QSFP-DD 2m Cable Channels

Tom Palkert
March 2019

molex®
one company › a world of innovation

Supporters:

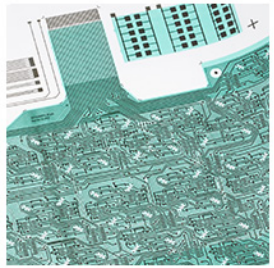
- Alex Haser, Molex
- Scott Sommers, Molex
- Sam Kocsis, Amphenol
- Erdem Matoglu, Amphenol
- Greg McSorley, Amphenol
- Nathan Tracy, TE

Overview:

- 2m QSFP-DD Cable Simulation
- COM Results
- 112G Loss Budget
- Thermal Considerations
- Conclusions

molex



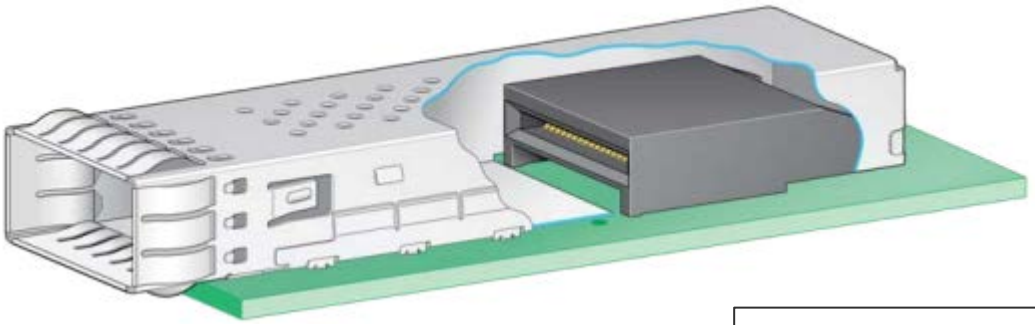


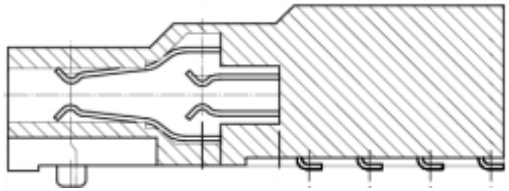
2m QSFP-DD Cable Simulation:

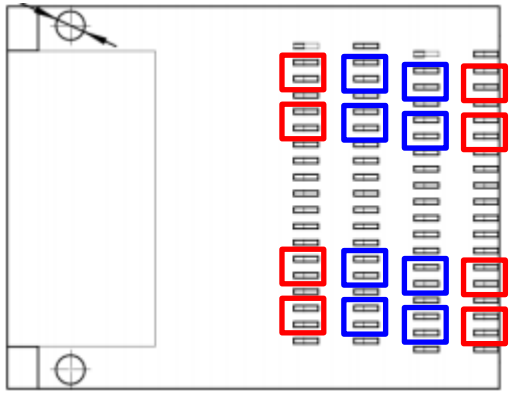
molex

QSFP-DD Model

- Full connector/ wire termination model
- 2m cable reach
- Mounted to MCBs (TP1 to TP4)





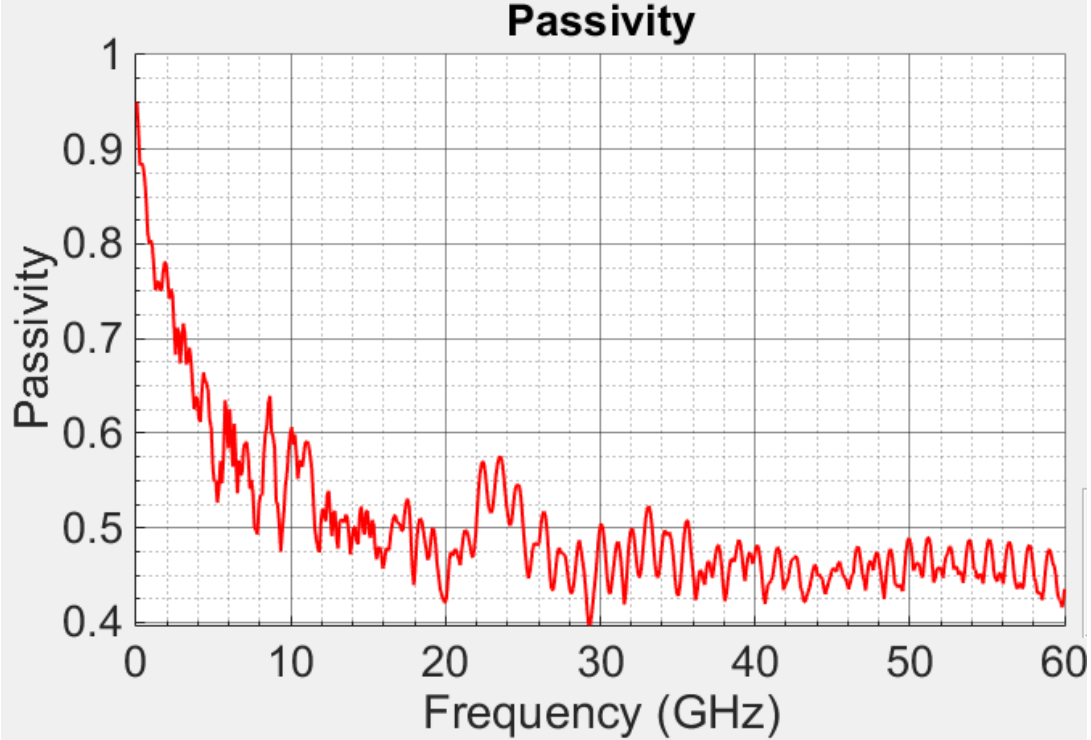


Bottom of connector

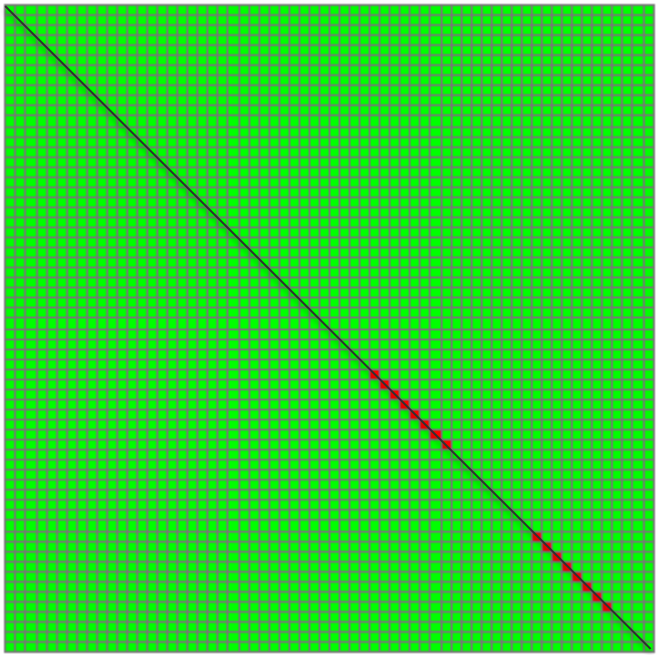
Legacy Pairs
DD Pairs

molex

Passivity:

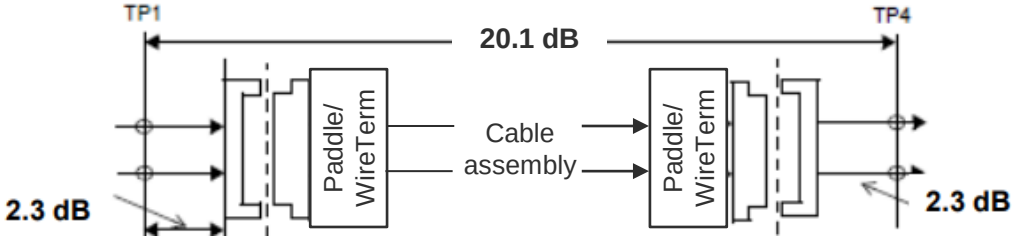

Passivity
Passivity
1
0.9
0.8
0.7
0.6
0.5
0.4
0
10
20
30
40
50
60
Frequency (GHz)

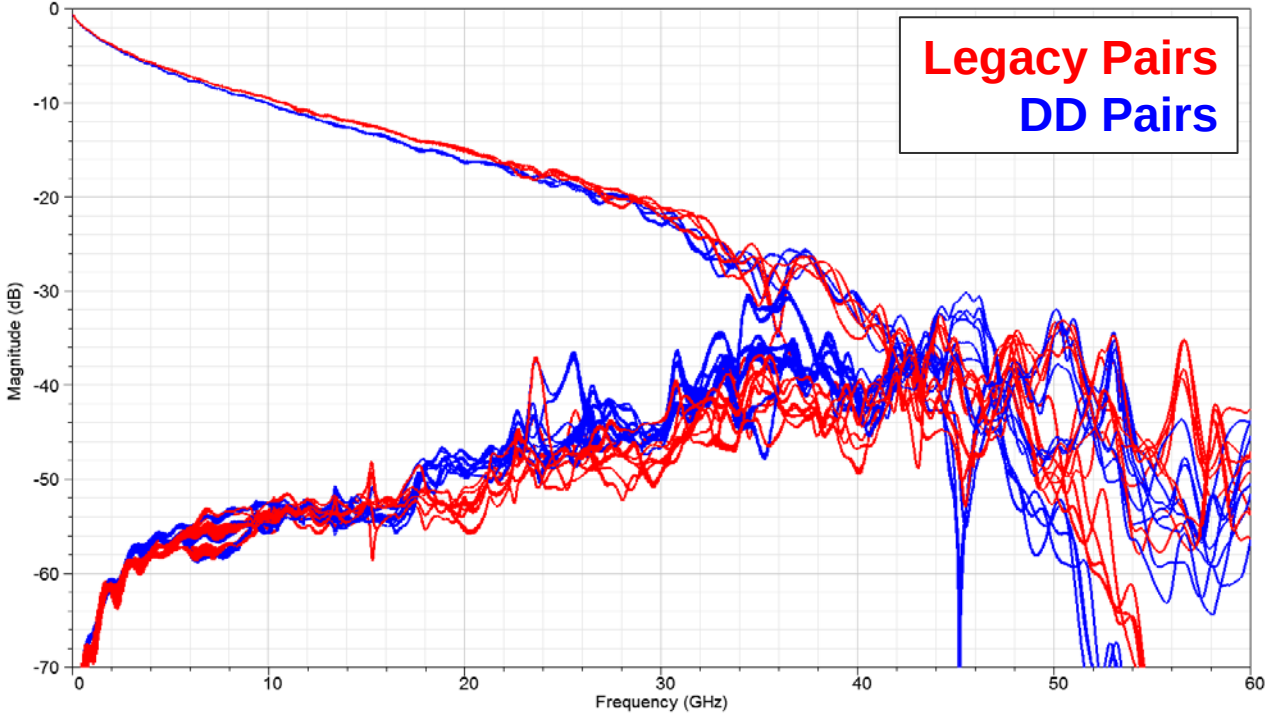
Causality Errors :



- P37-P37: 24.30 GHz (0.07)
- P38-P38: 24.54 GHz (0.07)
- P39-P39: 23.96 GHz (0.06)
- P40-P40: 31.86 GHz (0.07)
- P41-P41: 24.36 GHz (0.07)
- P42-P42: 38.41 GHz (0.09)
- P43-P43: 24.20 GHz (0.07)
- P44-P44: 23.86 GHz (0.05)
- P53-P53: 24.29 GHz (0.06)
- P54-P54: 24.33 GHz (0.07)
- P55-P55: 31.41 GHz (0.06)
- P56-P56: 31.76 GHz (0.06)
- P57-P57: 38.66 GHz (0.08)
- P58-P58: 38.59 GHz (0.09)
- P59-P59: 32.00 GHz (0.07)
- P60-P60: 32.10 GHz (0.07)

2m QSFP-DD Cable: TP1 to TP4

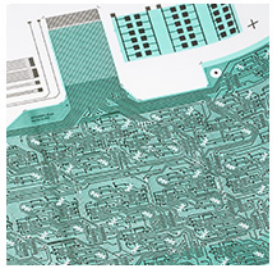




- Legacy pairs:
  - Minimum loss: 18.72 dB
  - Maximum loss: 19.32 dB
- DD pairs:
  - Minimum loss: 19.54 dB
  - Maximum loss: 20.47 dB

molex





COM Results:

molex

COM Version 2.58: Case 2 Results

Config sheet: config_com_ieee8023_93a=100GEL-CR_030119.xls (see last slide)

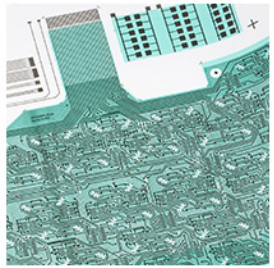
Victim Pair	ERL (dB)	COM (dB)	Victim Pair	ERL (dB)	COM (dB)
1 (Rx1-Tx1)	13.065	4.223	9 (Rx8-Tx8)	11.704	3.742
2 (Rx2-Tx2)	13.148	4.194	10 (Rx7-Tx7)	11.647	3.570
3 (Rx3-Tx3)	12.564	4.251	11 (Rx6-Tx6)	11.781	3.715
4 (Rx4-Tx4)	13.112	4.223	12 (Rx5-Tx5)	12.252	3.795
5 (Rx5-Tx5)	12.256	3.795	13 (Rx4-Tx4)	13.112	4.237
6 (Rx6-Tx6)	11.778	3.531	14 (Rx3-Tx3)	12.564	4.180
7 (Rx7-Tx7)	11.644	3.728	15 (Rx2-Tx2)	13.148	4.223
8 (Rx8-Tx8)	11.704	3.755	16 (Rx1-Tx1)	13.061	4.251

Legacy pairs: Victims 1-4, 13-16

DD pairs: Victims 5-12

molex

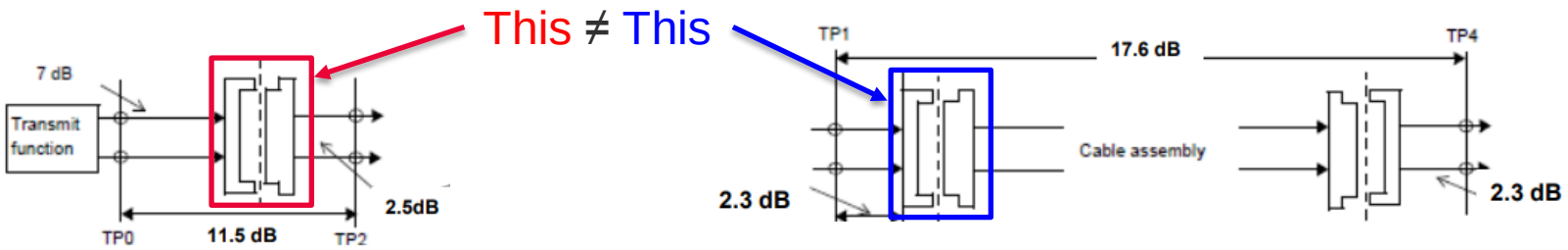




112G Loss Budget:

molex

Missing Pieces in the Loss Budget:

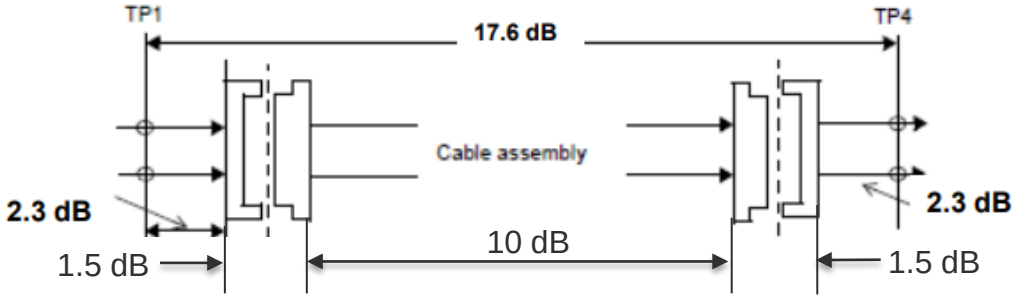


- TP0 to TP2:
  - Host + connector + HCB
    7 dB + 2 dB + 2.5 dB = 11.5 dB
- TP1 to TP4:
  - 2 x [MCB + (connector + paddle card + wire term)] + cable
    2 x [2.3 dB + (1.5 dB)] + 10 dB = 17.6 dB
- Per side: Red box (2 dB) ≠ Blue box (1.5 dB) ≠ Reality (~2.5 dB)
- The loss budget for the blue box needs to be increased to be realistic

molex

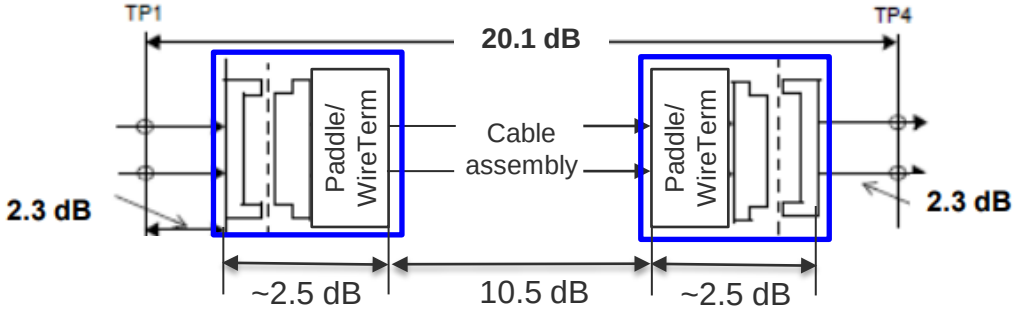
TP1 to TP4 Loss Budget:

Current budget:



Current proposed TP1 to TP4 budget: **17.6 dB**

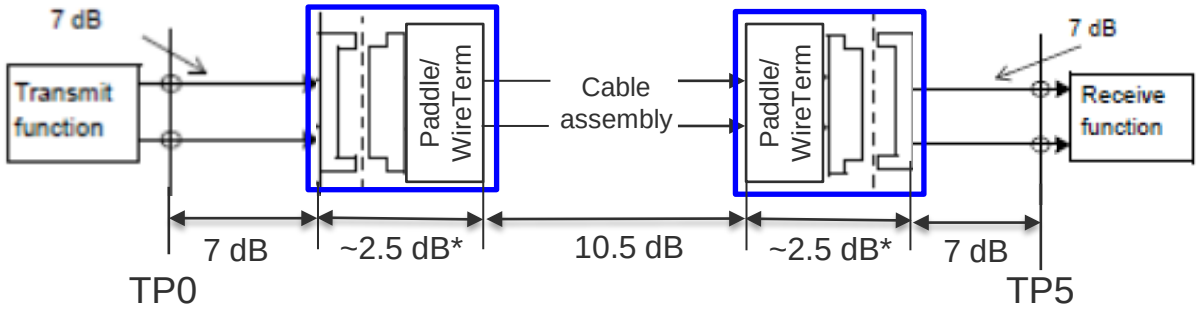
Proposed budget:



Revised TP1 to TP4 budget using a realistic “blue box” value: **20.1 dB**

molex

TP0 to TP5 Loss Budget:



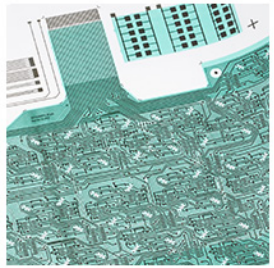
- Possible ways to reconcile:
  - Reduce host budget
  - Shorten cable reach
  - Extend total budget to 30 dB
  - Allow asymmetric channels
  - Others?
  - **Does it matter as long as the noise is low enough?**

*This number is based solely off simulation; needs to be verified via measurements

Total: **29.5 dB**
(doesn't include temperature affects on cable)

molex





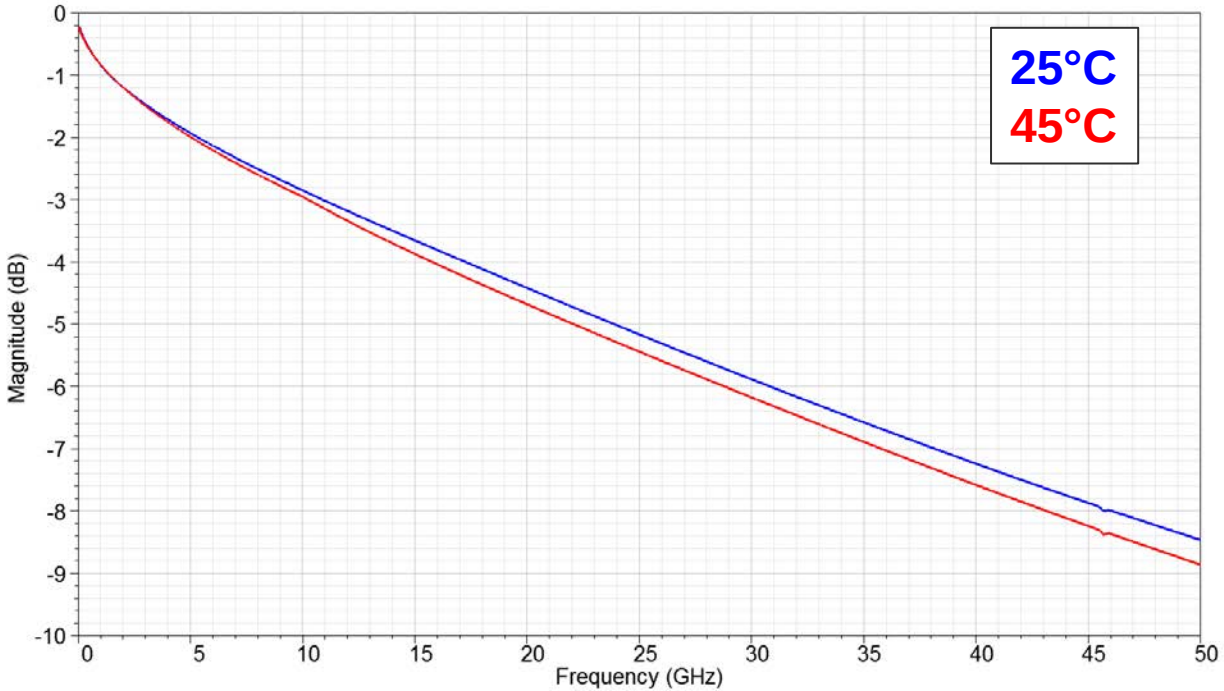
Thermal Considerations:

molex

Thermal Considerations:

- The data presented on the earlier slides assumes 26°C
- Increased temperatures, such as those encountered in use, cause losses to increase
- The following is presented to estimate how much of a loss increase is to be expected at elevated temperatures

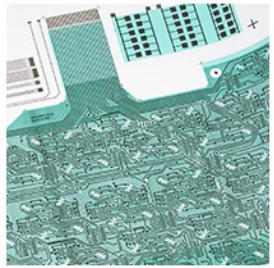
Thermal Results: Bulk Cable



- Loss results (1m simulated cable)
  - 25°C: 5.39 dB
  - 45°C: 5.67 dB
- **Delta:** ~0.3 dB/m

molex





Conclusions:

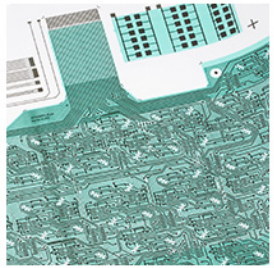
molex

Conclusions:

- Signal integrity and COM results shown for a 2m QSFP-DD simulated channel
  - Current TP1-TP4 budget (17.6 dB) is not realistic for 2m passive copper cables
  - Loss budget needs to be increased to allow 2m cable reach
- Temperature affects are expected to add ~0.3 dB/m of loss to bulk cable

molex





Thank you

molex

Config Sheet:

Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	53.125	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.1e-4 1.1e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12 32; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12 32; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12 32; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12 32; 1.8 1.8]	mm	[test cases]
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.413	V	vp/vf=.694
A_fe	0.413	V	vp/vf=.694
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.12]		[min:step:max]
c(-3)	[-0.06:0.02:0]		[min:step:max]
c(1)	[-0.1:0.05:0]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		
b_max(2..N_b)	0.3		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	1.00E-04	
T_r	6.16E-03	ns
FORCE_TR	1	logical
Include PCB	1	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	1000	
TDR_Butterworth	1	logical
beta_x	1.70E+09	
rho_x	**0.25**	
fixture delay time	0	enter sec
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	8.20E-09	V^2/GHz
SNR_TX	33	dB
R_LM	0.95	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 0.000599 0.0001022]*	
board_tl_tau	*6.200E-03*	ns/mm
board_Z_c	90	Ohm
z_bp (TX)	*92.7*	mm
z_bp (NEXT)	*92.7*	mm
z_bp (FEXT)	*92.7*	mm
z_bp (RX)	*92.7*	mm