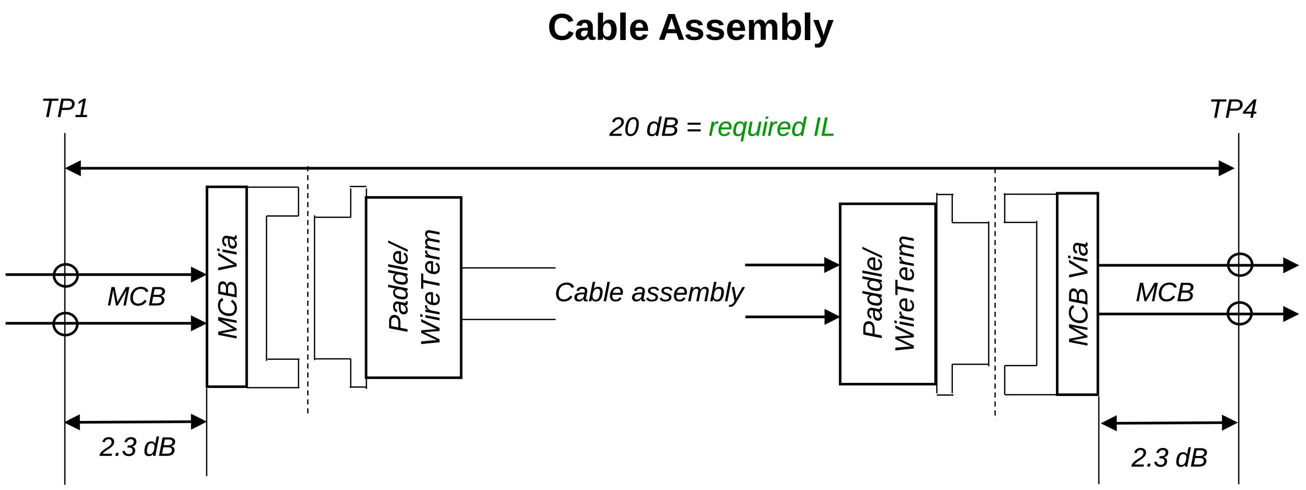
802.3cd Figure 136A–1—30 dB channel insertion loss budget at 13.28 GHz

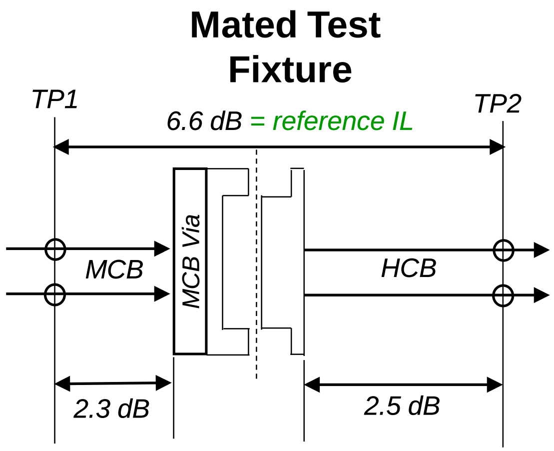


NOTE—The connector insertion loss is 1.07 dB for the mated test fixture. The host connector is allocated 0.62 dB of additional margin.

Figure 136A–1—30 dB channel insertion loss budget at 13.28 GHz

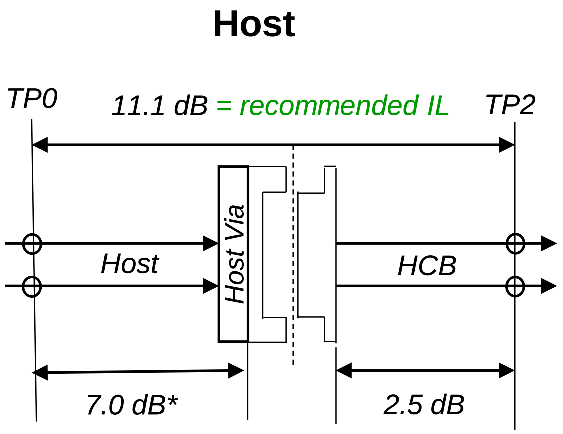
802.3ck Figure XX–1—29 dB channel insertion loss budget at 26.56 GHz





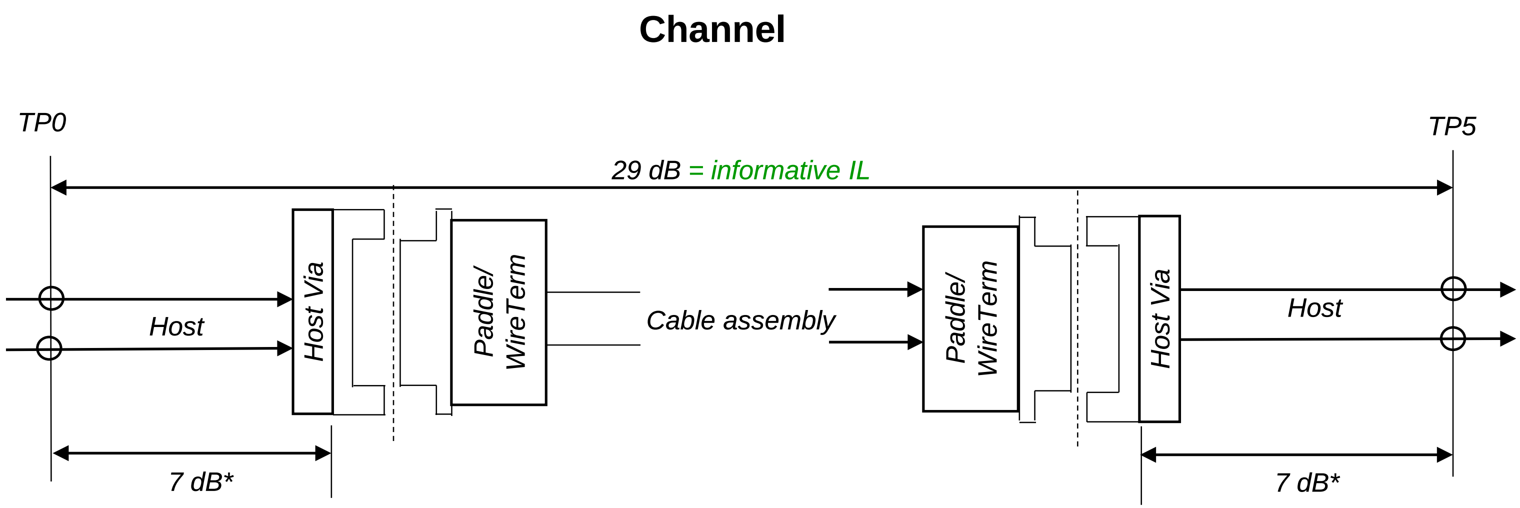
Note: 2.3 dB MCB PCB includes test point IL

and MCB Via allowance is 0.2 dB



Note: The 7 dB includes via allowances for BGA and connector footprint

802.3ck Figure XX–1—29 dB channel insertion loss budget at 26.56 GHz



Channel IL = 29 dB @26.56 GHz =2*(7+1.6)+11.8

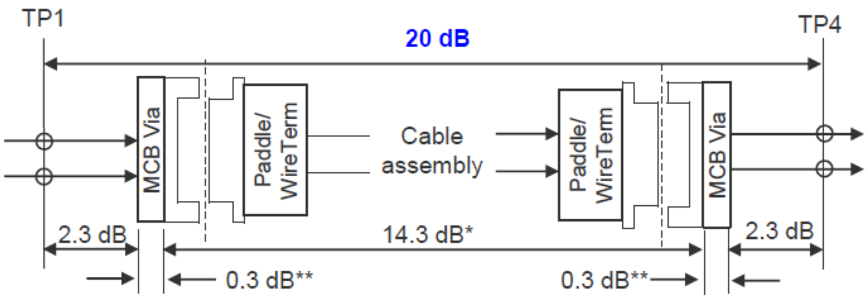
Note: Channel IL derived from cable assembly host, and mated test fixture IL=29 dB @26.56 GHz =2*(7+1.6)+11.8

Supporting Slides

Cable assembly - palkert_3ck_01a_0519.pdf

TP1-TP4 Loss Budget:

- Simulated loss curves put TP1-TP4 loss just below 20 dB
- They are simulated and don't account for manufacturing variation
- Adding some room for error, proposed TP1-TP4 IL: **20 dB**



This leaves ~0.5 dB of margin for manufacturing variation

*Value determined working backwards from 19.5 dB work case loss
**This is a rough estimate based on one MCB design

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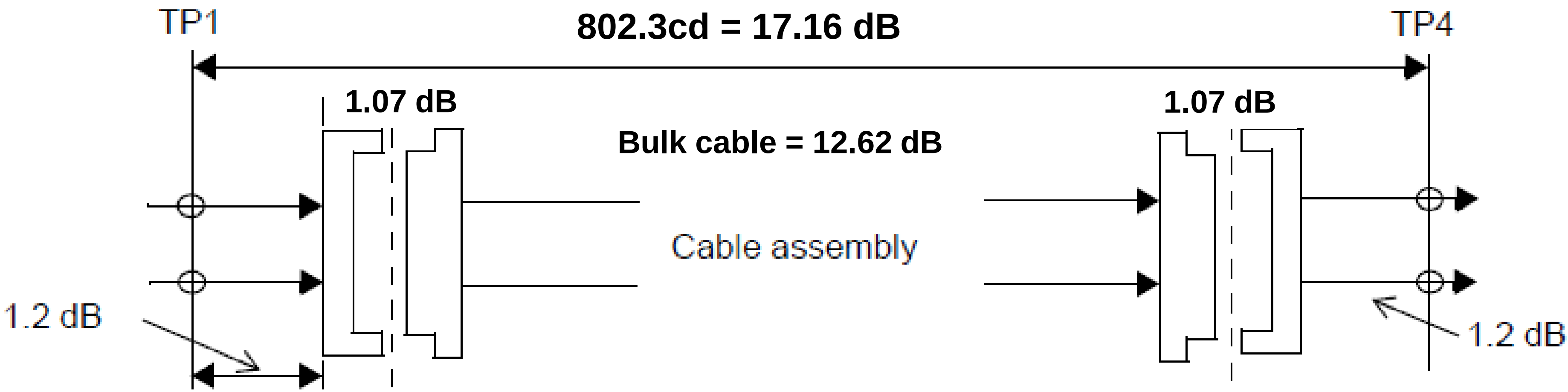
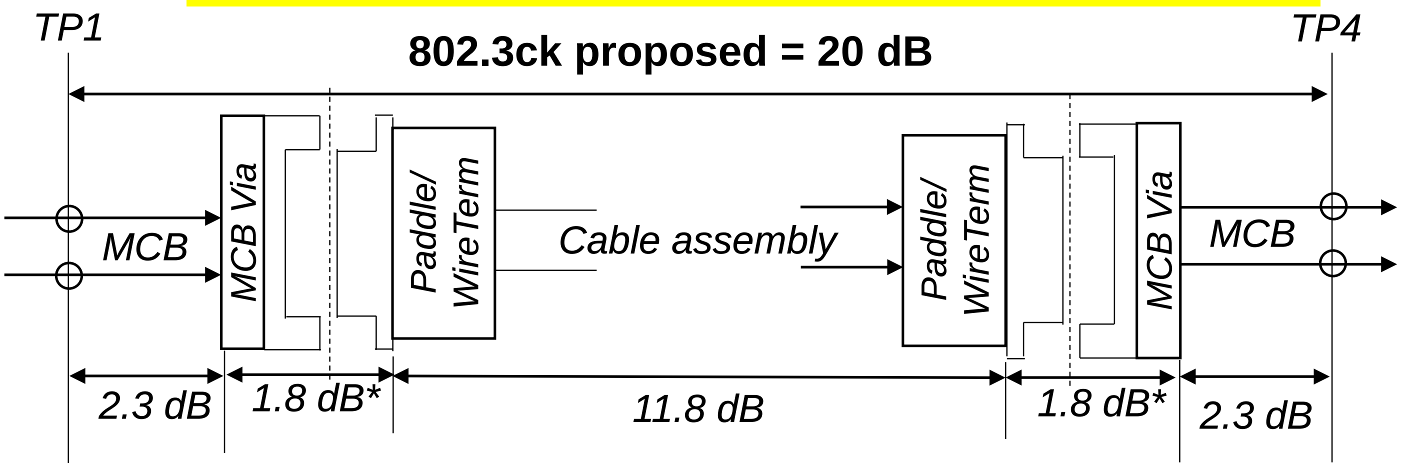
molex

Cable assembly - IL Review



Cable assembly IL= 17.16 dB @13.28 GHz =2*(1.2+1.07)+12.62



Note: The connector insertion loss is 1.6 and via allowance of 0.2 dB for the mated test fixture.

Cable assembly IL =20 dB @26.56 GHz =2*(2.3+1.6+0.2)+11.8

Cable assembly – baseline

- Cable assembly specifications – Adopt CL136 – referenced parameters @ 26.56 GHz, f=0.01≤f≤38 (signaling rate 53.125 GBd).

Cable assembly characteristics summary

Parameter description	Value	Unit
Maximum insertion Loss	20	dB
Minimum Insertion Loss	11.15	dB
Minimum ERL	TBD	dB
Differential to Common-mode return loss	Equation(TBD)	dB
Differential to Common-mode conversion loss	Equation(TBD)	dB
Common-mode to common–mode return loss	Equation(TBD)	dB
Minimum COM	TBD	dB

http://www.ieee802.org/3/ck/public/19_03/diminico_3ck_01_0319.pdf

Cable Assembly COM- Baseline

- COM - consistent with methodology CL136 – signaling rate 53.125 GBd
- COM parameter values TBD

Table 136–18—COM parameter values

TBD

Parameter	Symbol	Value	Units
Signaling rate	f_b	26.5625	GBd
Maximum start frequency	f_{min}	0.05	GHz
Maximum frequency step[a]	Δf	0.01	GHz
Device package model Single-ended device capacitance Transmission line length, Test 1 Transmission line length, Test 2 Single-ended package capacitance at package-to-board interface Package transmission line characteristic impedance	 C_d z_p z_p C_p Z_c	 1.8×10^{-4} 12 30 1.1×10^{-4} 95	 nF mm mm nF Ω
Single-ended reference resistance	R_0	50	Ω

Table 136–18—COM parameter values *(continued)*

TBD

Parameter	Symbol	Value	Units
Single-ended termination resistance	R_d	50	Ω
Receiver 3 dB bandwidth	f_r	$0.75 \times f_b$	GHz
Transmitter equalizer, minimum cursor coefficient	$c(0)$	0.6	—
Transmitter equalizer, 1st pre-cursor coefficient Minimum value Maximum value Step size	$c(-1)$	 –0.25 0 0.05	—
Transmitter equalizer, 2nd pre-cursor coefficient Minimum value Maximum value Step size	$c(-2)$	 0 0.1 0.025	—
Transmitter equalizer, post-cursor coefficient Minimum value Maximum value Step size	$c(1)$	 –0.25 0 0.05	—
Continuous time filter, DC gain Minimum value Maximum value Step size	g_{DC}	 –20 0 1	 dB dB dB
Continuous time filter, DC gain 2 Minimum value Maximum value Step size	g_{DC2}	 –6 0 1	 dB dB dB
Continuous time filter, zero frequency for $g_{DC} = 0$	f_z	f_b / 2.5	GHz
Continuous time filter, pole frequencies	f_{p1} f_{p2}	f_b / 2.5 $2 \times f_b$	GHz GHz
Continuous time filter, low-frequency pole/zero	f_{LF}	f_b / 40	GHz
Transmitter differential peak output voltage Victim Far-end aggressor Near-end aggressor	 A_v A_{fe} A_{ne}	 0.415 0.415 0.604	 V V V
Number of signal levels	L	4	—
Level separation mismatch ratio	R_{LM}	0.95	—
Transmitter signal-to-noise ratio	SNR_{TX}	32.5	dB
Number of samples per unit interval	M	32	—
Decision feedback equalizer (DFE) length	N_b	12	UI
Normalized DFE coefficient magnitude limit for $n = 1$ for $n = 2$ to N_b	$b_{max}(n)$	 0.7 0.2	—
Random jitter, RMS	σ_{RJ}	0.01	UI

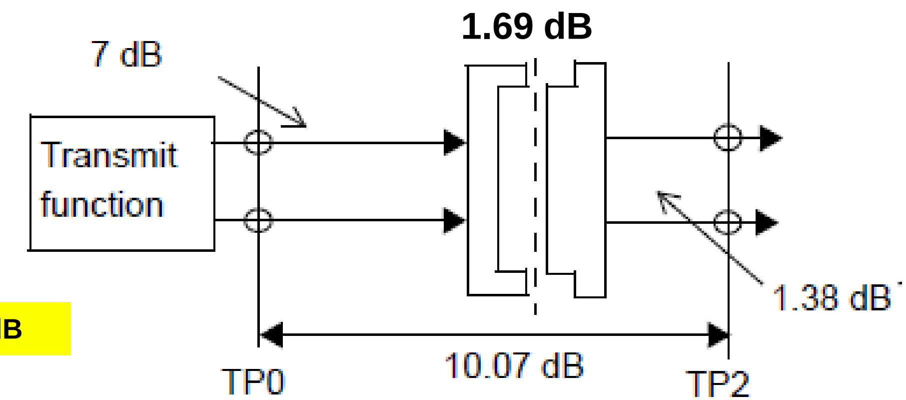
http://www.ieee802.org/3/ck/public/19_03/diminico_3ck_01_0319.pdf

Why 7.0 dB is Required for Host PCB Budget ?

- With Meg-7N material, 4.5mil trace IL at HT is measured to be 1.26 dB/in at 26.56 GHz
- For each front port channel there will be 2 set of vias (at host ASIC BGA footprint & at I/O connector footprint) with stripline routing
  - BGA footprint via with 7.9mil drill is simulated to be 0.73 dB at 26.56 GHz
  - Connector footprint via with 9.8mil drill is simulated to be 0.61 dB at 26.56 GHz
- Total host PCB budget = (4.5” x 1.26 + 0.73 + 0.61) = **7.01 dB**
- **Revised in this presentation to Total host loss budget**

Host - IL Review

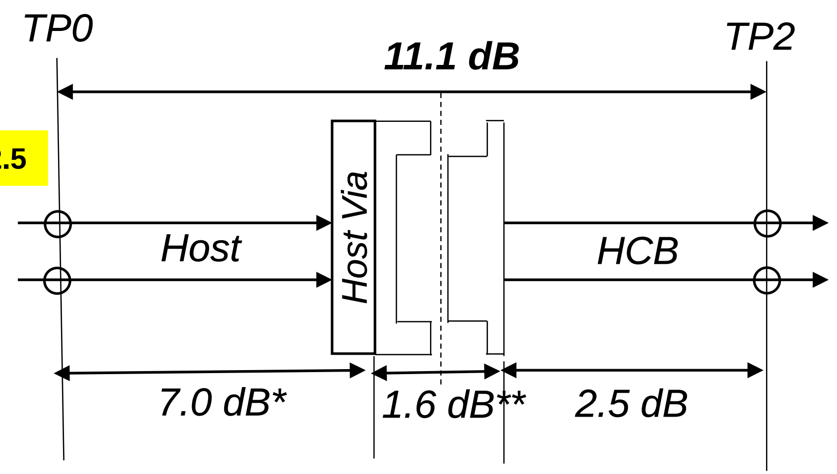
Host IL= 10.07 @13.28 GHz = 7+1.69+1.38 dB



802.3cd

NOTE—The connector insertion loss is 1.07 dB for the mated test fixture. The host connector is allocated 0.62 dB of additional margin.

Host IL = 11.1 dB @26.56 GHz =7.1+1.6+2.5



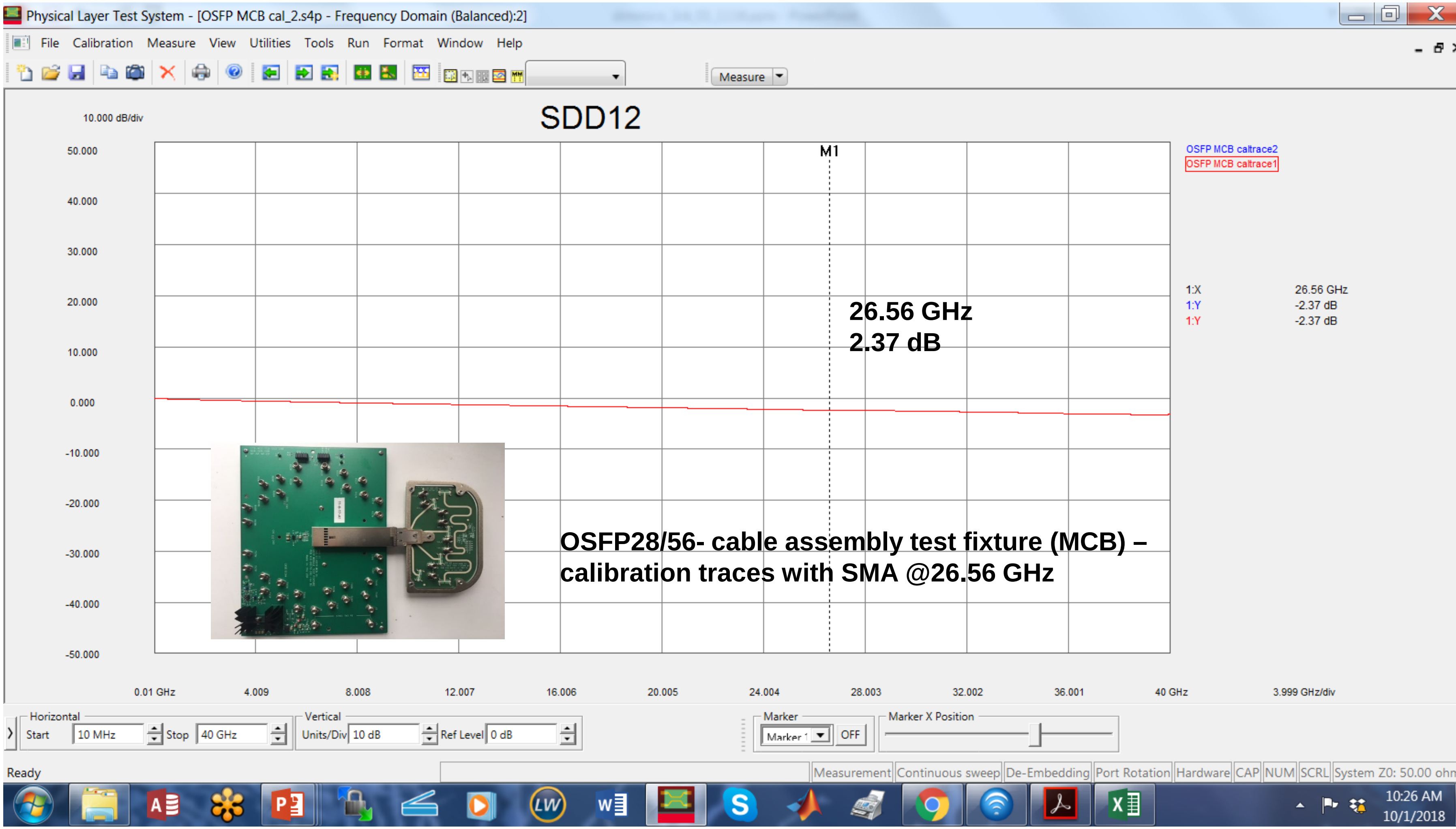
802.3ck proposed

Note: *The 7 dB includes via allowances of 1.34 dB - BGA (0.73) and connector (0.61).

*Note: **The connector mating interface is allocated 0.3 dB implementation allowance.*

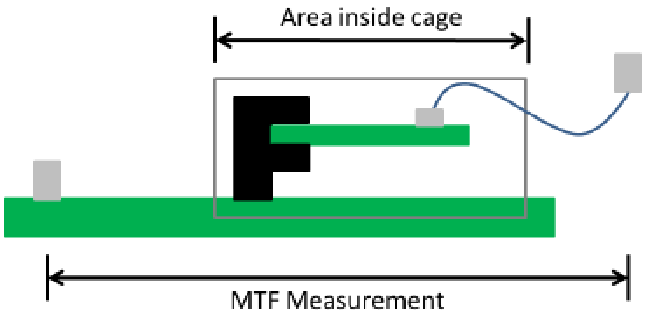
MTF - diminico_3ck_01_0519.pdf

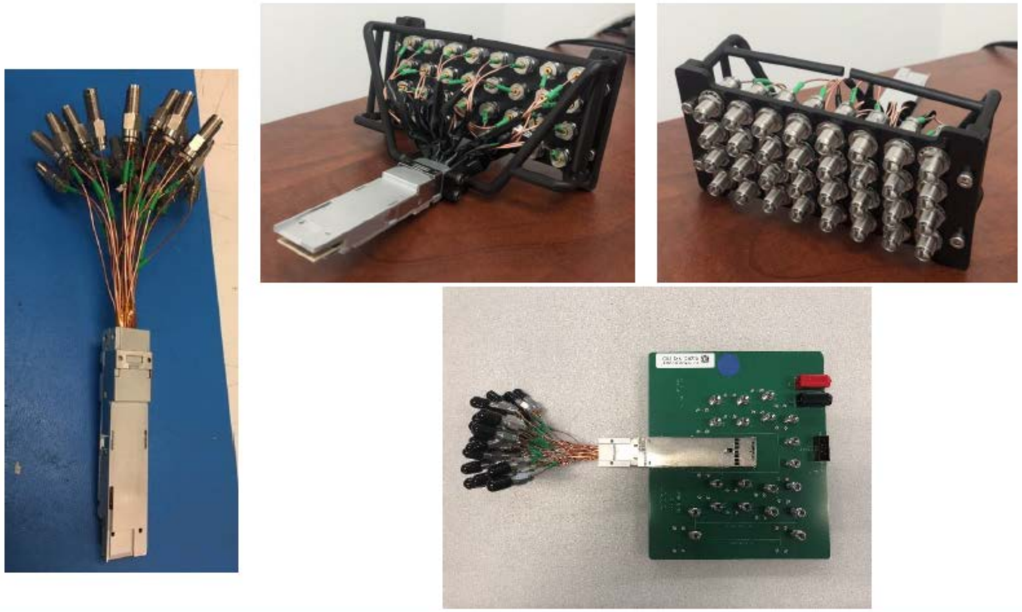
•MCB reference IL 2.3 dB @ 26.56 GHz achievable with PCB<>SMA



MTF - diminico_3ck_01_0519.pdf

- PCB + Cable IL 2.5 dB @26.56 GHz Achievable
- Breakout all 16 lanes for QSFP-DD and OSFP testing (32 single ended).
- No de-embedding



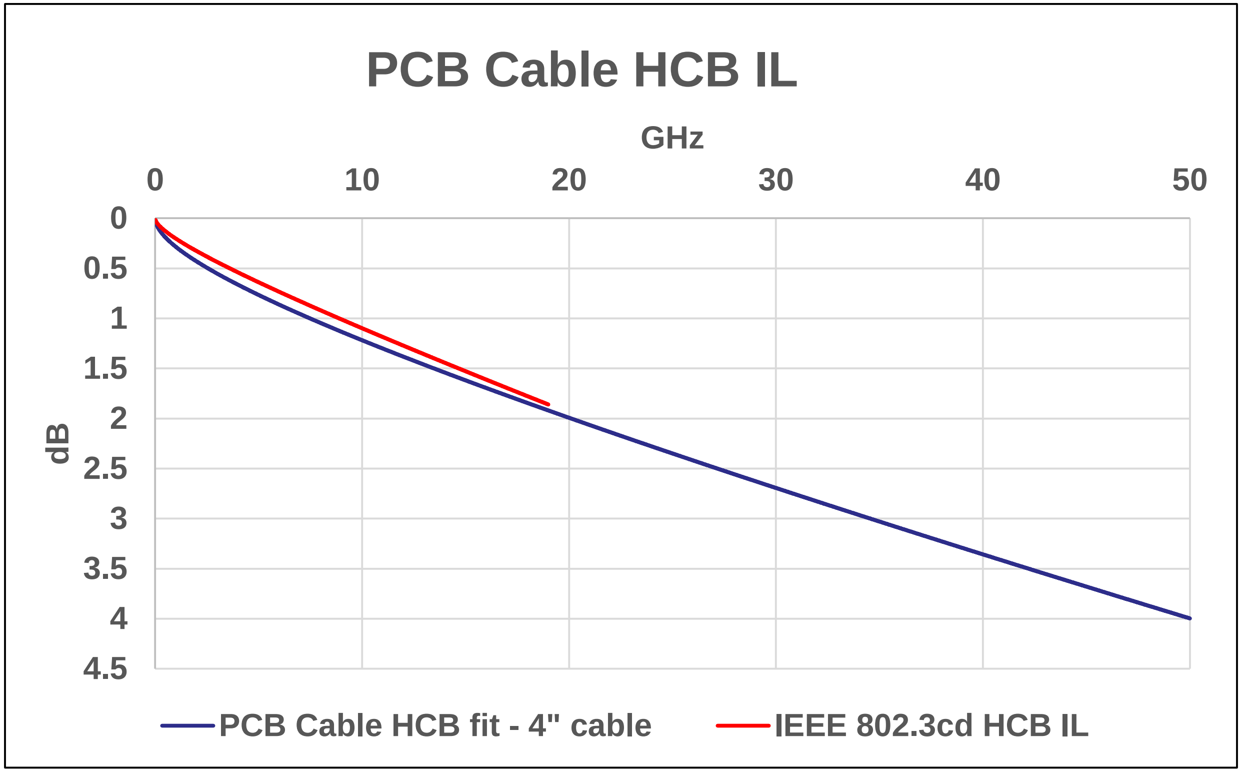


HCB with PCB and Cable

Content Source: OIF_Presentation_OIF2018_249_03.pdf, Sam Kocsis, Amphenol

MTF - diminico_3ck_01_0519.pdf

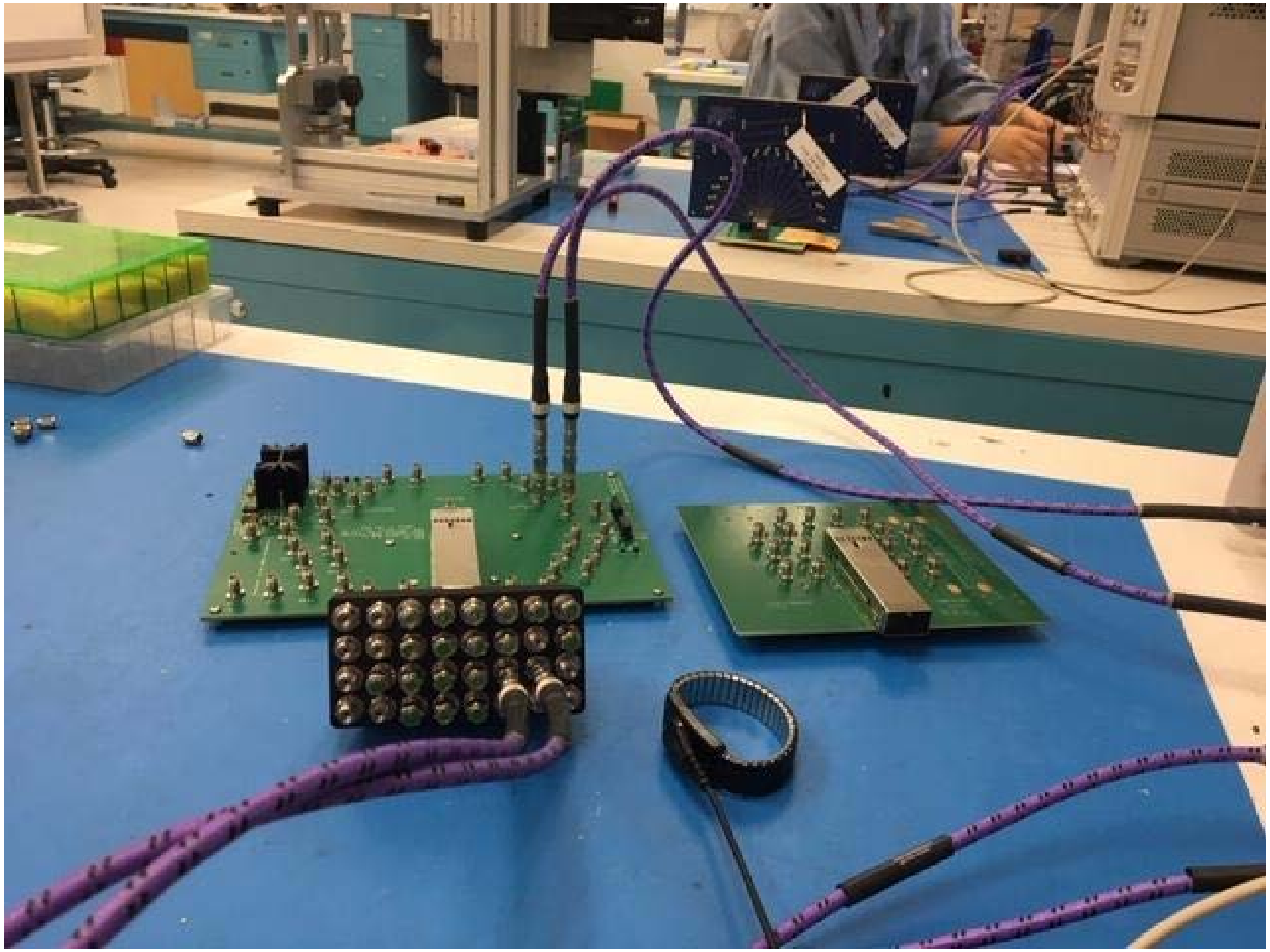
- HCB reference IL 2.5 dB @ 26.56 GHz achievable with PCB Cable HCB



HCB IL $(f_{GHz}) = 1.00*(0.001+0.360*SQRT(f_{GHz})-0.046*f_{GHz} \sim 2.5$ *dB* *4” cable*

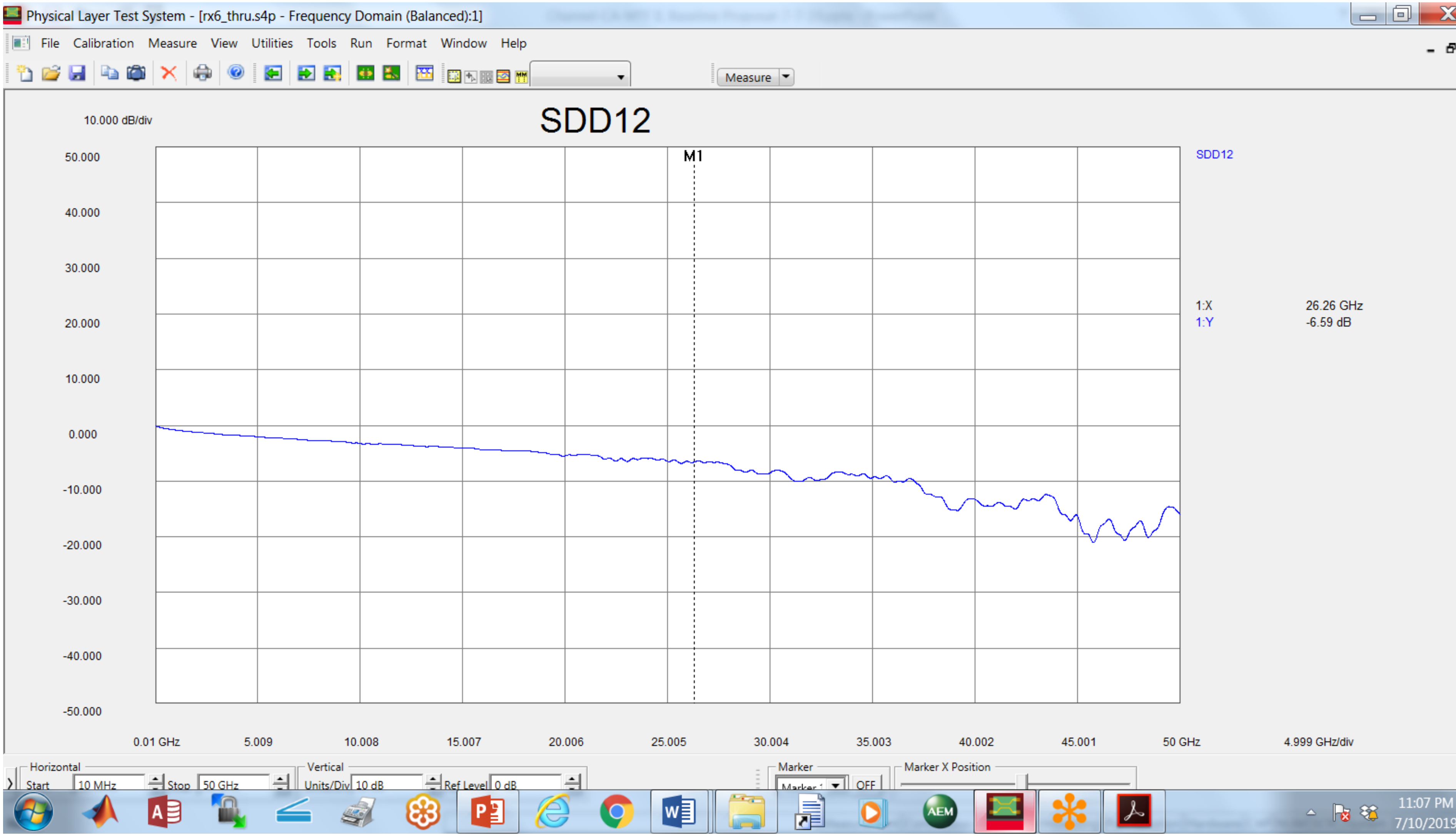
Content Source: OIF_Presentation_OIF2018_249_03.pdf, Sam Kocsis, Amphenol

Mated Test Fixtures



Contributor: Sam Kocsis, Amphenol

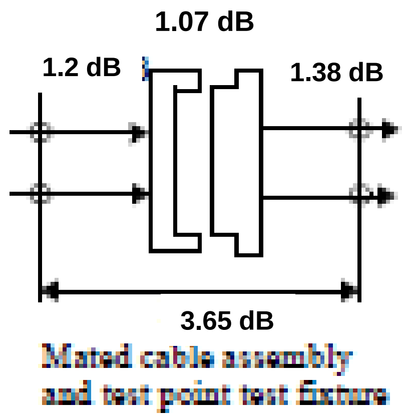
Mated Test Fixtures - IL



MTF - IL Review

802.3cd

MTF IL= 3.65 @13.28 GHz = 1.2+1.07+1.38 dB

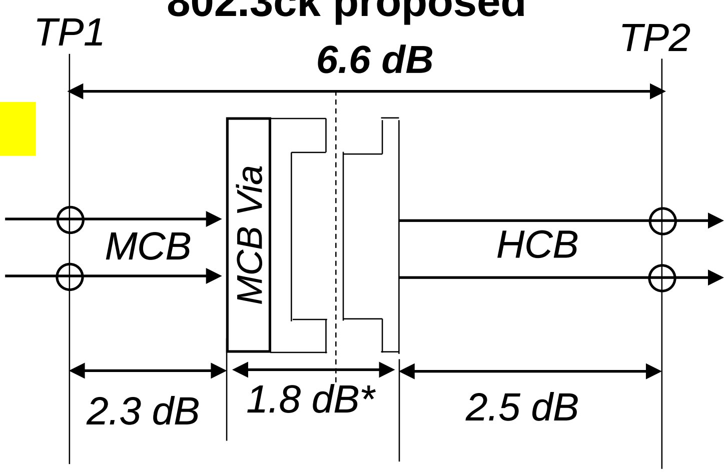


IL @ 13.28 GHz

Note: The connector insertion loss is 1.07 dB for the mated test fixture.
The host connector is allocated 0.62 dB of additional margin.

802.3ck proposed

MTF IL= 6.6 @26.56 GHz = 2.3+1.8+2.5 dB



Note: includes 0.2 dB via allowance

162B.1 Test Fixtures

- 802.3cd
  - (2) groups of MDIs
    - SFP28 MTF (1-Lane MDI)
      - Table 136B-1/2
    - Multi-Lane MTF (2,4,8-Lane MDI)
      - Table 136B-3/4

- 802.3ck
  - (4) groups of MDIs, per palkert_3ck_01_0918
    - SFP112 (1-Lane MDI)
    - SFP112-DD, DSFP (2-Lane MDI)
    - QSFP112, microQSFP, (4-Lane MDI)
    - QSFP-DD, OSFP (8-Lane MDI)

  http://www.ieee802.org/3/ck/public/18_09/palkert_3ck_01_0918.pdf

162B.1.1.1 MTF Insertion Loss

- Update MCB and HCB IL requirements, per diminico_3ck_01_0519
  - IL (CATF/MCB) = 1.073*(-0.00125+0.12*√(f)+0.0575*f) = 2.3dB (26.56GHz)
  - IL (HCB) = 1.00*(0.001+0.360*√(f)-0.046*f) = 2.5dB (26.56GHz)

  http://www.ieee802.org/3/ck/public/19_05/diminico_3ck_01_0519.pdf

- Update reference insertion loss equation 136B-1,

The reference insertion loss of the mated test fixture is determined using Equation (136B–1).

$$IL_{\mathrm{MatedTF}}(f) = 0.471\sqrt{f} + 0.1194f + 0.002f^2 \text{ (dB)} \qquad (136\text{B}–1)$$

for 0.01 GHz ≤ f ≤ 25 GHz

where

f is the frequency in GHz

ILmatedTF(f)=0.9502(0.471*SQRT(f)+0.1194*f+0.002*f^2)*
= 6.6 @26.56 GHz

Table 136B-1 and 136B-3 – MTF (ICN) Tables

Table 136B–1—SFP28 mated test fixture integrated near-end crosstalk noise parameters

Description	Symbol	Value	Units
Symbol rate	f_b	26.5625	GBd
3 dB reference receiver bandwidth	f_r	19.92	GHz
Near-end disturber peak differential output amplitude	A_{nt}	600	mV
Near-end disturber 20% to 80% rise and fall times	T_{nt}	9.27	ps

Table 136B–3—Multi-lane mated test fixture integrated crosstalk noise parameters

Description	Symbol	Value	Units
Symbol rate	f_b	26.5625	GBd
3 dB reference receiver bandwidth	f_r	19.92	GHz
Near-end disturber peak differential output amplitude	A_{nt}	600	mV
Far-end disturber peak differential output amplitude	A_{ft}	600	mV
Near-end disturber 20% to 80% rise and fall times	T_{nt}	9.27	ps
Far-end disturber 20% to 80% rise and fall times	T_{ft}	9.27	ps

162B.1.1.6 Mated test fixtures (ICN) Tables

Description	Symbol	Value	Units
Symbol rate	f_b	53.125	GBd
3dB reference receiver bandwidth	f_r	39.84	GHz
Near-end disturber peak differential output amplitude	A_{nt}	600	mV
Far-end disturber peak differential output amplitude	A_{ft}	600	mV
Near-end disturber 20% to 80% rise and fall times	T_{nt}	TBD	ps
Far-end disturber 20% to 80% rise and fall times	T_{ft}	TBD	ps

162B.1.1 Mated test fixtures

- Test Fixture specifications – Adopt– referenced parameters 26.56 GHz f=0.01≤f≤40 (signaling rate 53.125 GBd).

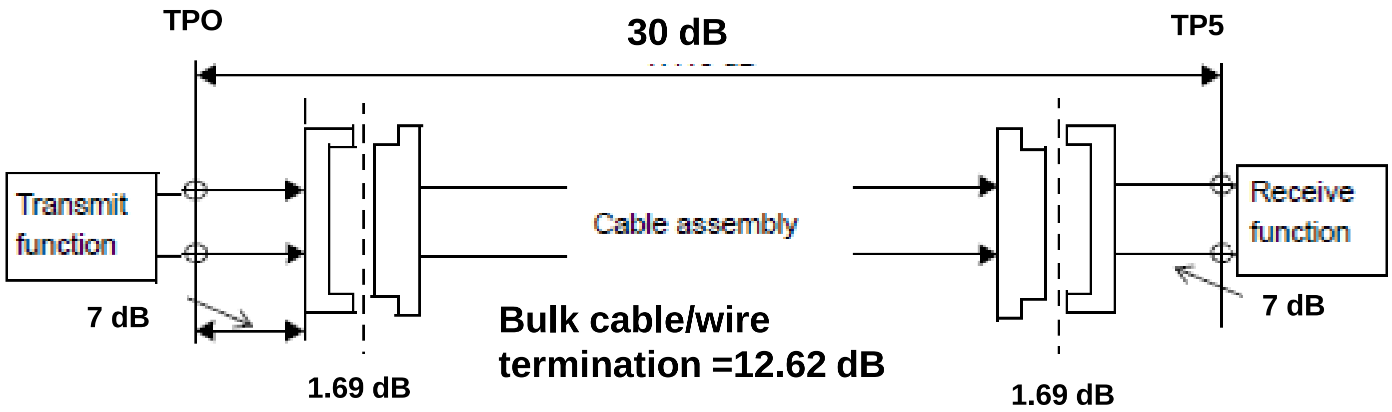
Mated test fixtures parameters

Parameter description	Value	Unit
Maximum differential insertion Loss	Equation(TBD)	dB
Minimum differential Insertion Loss	Equation(TBD)	dB
Reference differential insertion loss	Equation (slide 22)	dB
Figure of Merit(FOM) ILD	Equation(TBD)	dB
Minimum Differential Return Loss	Equation(TBD)	dB
Common-mode conversion insertion loss	Equation(TBD)	dB
Common-mode return loss	Equation(TBD)	dB
Common-mode to differential –mode return loss	Equation(TBD)	dB
Integrated crosstalk noise	(TBD)	mV

http://www.ieee802.org/3/ck/public/19_03/diminico_3ck_01_0319.pdf

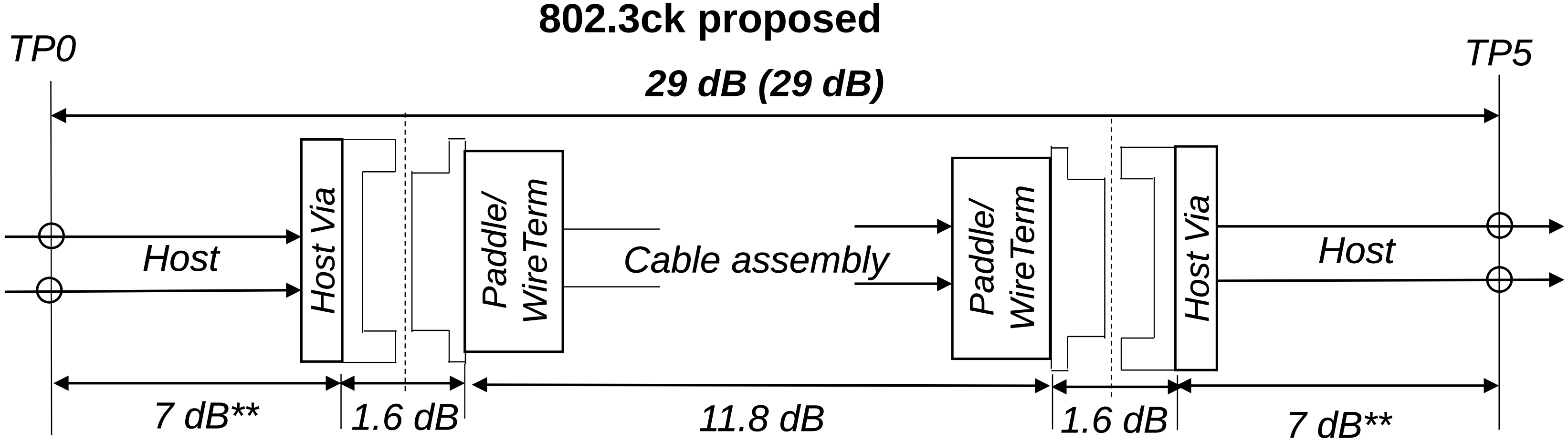
Channel - IL Review

802.3cd



Channel IL = 30 dB @13.28 GHz =2*(7+1.69)+12.62

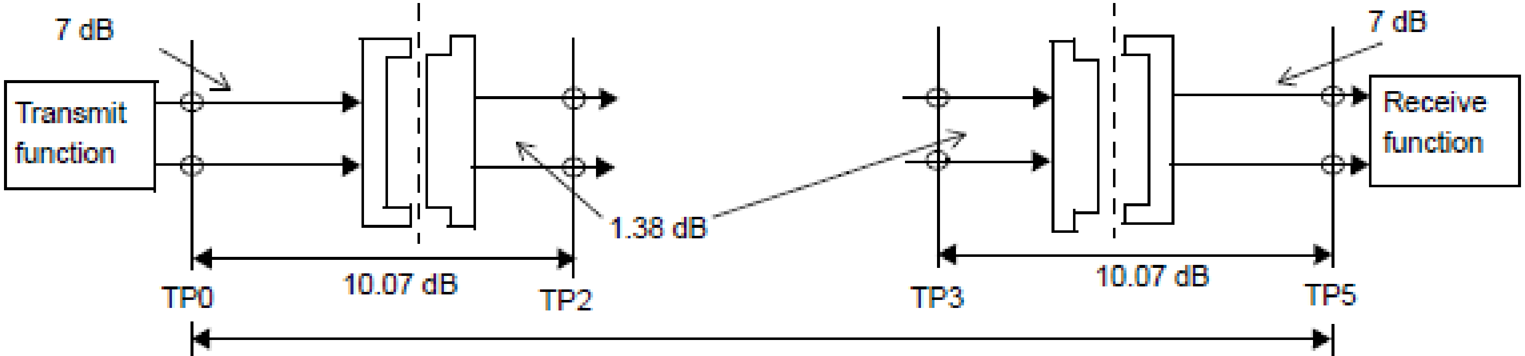
802.3ck proposed



Channel IL (TBD) = 29 dB @26.56 GHz =2*(7+1.6)+11.8

Channel - IL Review

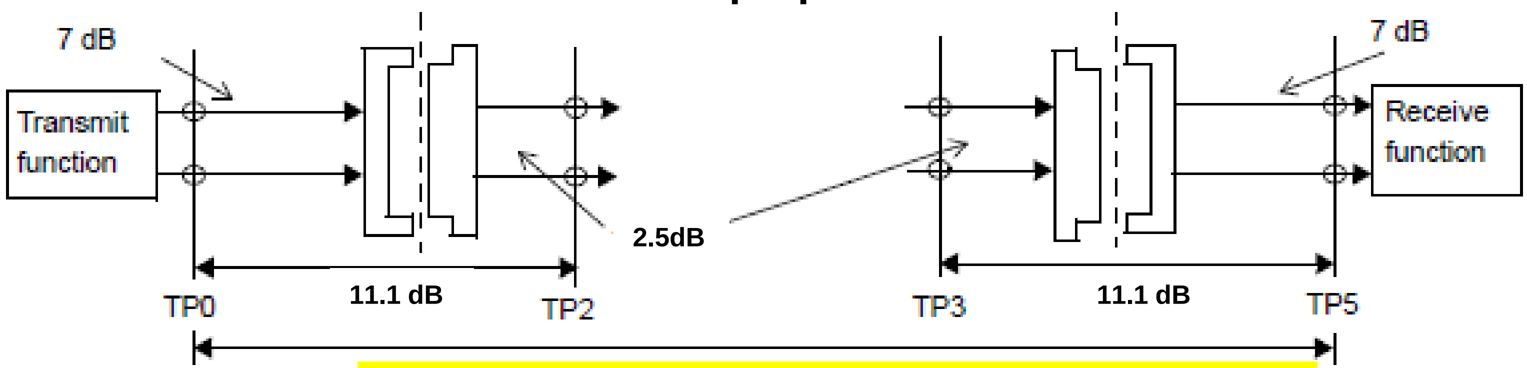
802.3cd



17.16 + (2 × 10.07) – (2 × 3.65) = 30 dB

CA Host MTF Channel

802.3ck proposed



Channel IL= 20+(2*11.1)-(2*6.6)=29 (TBD) dB

CA Host MTF Channel