Dual Port Type MDI

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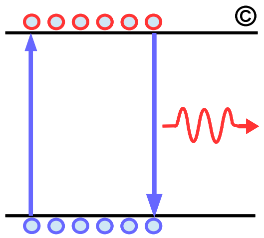
List of Supporters

- **Rob Stone – Broadcom**
- **Jane Lim – Cisco**
- **Pirooz Tooyserkani - Cisco**
- **David Piehler - Dell**
- **Xinyuan Wang – Huawei**
- **Hong Feng - Huawei**

Background



- **During May interim meeting ghiasi_3ck_01a_050918.pdf investigated 3 options for C2M and Cu MDI**
  - Symmetric – single port type with 10.4 dB loss will double host retimers to support C2M applications
  - Asymmetric – single port type switch-NIC ports with 14 dB loss for switch and 7 dB for NIC but NIC loss is restrictive
  - Symmetric – dual port type 15 dB for C2M/AOC and 10.4 dB for port type supporting Cu
- **After further investigations and consensus building 802.3ck group should consider symmetric dual port but compatible with 16 dB for C2M applications and ~11.5 dB for Cu MDI**
  - Symmetric single port type in order to support 2 m Cu restrictive on C2M applications and require adding retimers on the host card
  - Asymmetric single port type supporting 2 m Cu cable challenging and require impractical loss on the NIC and does not support switch-switch applications
- **This contribution also investigates how to improve measurement methodology and how to deal with mated boards for MDIs from one lane to 8 lanes.**

C2M Channel Reach

- **PCB loss estimate assumptions and tools for calculation**
  - Rogers Corp impedance calculator (free download but require registration) https://www.rogerscorp.com/acm/technology/index.aspx
  - The IEEE tool if updated could be another option to estimate channel reach http://www.ieee802.org/3/bj/public/tools/Reference__DkDf_AlegbraicModel_v2.04.pdf
  - Stripline ~ 50 Ω, trace width is 5.5 mils, and with ½ oz Cu HVLP
  - Isola 408HR DK=3.65, DF=0.0095, RO=2.5 um, Meg-6 DK=3.4, DF=0.005, RO 1.2 µm, Tachyon100 DK=3.02, DF=0.0021, RO=1.2 µm
  - To support equivalent PCB traces for C2M need at least 15 end-end channel loss consistent with tracy_100GEL_01a_0118
  - Assumed loss for two vias is 1 dB@26.55 GHz.

Host Trace Length (in)	Total Loss (dB)	Via Loss (dB)	Host PCB Loss(dB) - 2 via loss	Isola 408HR	Megtron 6	Tachyhon100
Nominal PCB Loss/in at 5.15 GHz	N/A	0.05	N/A	0.65	0.52	0.46
Nominal PCB Loss/in at 13 GHz	N/A	0.15	N/A	1.27	0.98	0.83
Nominal PCB Loss/in at 27 GHz	N/A	0.5	N/A	2.18	1.60	1.28
10GSFP+ with one connector & HCB	6.5	N/A	4.9	7.5	9.4	10.7
28G-VSR + stack connector *	10.3	N/A	6.31	5.0	6.4	7.6
100G Cu MDI SMT Connector **	11.5	N/A	7.5	3.4	4.7	5.9
100G Cu MDI Stacked Connector ***	11.5	N/A	6.5	3.0	4.1	5.1
C2M with SMT connector **	16	N/A	11.5	5.3	7.2	9.0
C2M with Stacked connector ***	16	N/A	10.5	4.8	6.6	8.2

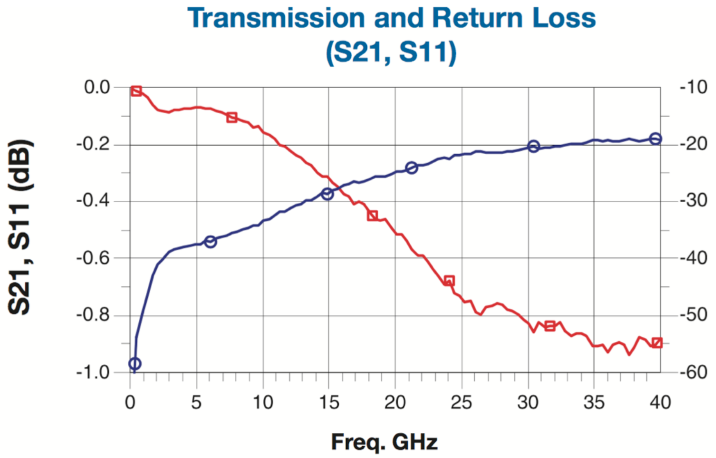
* Assumes connector loss is 1.69 dB and HCB loss is 2.0 dB at 12.89 GHz

** Assumes SMT connectors with 1 dB loss, 2.5 dB for HCB, and 1 dB for 2 vias at 26.55 GHz.

*** Assumes SMT connectors with 2 dB loss, 2.5 dB for HCB loss at 26.55 GHz, and 1 dB for 2 vias at 26.55 GHz.

Building Cu Cable Assembly Loss from Ground Up

- **Assuming 2 m objective can only be met with 26 AWG**
  - Also supporting ~1.3 m on 28 AWG
- **QSFP Cu cable loss estimate 4.85 dB/m for 26 AWG and 7.4 dB for 28 AWG, slightly better than reported in**
  - http://www.ieee802.org/3/100GEL/public/18_03/palkert_100GEL_01a_0318.pdf
- **Key assumed cable assembly losses:**
  - DC block 0.8 dB one of
  - Plug PCB loss 0.75 dB 2 of
  - MCB connector 1 dB 2 of
  - Nominal MCB PCB board loss 1 dB 2 of
  - Analysis does not include any via loss associated with QSFP-dd rear contacts
- **Reducing Cu cable assemblies loss <17.0 dB may result not meeting our 2 m reach objective!**

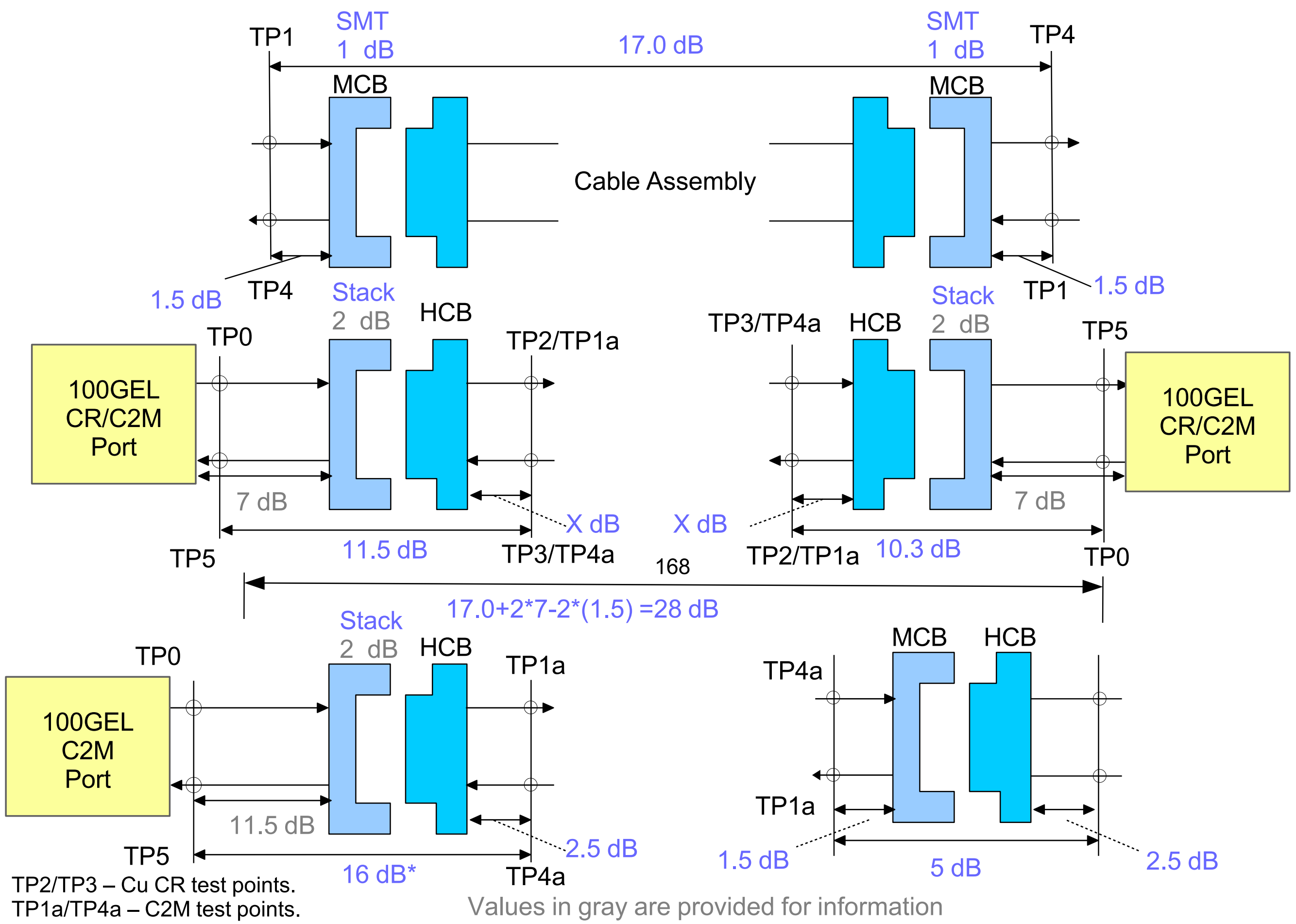


Presidio Microwave Broadband DC Block MBB0502X104MGP5C8

Cable assembly element loss @ 26.55 GHz	2 m 26 AWG	1.3 m 28 AWG
Cable loss dB/m	4.85	7.40
Cable loss (dB)	9.7	9.6
Nominal MCB PCB loss 2 of (dB)	3.0	3.0
MCB connector loss 2 of (dB)	2.0	2.0
Cable plug PCB loss 2 of (dB)	1.5	1.5
DC block (dB)	0.8	0.8
Cable assembly end-end loss (dB)	17.0	16.9
Host PCB + Host Connector Loss (dB) (28- 17.0 + 2*MCB Loss))/2	7.00	7.04

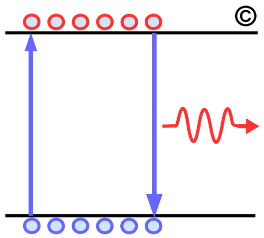
Proposed Symmetric Dual-Port Types

- **Symmetric dual-port type allow building a superset port supporting passive Cu cable and optical port/AOC or build an optical/AOC/Active Cu ports if passive Cu cable support not required**
- **As the figure illustrate the normative compliance points TP2/TP3 and TP1a/TP4a can support multiple MDIs and each of the MDIs may have distinct MCB/HCBs**
- **QSFP-dd/OSFP 8 lanes HCB may require construction of HCB1/2 or de-embeding**
- **Symmetric dual-port type with 11.5 dB host budget supports both C2M and Cu MDI**
  - Proposed symmetric dual-port type budget assumes 28 dB ball-ball to support 2 m of passive Cu cable with loss of 17.0 dB
- **C2M ports with 15 dB supports optical/AOC**
  - C2M host channel loss based on 11.5 dB after assuming stack connector with 2 dB loss but an SMT host may allocate 11.5 dB
    - 2 Vias will reduce above budget by ~ 1 dB.



* Assues 3 dB ASIC package actual AUI channel loss determined with COM.

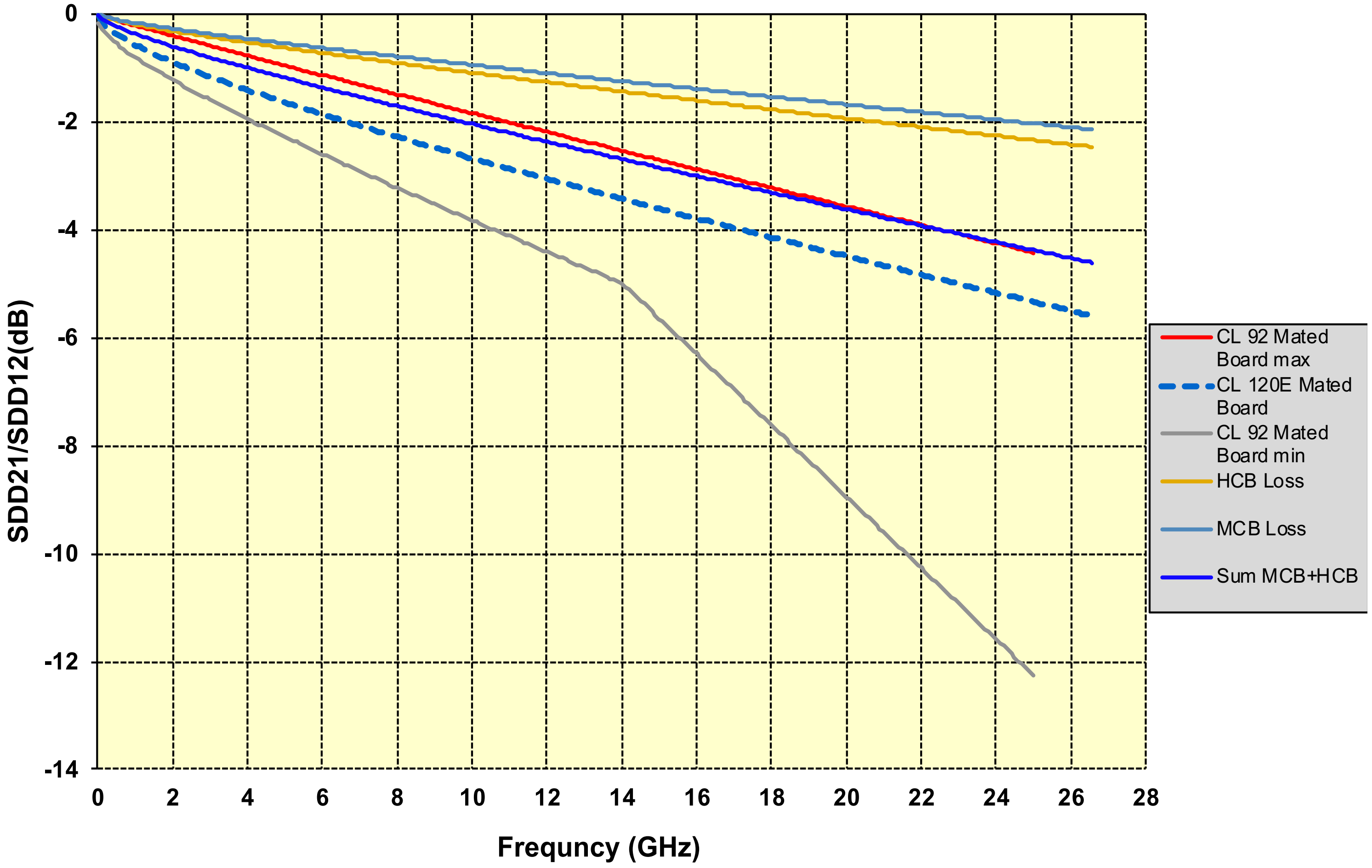
Why Use COM for C2M



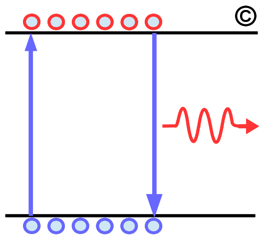
- **The normative TP1a/TP4a EW/EH historically measured with reference EQ on the scope**
  - Clause 120E defines C2M loss *up to 10.2 dB*
  - In practice any host/SerDes that deliver the TP1a EW/EH is compliant then why use COM?
  - We have a wide range of MDIs SFP-112, SFP-dd, QSFP112, QSFP-dd, and OSFP from 1-8 lanes with different crosstalk, ILD, and reflections
    - Crosstalk will be very different between 1 vs 8 lanes
    - Some of these connector may perform better than others
    - Stack connector vs SMT connector
    - More complex PCB routing to 8 lanes modules
  - COM can be used as channel design guide to improve compliance given the diverse set of ports supported
- **Propose starting point for COM/channel analysis (ADS, etc):**
  - 4 tap TX FFE (2 pre)
  - 5 tap RX FFE with 4 post or equivalent
    - To measure TP1a/TP4a signals the reference EQ needs to be implementable on sampling scopes
    - The 5 tap FFE T-spaced already used for TDECQ
  - Host ASIC package having 4 dB loss and CDR package with 1 dB loss @26.55 GHz
  - Operation up to 15 dB of well constructed channels with 4 dB package or 16 dB channel with 3 dB package
    - http://www.ieee802.org/3/100GEL/public/18_01/tracy_100GEL_01a_0118.pdf
    - http://www.ieee802.org/3/100GEL/public/18_03/lim_100GEL_01b_0318.pdf.

Overview of Current Mated Boards

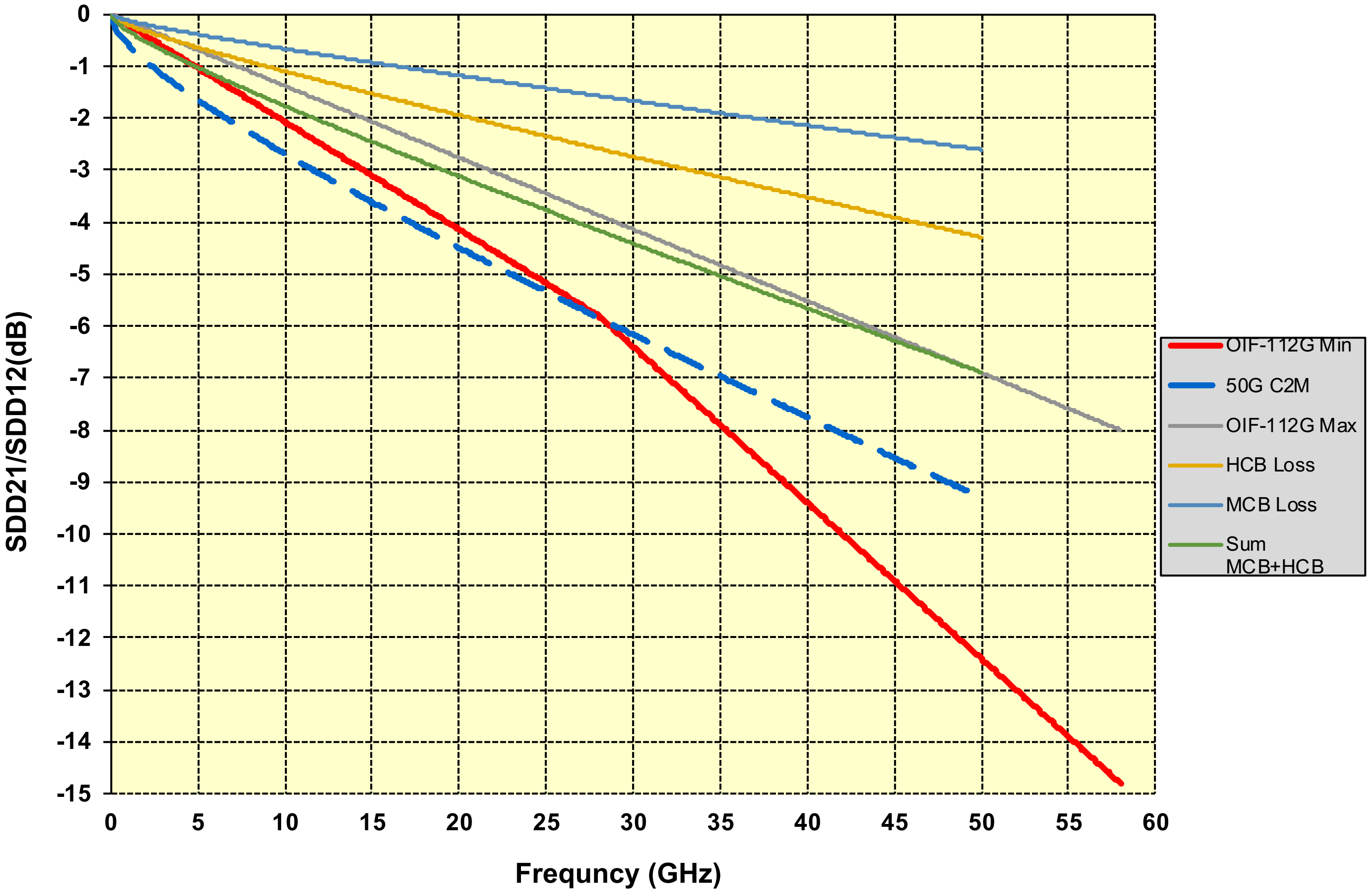
- **IEEE 802.3 CL92.11 mated boards are the bases for CL120E.4.1 and CL 136B**
  - CL120E/136B nominal mated board loss to CL92 mated boards
  - CL92 mated board bases were Ghiasi_3bj_01a_0912.pdf
  - CL92 boards were constructed from Rogers 4350B with DF=0.037@10 GHz where today Megtron-7N has DF=0.02@10 GHz so improved board can be built now even with standard PCB material
- **CL 92 states deviation from reference mated board loss should be accounted in the measurement**
  - No specific method how to account for any deviation
  - Unless the mated board are improved drastically then it further raises the need to better account for board variations at 53 GBd!



Starting Point for 53 GBd Mated Boards



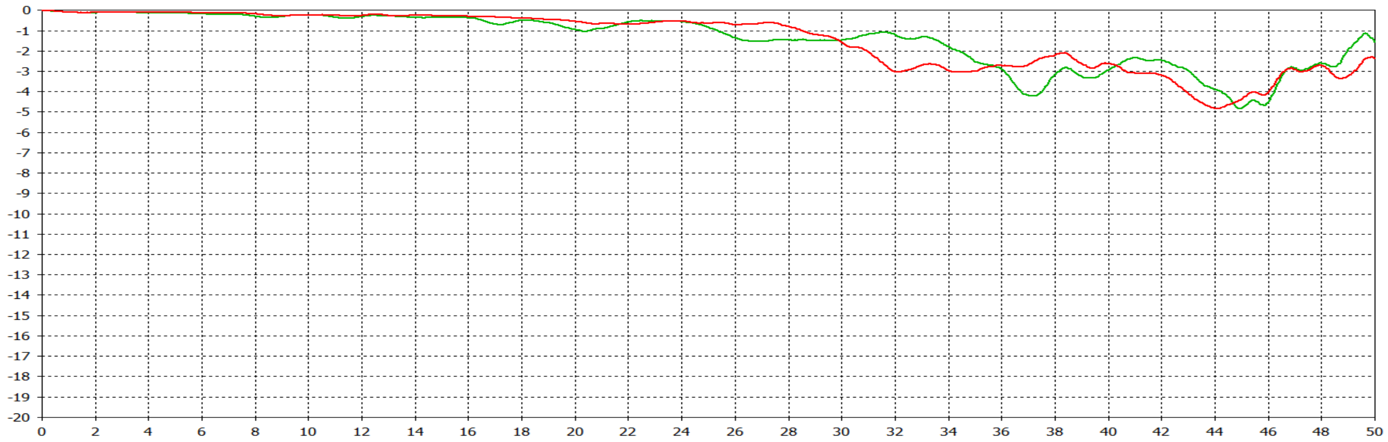
- **Graph on the right extend CL92 and CL120E/CL136B from 25 GHz to 50 GHz**
  - In addition the graph includes OIF 112G-VSR mated boards
  - At 28 GHz OIF-112G-VSR max loss overlaps wit CL120E/CL136B mated board having a loss of 6 dB
  - CL92 mated board loss can be improved by ~1/3 if one uses higher grade material instead of RO4350B that was used in Ghiasi_3bj_01a_0912.pdf
- **We have more MDI with different attribute than ever before**
  - SFP112 – single lane
  - QSFP112 – 4 lanes
  - QSFP-dd – 8 lanes but 4 of the lanes have 2 via
  - OSFP – 8 lanes
- **Unless we account for MDI differences, will end up throwing away precious host PCB trace reach and increase product passing/failing hysteresis!**



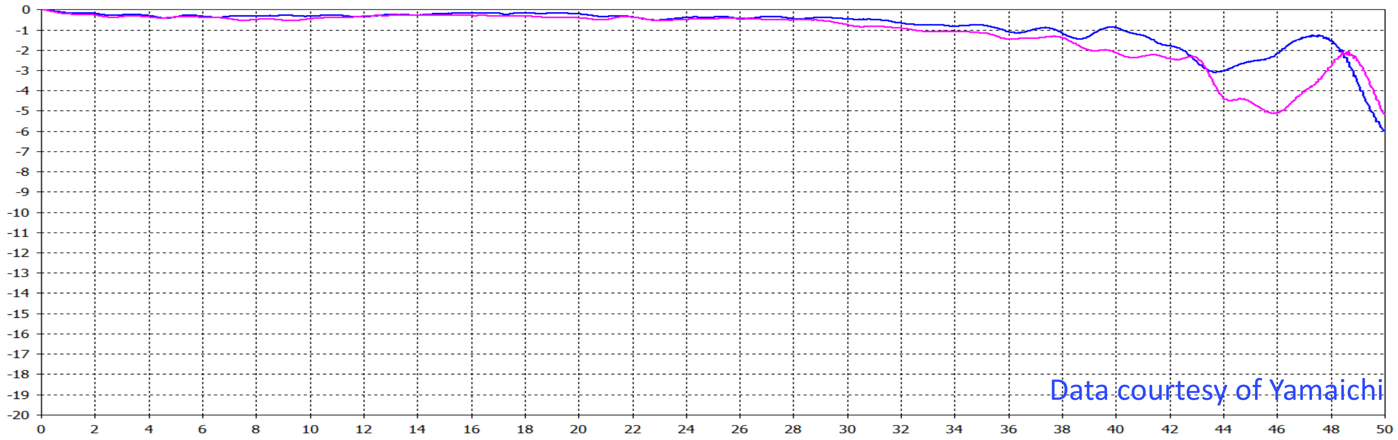
Example of SMT Connector Suitable for 100GEL

- **Yamaichi QSFP-56 and OSFP SMT connector suitable for MCB construction has loss <1 dB**
  - But the stack connector loss estimated to be in 2-2.5 dB @26.55 GHz!

QSFP-56



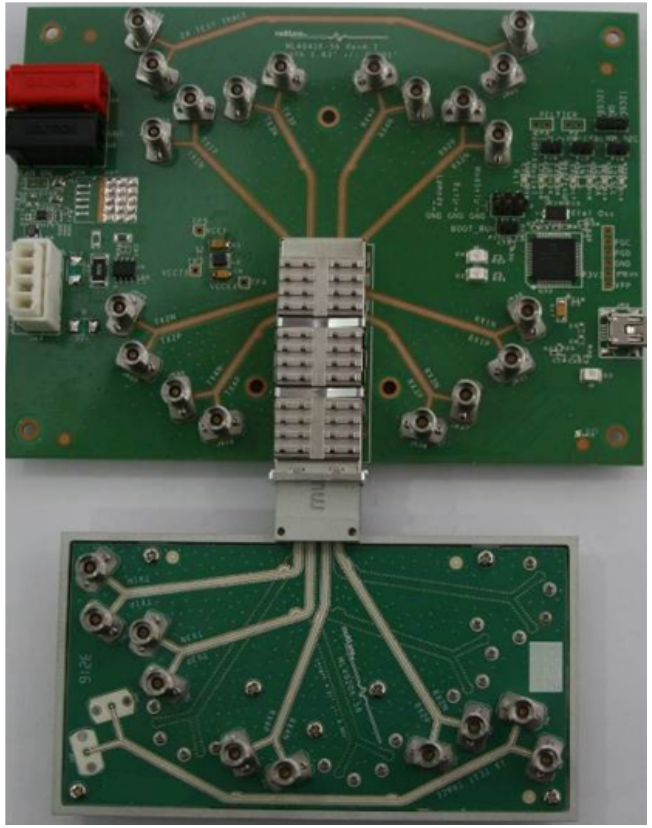
OSFP

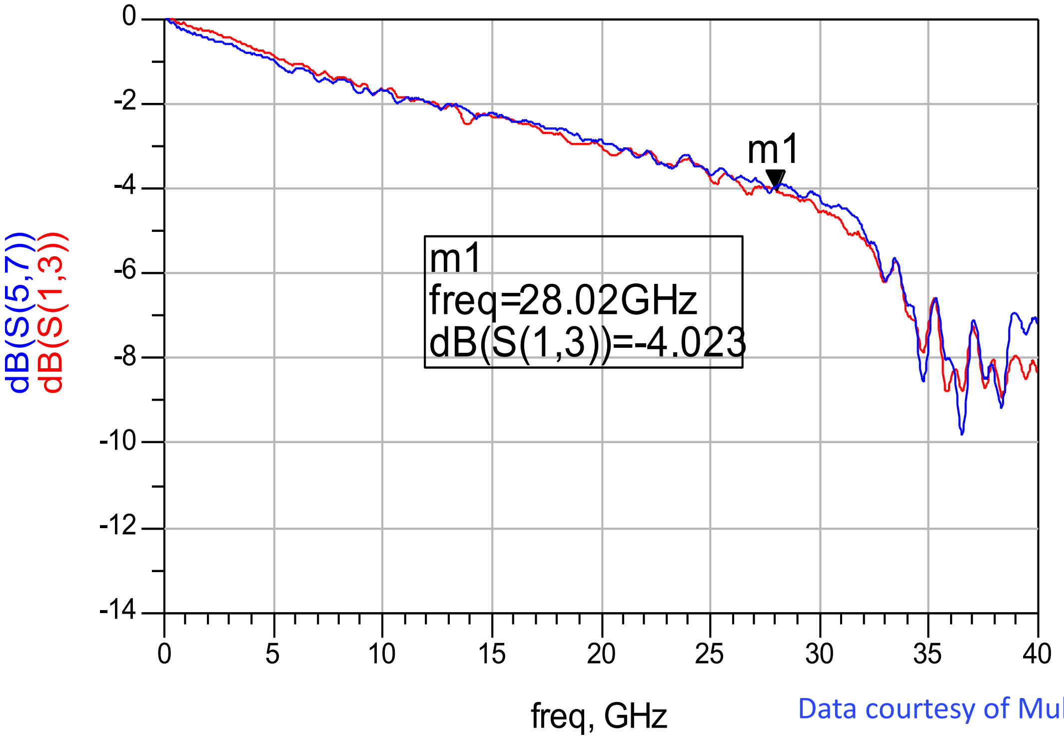


Example Mated Board Suitable for 100GEL

©

- **Multilane mated board using Yamaichi QSFP-56 connector**
  - A QSFP56 mated board below has about the same loss at 26.55 GHz as current 50G test boards at 13.27 GHz!
  - An SFP112 board could be constructed to have even lower loss
  - OSFP/QSFP-dd HCB with octal I/O would require at least 6" long HCB with narrower traces which may push the HCB loss to 5 and the mated board to 8 dB
  - Should we instead consider cabled HCB or custom high density RF connectors for OSFP/QSFP-dd to reduce the loss to sub 5 dB?





MCB Trace length ~1.7"
HCB Trace Length ~4.2"
Material Rogers 3003
DK=3.0, DF=0.001@ 10 GHz

Data courtesy of Multilane

Distinct Port/Connectors Will Use Distinctly Different Mated Boards

- **Is it really outrageous to have different mated board specifications/loss for SFP112 vs QSFP-dd?**
  - Clause 136C defines each of these distinct SFP28, QSFP28, µQSFP, QSFP-dd, and OSFP connectors
  - We shouldn't saddle the SFP112/QSFP112 with additional loss in order to have one mated board specifications
  - We could define 5 mated boards but high loss 7.5-8 dB mated board will not provide representative results for QSFP-dd/OSFP!

Table 136C–1—Number of PMDs supportable for each connector type

MDI types	50GBASE-CR	100GBASE-CR2	200GBASE-CR4	Mated Board Loss 26.55 GHz (dB) if all 8 signal pairs are broken
SFP28	1	—	—	~3.5 dB
QSFP28	1, 2, 4	1, 2	1	~4.0 dB
microQSFP	1, 2, 4	1, 2	1	~4.5 dB
QSFP-DD	1, 2, 4, 8	1, 2, 4	1, 2	~8 dB
OSFP	1, 2, 4, 8	1, 2, 4	1, 2	~7.5 dB

How to Deal Perplexity of Mated Boards

- **Lets step back some 10 years ago when we created SFP+ mated board as part of SFF-8431**
  - The HCB RF connector location was representative of the module PMA/PMD input/output chip balls
  - The MCB RF connector was representative of min host loss
- **For sake of simplicity we can go with 1.5 dB MCB loss for all MDIs**
- **Technically we can define 4 different mate board specifications if needed with identical C2M specifications at TP1a/TP4a and Cu CR specifications**
- **We have two options how to deal with perplexity of HCB in support of OSFP/QSFP-dd**
  - Go with 2.5 dB HCB loss and mated board loss of 5 dB for all MDIs as shown on page 6 figure
    - QSFP-dd/OSFP HCB would need to be constructed with cable, use HCB1 and HCB2 to reduce trace length ~4”, or use de-embeding
    - Define a set of optimized MCB/HCB for each of the representative MDIs SFP112, QSFP112, QSFP-dd, and OSFP and use higher loss for QSFP-dd/OSFP HCB but may not produce representative and accurate results
- **What ever scheme we choose shouldn’t penalize SFP112/QSFP112 and should produce representative/accurate results for QSFP-dd/OSFP!**

Summary

- **Dual port symmetric offers practical solution to support C2M and CRx applications**
  - The proposed C2M budget can support up to 16 dB with 3 dB package consistent with lim_3ck_01_0718.pdf
    - To keep module PMA power reasonable should keep channel+ASIC package loss ≤ 19 dB
  - The proposed CRx TP0-TP2 is 11.5 dB
- **At 112G no longer we have luxury of extra margin and overall test methodology needs to improve**
  - Testing cables using an MCB with SMT connectors with lower loss/crosstalk but with deployed system using stacked connector may result in 2-3 dB increase in end-end loss and possibly as much as 6 dB increase in PSXT
    - COM could potentially provide two additional knobs to adjust for connector loss and PSXT
    - Another alternative is to test cable with MCB having stack connectors
  - Given the diverse set of MDIs with varying degree of crosstalk/loss need to consider using COM for C2M
- **802.3ck is defining PMDs for a diverse set of MDIs: SFP112, QSFP112, μQSFP, QSFP-dd, and OSFP**
  - Defining 8 dB mated board loss needlessly penalizes SFP112, QSFP112, μQSFP and wouldn't produce representative/accurate results equivalent to PMA/PMD BGA balls instead need to consider using HCB1/2, cabled HCB, or de-embeding
  - SFP112, QSFP112 and μQSFP can be constructed using premium PCB material with mated loss of ≤5 dB
    - We should not saddle SFP112/QSFP112 mated boards with extra loss and loose precious link budget
  - Overall the best option is to use 5 dB mated board loss for all MDIs and use HCB1/HCB2 or de-embeding for QSFP-dd/OSFP ports.