Inter-operability risk for 50GBASE-CR with Draft 3.3 ERL specifications (updated)

Mike Dudek Marvell Technologies
Tao Hu Marvell Technologies

Supporters.

Ali Ghiasi	Ghiasi Quantum
Rick Rabinovich	Keysight Technologies
Rich Mellitz	Samtec (for ERL proposal)
Adee Ran	Intel (for ERL proposal)

Introduction

- This presentation is related to comment r03-18. It investigates the effect on system performance as measured by COM of changes in ERL performance. It builds on work presented in dudek_3cd_01_0318 and dudek_3cd_01a_0518.
- It is an update to the presentation made at the 802.3cd ad hoc on 6-27-18. It corrects the proposed equation for the potential SNRisi specification and adds some additional information.
- No cable S parameters are available on the web site for cables with ERL close to the specification limit so Cavium CA2 was created to see what the effect would be on system performance with hosts with different ERL. The creation method and more details of this cable and the others used in the analysis are given in the back-up. In addition two cables (Cavium M2 and Cavium M3) with marginal passing performance were measured and added to the data set.
- All hosts used in this presentation pass all the draft 3.3 specifications including Pmax/Vf except for the marginal fail for Pmax/Vf of the standard COM Tx.

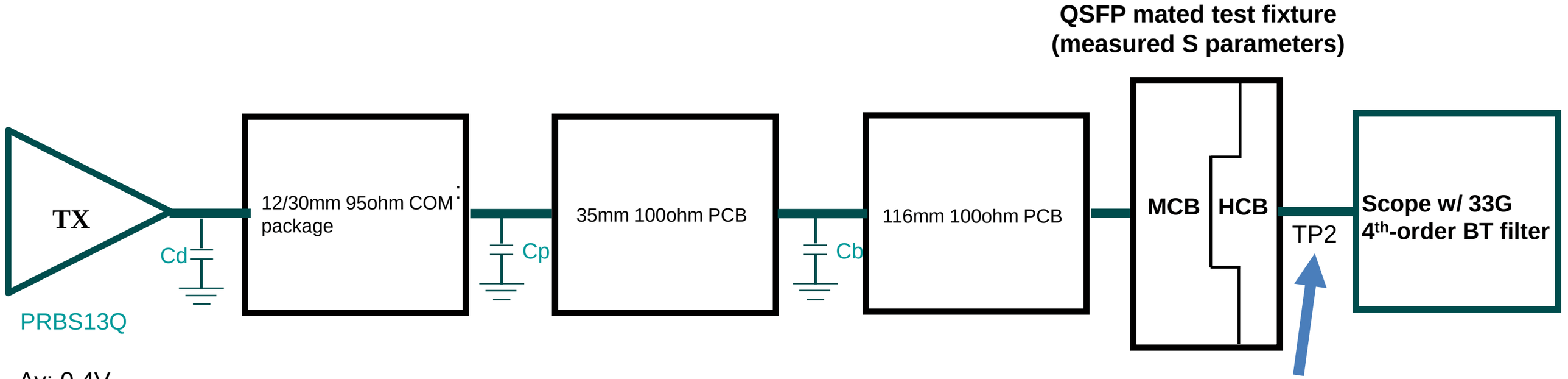
Cable assembly:

Cable ERL results

	COM TX 30mm (dB)	ERL11 (dB)	ERL22 (dB)
TE w/ XTALK	4.19	20.52	19.47
CAVIUM CA2	3.56	10.70	16.13
Cavium M2 w/ XTALK	4.10	10.65	12.77
Cavium M3 w/ XTALK	3.15	13.35	12.24

Host Tx and system performance

Transmitter parameters at TP2



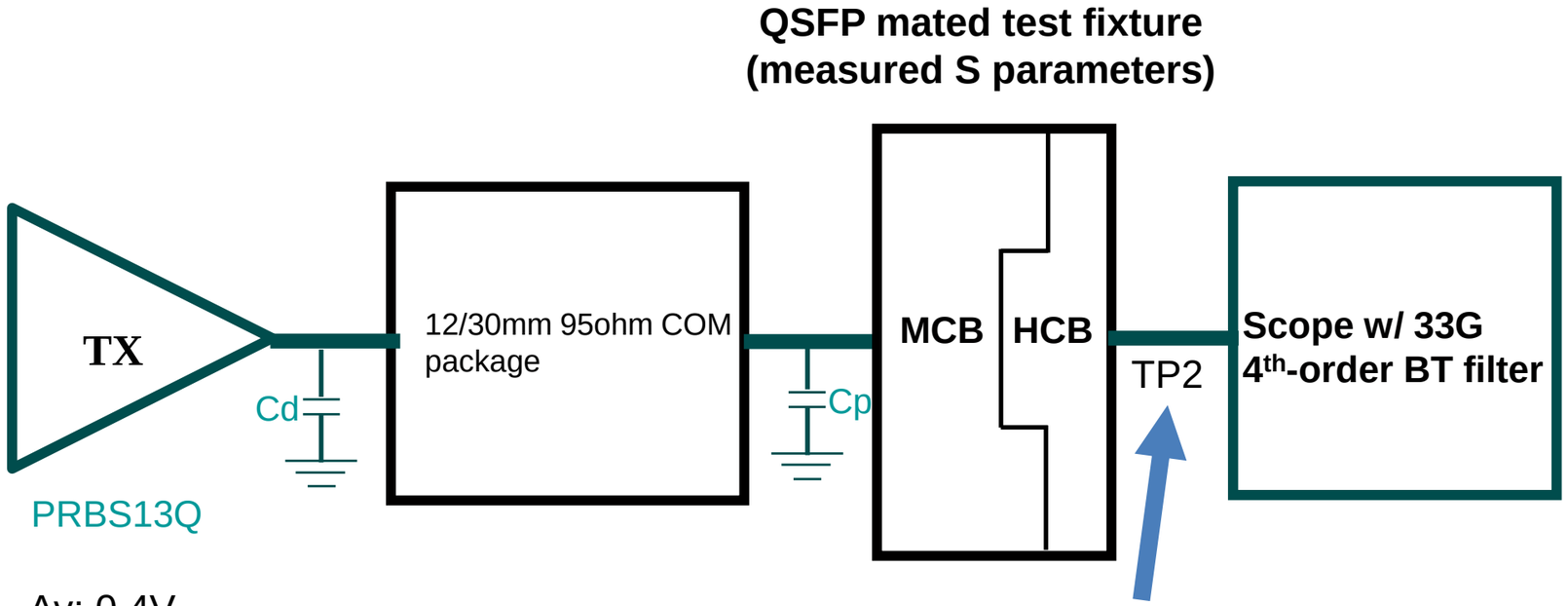
Av: 0.4V
Rd: 50ohm
Risetime: 12pS/5pS
Cd: 0.18pF
Cp: 0.11pF

Sweep Cb 0 to 0.4pF w/0.1pF step
Risetime adjusted to keep Pmax/Vf in specification

Extract transmitter parameters at TP2:

- SNDR
- SNRisi
- Pmax/Vf
- ERL

Transmitter parameters at TP2 w/o host trace

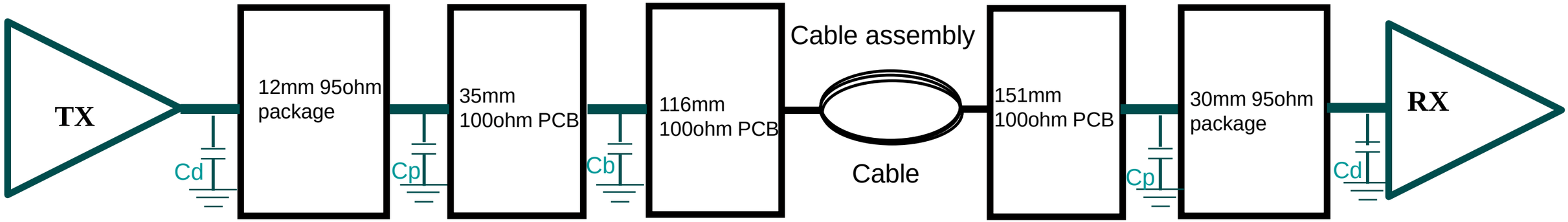


Av: 0.4V
Rd: 50ohm
Risetime: 12pS
Cd: 0.18pF
Cp: 0.11pF

Extract transmitter parameters at TP2:

- SNDR
- SNRisi
- Pmax/Vf
- ERL

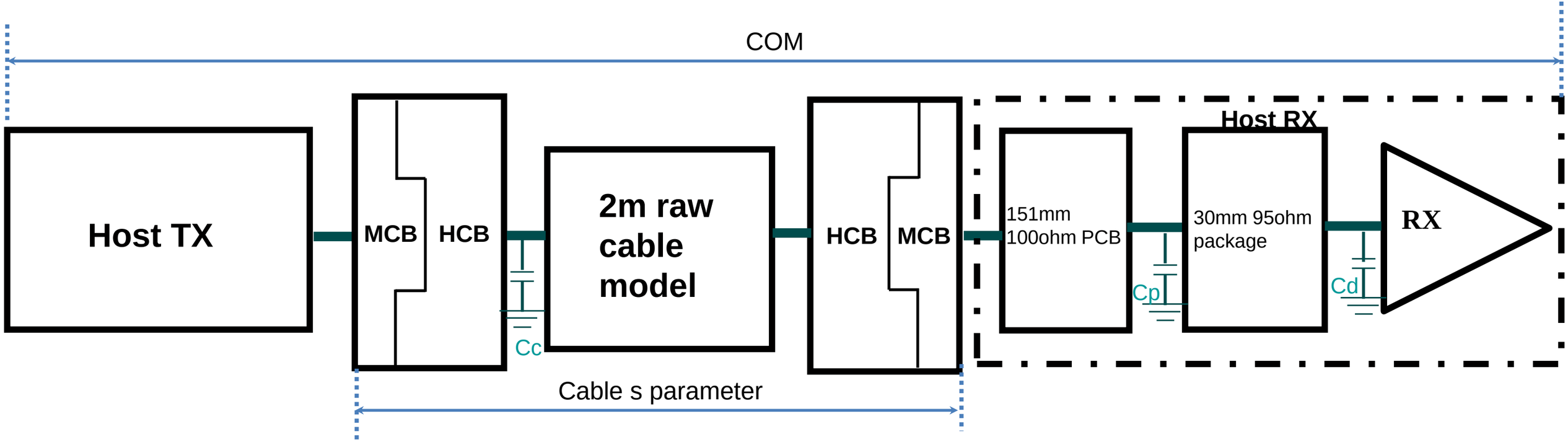
COM



Av: 0.415V
Afe：0.415V
Ane：0.604V
Rd: 50ohm
Cd: 0.18pF
Cp: 0.11pF

Thru channel includes Cb on TX host trace. XTALK channels don’t include Cb.
Same host Tx’s used as for Transmitter parameter measurement
Other parameters refer to table 136-15

COM for Cavium CA2



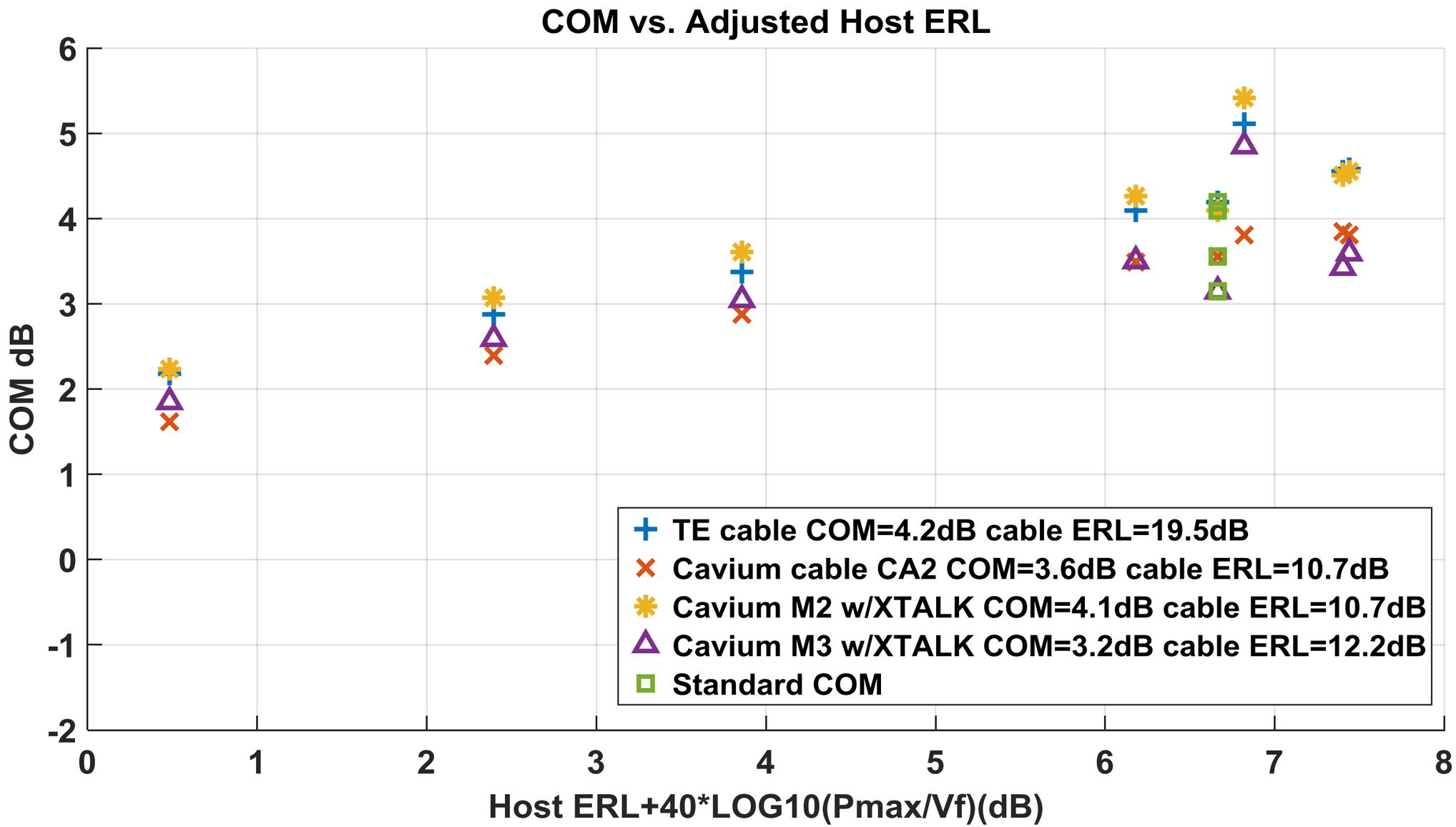
Av: 0.415V
Afe：0.415V
Ane：0.604V
Rd: 50ohm
Cd: 0.18pF
Cp: 0.11pF
Cc: 0.27pF

D3.3 parameters

Host	Die risetime (pS)	Cb (pF)	Pmax/Vf	SNRisi(dB)	ERL22 (dB)	ERL+ 40LOG10 (pmax/vf) (dB)	SNRisi+ 40LOG10 (pmax/vf) (dB)	COM TE (dB)	COM CAVIUM CA2 (dB)	COM CAVIUM M2 w/XTLK (dB)	COM CAVIUM M3 w/ XTALK (dB)
12mm TX pkg+35mm brd +Cb+116mm brd+Mated QSFP test fixture	12	0	0.517	34.28	18.9	7.44	22.82	4.58	3.81	4.55	3.60
	12	0.1	0.512	32.71	17.81	6.18	21.08	4.10	3.49	4.27	3.50
	12	0.2	0.502	30.08	15.83	3.86	18.11	3.38	2.88	3.61	3.05
30mm TX pkg+35mm brd +Cb+116mm brd+Mated QSFP test fixture	12	0	0.484	32.23	19.27	6.66	19.62	4.19	3.56	4.10	3.15
12mm TX pkg+Mated QSFP test fixture	12	0	0.731	27.67	12.69	7.25	22.22	5.16	3.62	5.75	5.07
30mm TX pkg+Mated QSFP test fixture	12	0	0.68	28.86	13.52	6.82	22.16	5.11	3.81	5.42	4.85
12mm TX pkg+35mm brd +Cb+116mm brd+Mated QSFP test fixture	5	0.3	0.508	27.68	14.16	2.39	15.91	2.88	2.40	3.07	2.59
	5	0.4	0.491	25.98	12.84	0.48	13.62	2.18	1.62	2.24	1.85
30mm TX pkg+35mm brd +Cb+116mm brd+Mated QSFP test fixture	5	0	0.505	32.53	19.27	7.40	20.66	4.55	3.85	4.51	3.43

This is the Standard 30mm COM configuration

COM vs. adjusted Host ERL (D3.3) All points meet Pmax/Vf spec



Conclusions and further work on host Tx

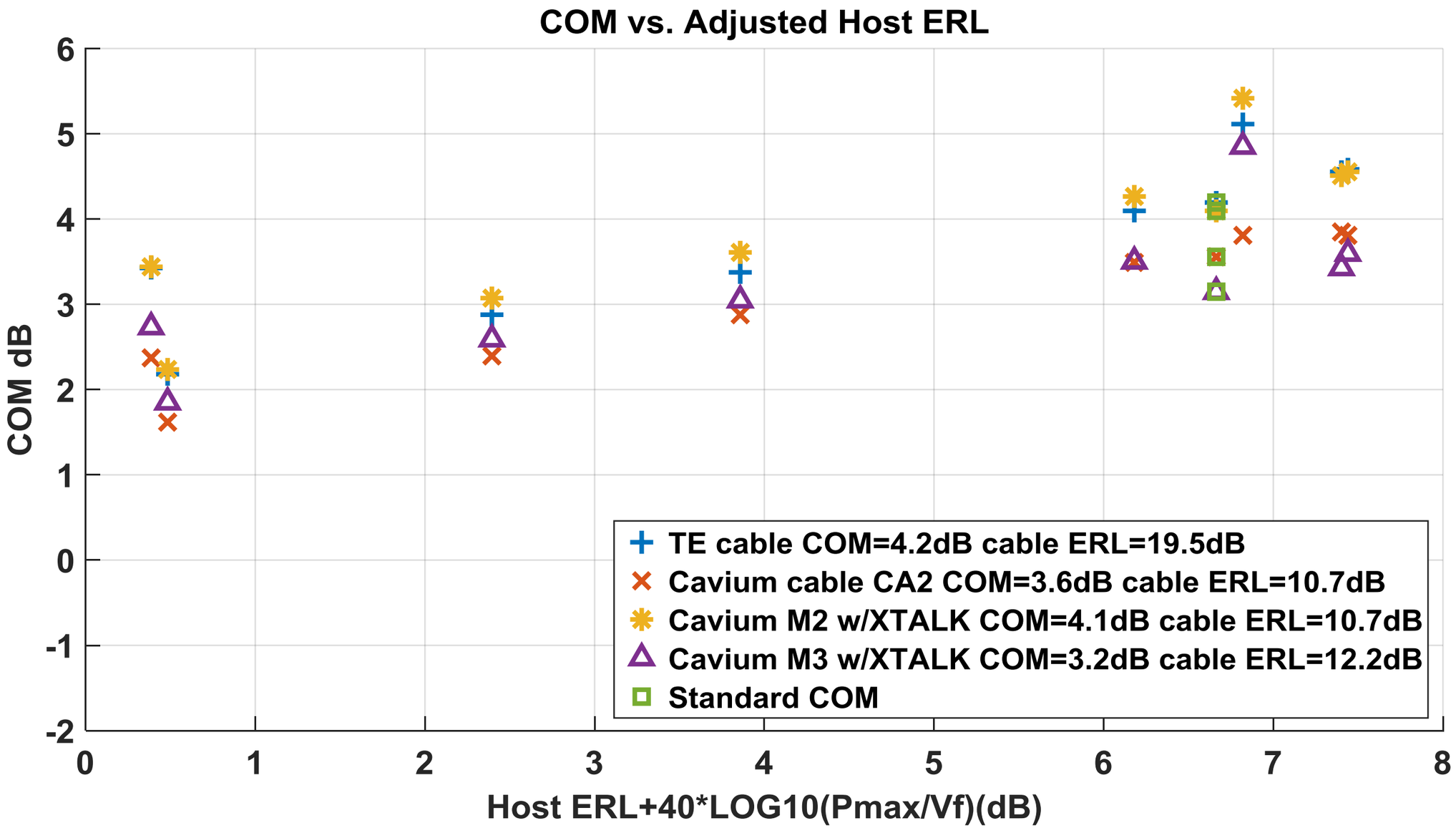
- The long host with the Cb capacitance at 0.4pF provides bad system performance on all these cables. It should fail the Tx specification as it is a significant inter-operability risk.
- An investigation was made to see what about this host was causing the problem.
- It was noticed that this host had significantly poorer performance on all the cables independent of whether the cables had low ERL, (although a low ERL on the cable made it worse).
- It was also noticed that the SNRisi for this host was low and Pmax/Vf was also low.
- Another host Tx was therefore constructed by moving Cb to be closer to TP2 such that ERL and Pmax/Vf were similar but SNRisi was significantly better. The details of the host construction are in the back-up.

D3.3 parameters

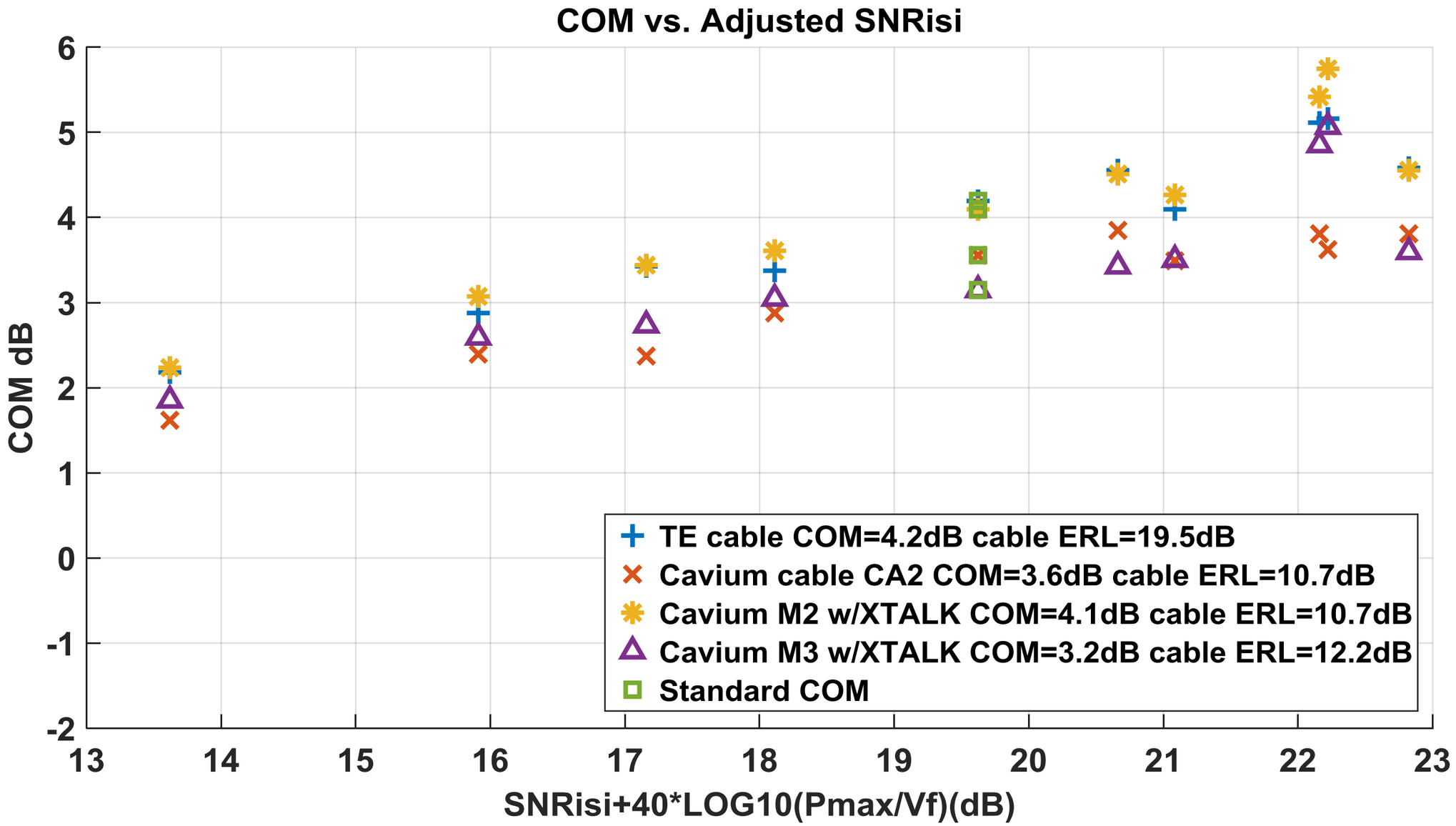
Host	Die risetime (pS)	Cb (pF)	Pmax/Vf	SNRisi(dB)	ERL22 (dB)	ERL+ 40LOG10 (pmax/vf) (dB)	SNRisi+ 40LOG10 (pmax/vf) (dB)	COM TE (dB)	COM CAVIUM CA2 (dB)	COM CAVIUM M2 w/XTLK (dB)	COM Cavium M3 w/ XTALK (dB)
12mm TX pkg+Mated QSFP test fixture	12	0	0.731	27.67	12.69	7.25	22.22	5.16	3.62	5.75	5.07
12mm TX pkg+35mm brd +Cb+116mm brd+Mated QSFP test fixture	5	0.3	0.508	27.68	14.16	2.39	15.91	2.88	2.40	3.07	2.59
	5	0.4	0.491	25.98	12.84	0.48	13.62	2.18	1.62	2.24	1.85
12mm TX pkg+141mm brd +Cb+10mm brd+Mated QSFP test fixture	15	0.2	0.491	29.52	12.74	0.39	17.16	3.43	2.37	3.44	2.73

Additional host Tx

COM vs. adjusted Host ERL (D3.3) All points meet Pmax/Vf spec



COM vs. adjusted SNRisi All points meet Pmax/Vf spec



Conclusion and proposal.

- **The host with approximately the same Pmax and Vf but with better SNRisi performed significantly better with all the cables, however it is still significantly worse than the standard COM transmitter.**
- **Either**
  - Change the host pass/fail criterion to

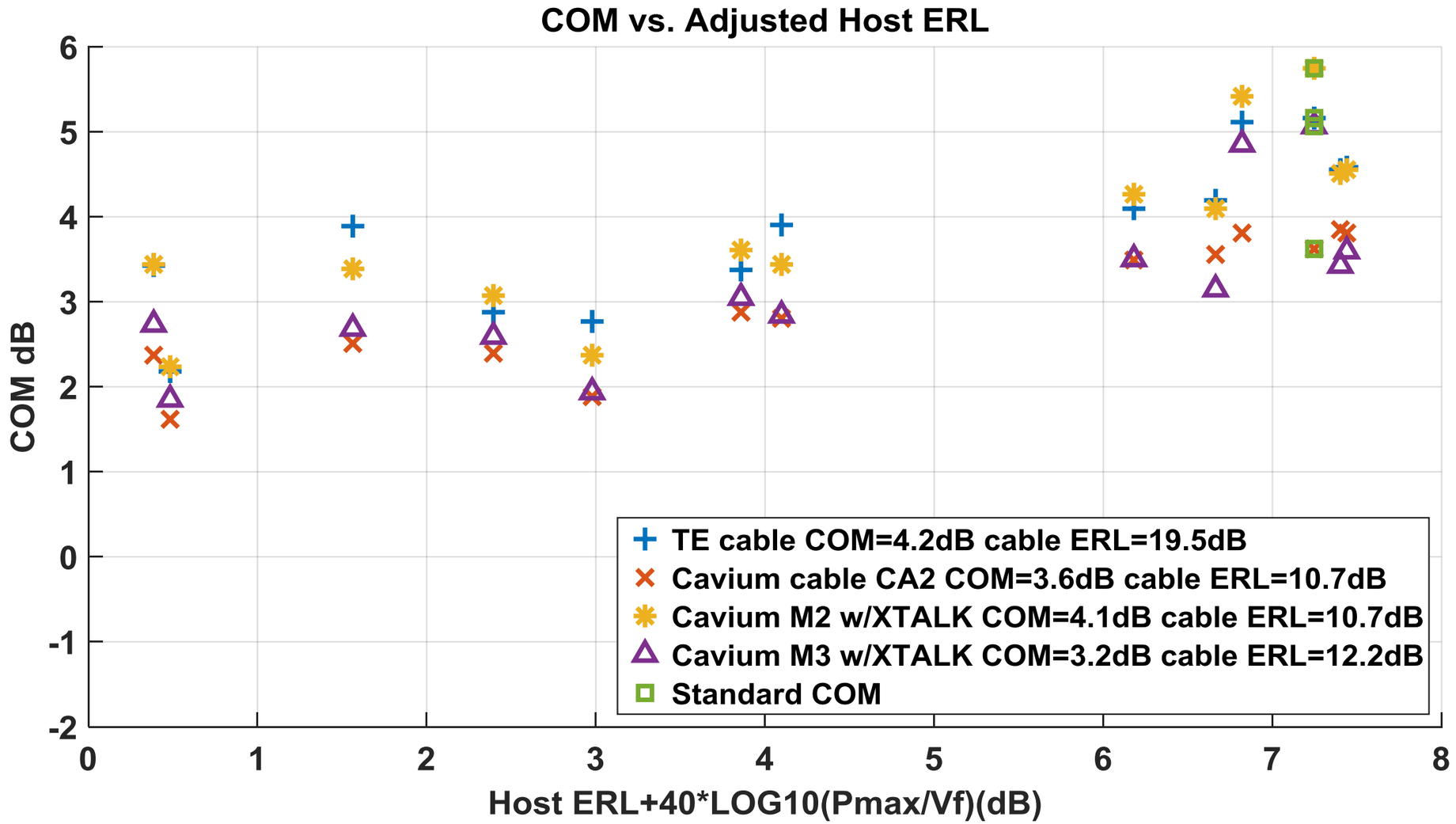
$$ERL \geq 40\log_{10}\left(\frac{v_f}{\max_k (p(k))}\right) + 3 \quad \text{dB}$$

- **Or**
  - Add an additional transmitter specification

$$\text{SNRisi} \geq 40\log_{10}\left(\frac{v_f}{\max_k (p(k))}\right) + 19 \quad \text{dB}$$

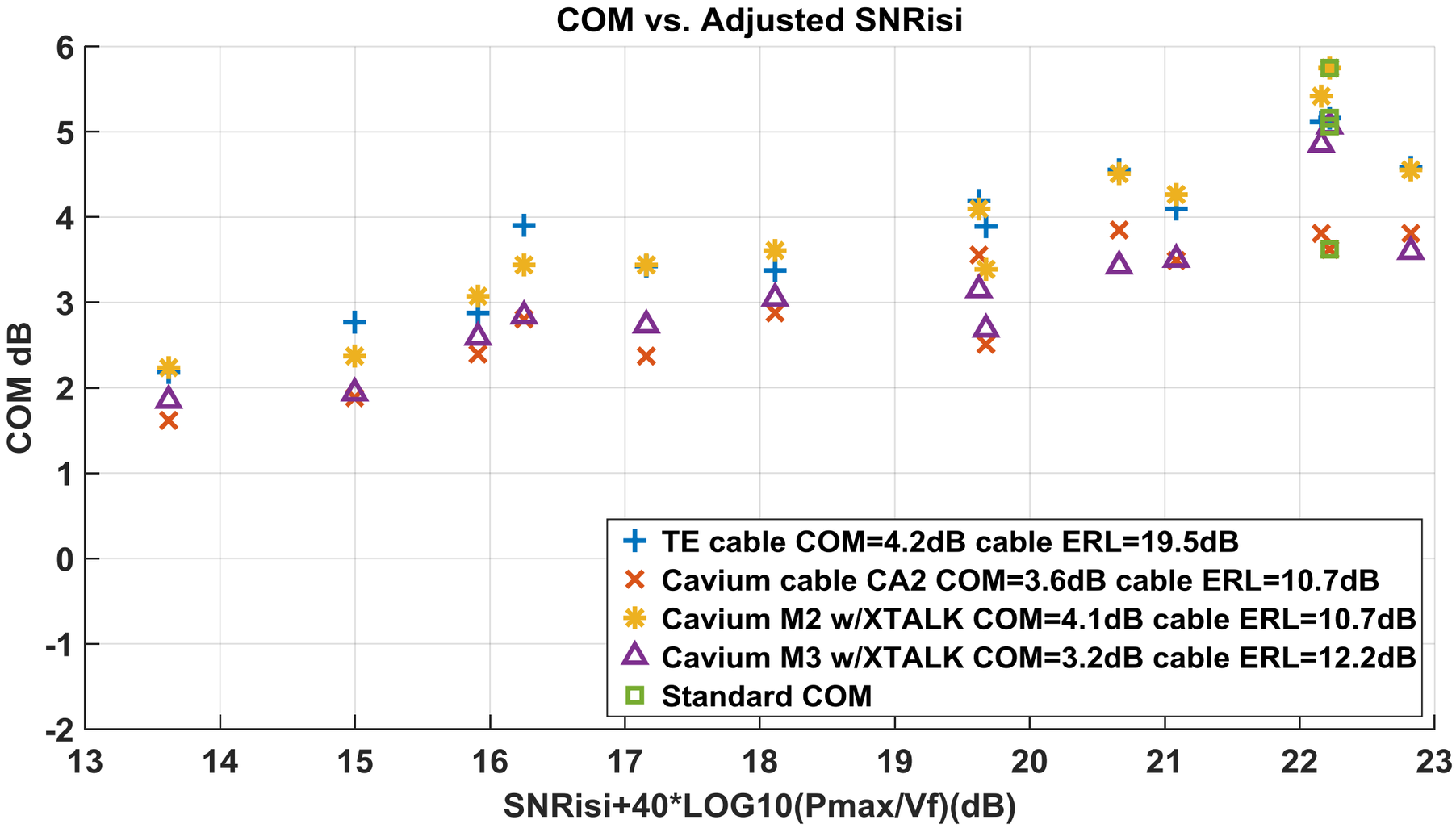
Back-up

COM vs. adjusted Host ERL (D3.3) All points meet Pmax/Vf spec



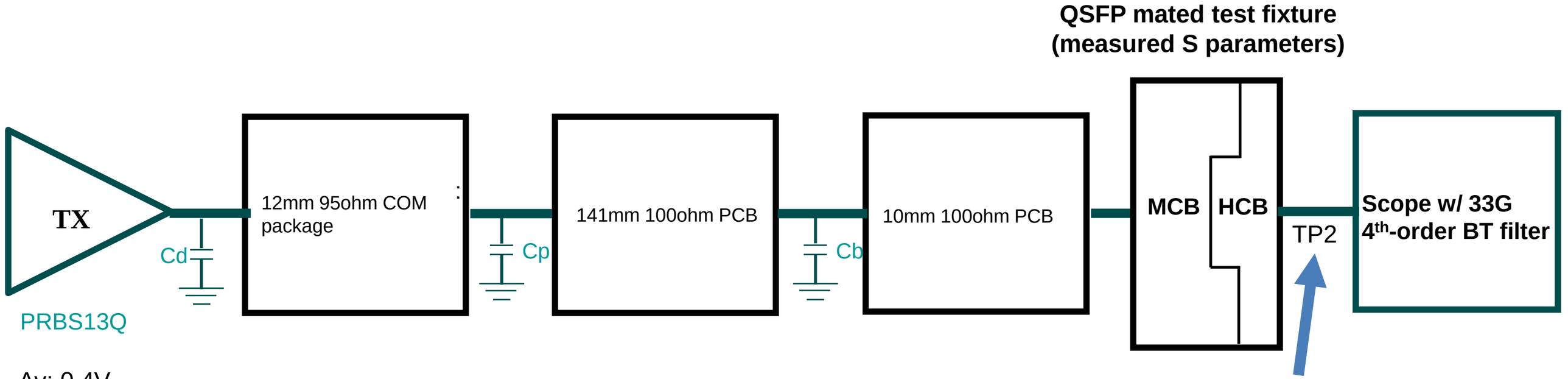
With additional Tx hosts created with via stub instead of capacitor.

COM vs. adjusted SNRisi All points meet Pmax/Vf spec



With additional host Tx's created with via stubs instead of capacitors.

Additional host with lower SNRisi but similar Pmax/Vf and ERL



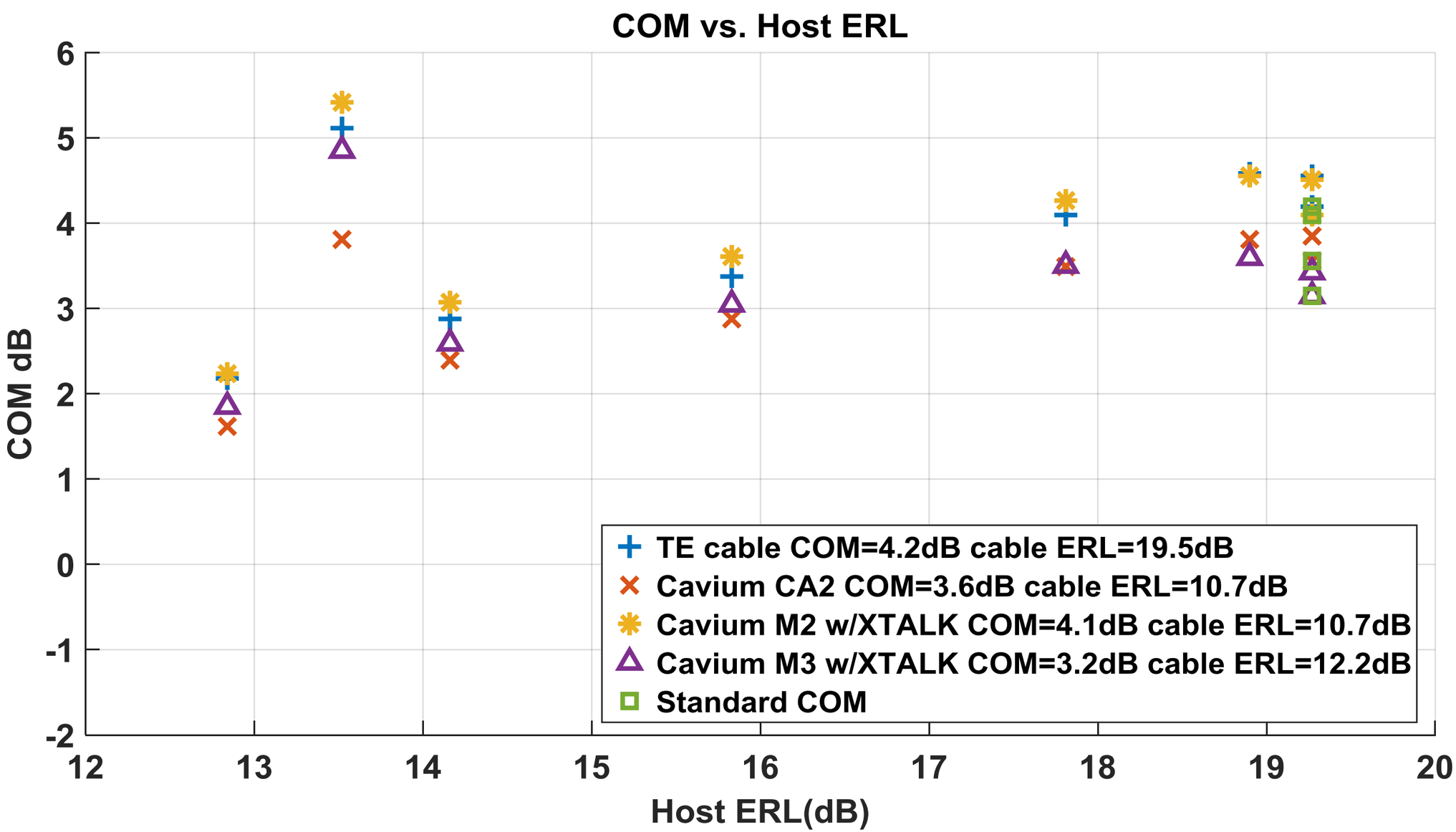
Av: 0.4V
Rd: 50ohm
Risetime: 15pS
Cd: 0.18pF
Cp: 0.11pF

Cb =0.2pF
Risetime adjusted to keep Pmax/Vf in specification

Extract transmitter parameters at TP2:

- SNDR
- SNRisi
- Pmax/Vf
- ERL

COM vs. Host ERL (D3.3) All points meet Pmax/Vf spec



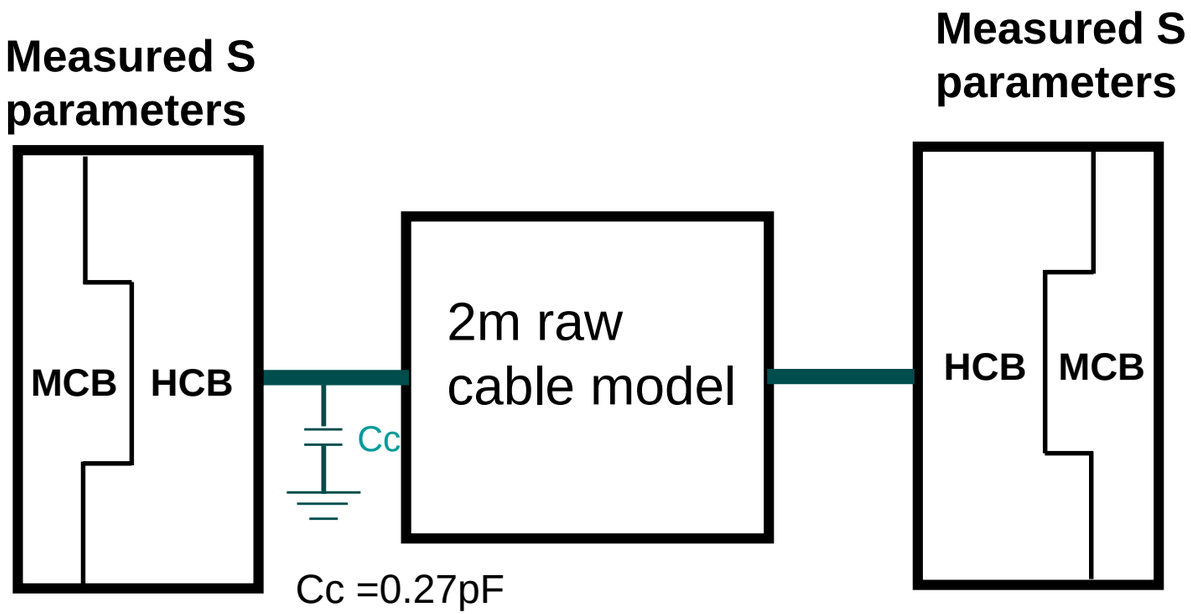
Host Rx comments.

Comments on host Rx.

- Degradations caused by reflections within the host Rx are present during the interference tolerance test therefore they have to be compensated by the receiver having better other performance. (e.g. can work with lower COM).
- The improved Rx performance required for reflections within the host Rx is somewhat similar to requiring higher Pmax/Vf when the ERL is poorer.
- ERL is required to limit reflections from the host Rx that are re-reflected by the cable.
- Simulations have shown that the draft 3.3 ERL limits for the Rx and the cable do not create a large inter-operability risk and therefore no comment was made to change this limit.

Cable creation.

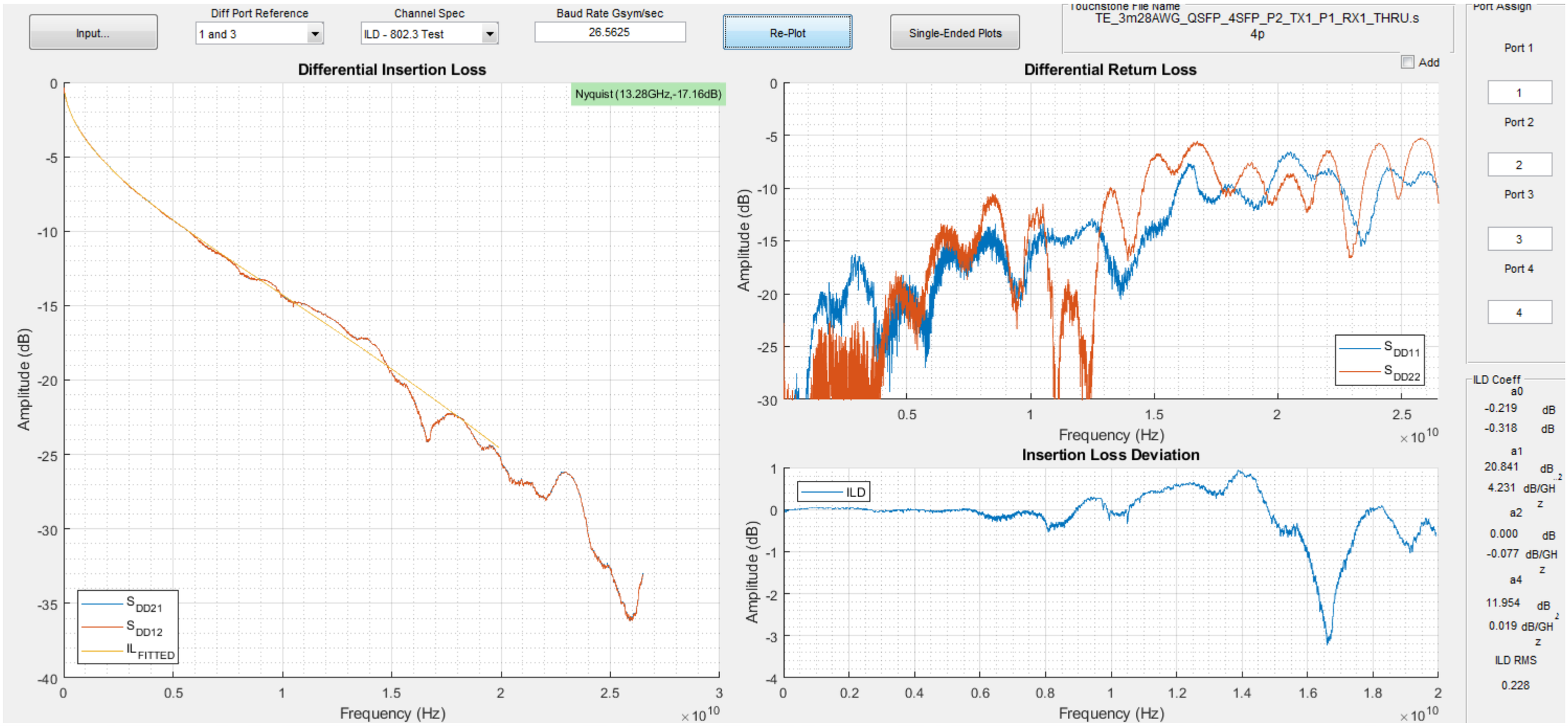
Block diagram of cable assembly CaviumCA2



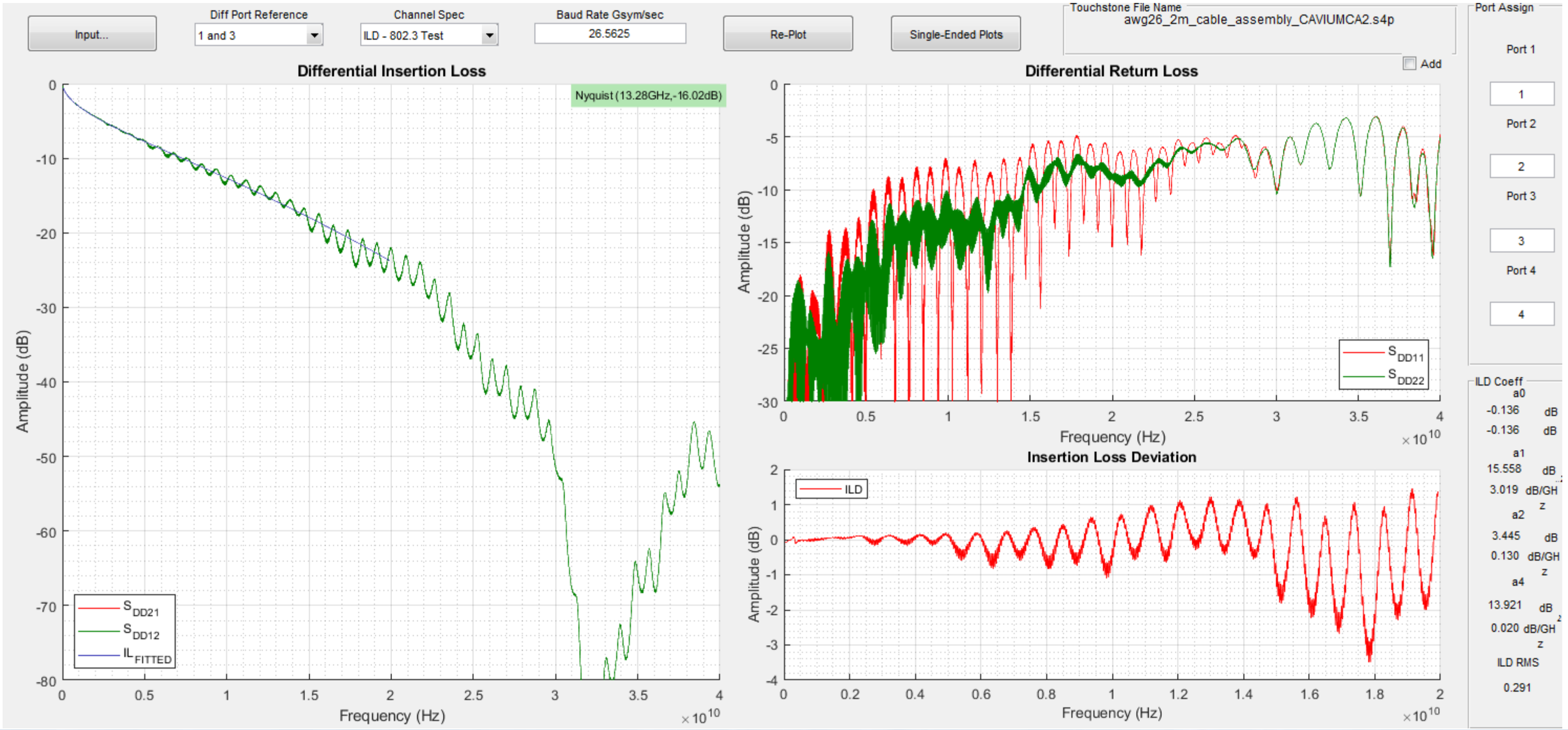
The raw cable model uses the transmission line model in Clause 93A with parameters provided by Rich Mellitz for a 26AWG cable.

Cable Frequency Domain Performance

TE cable

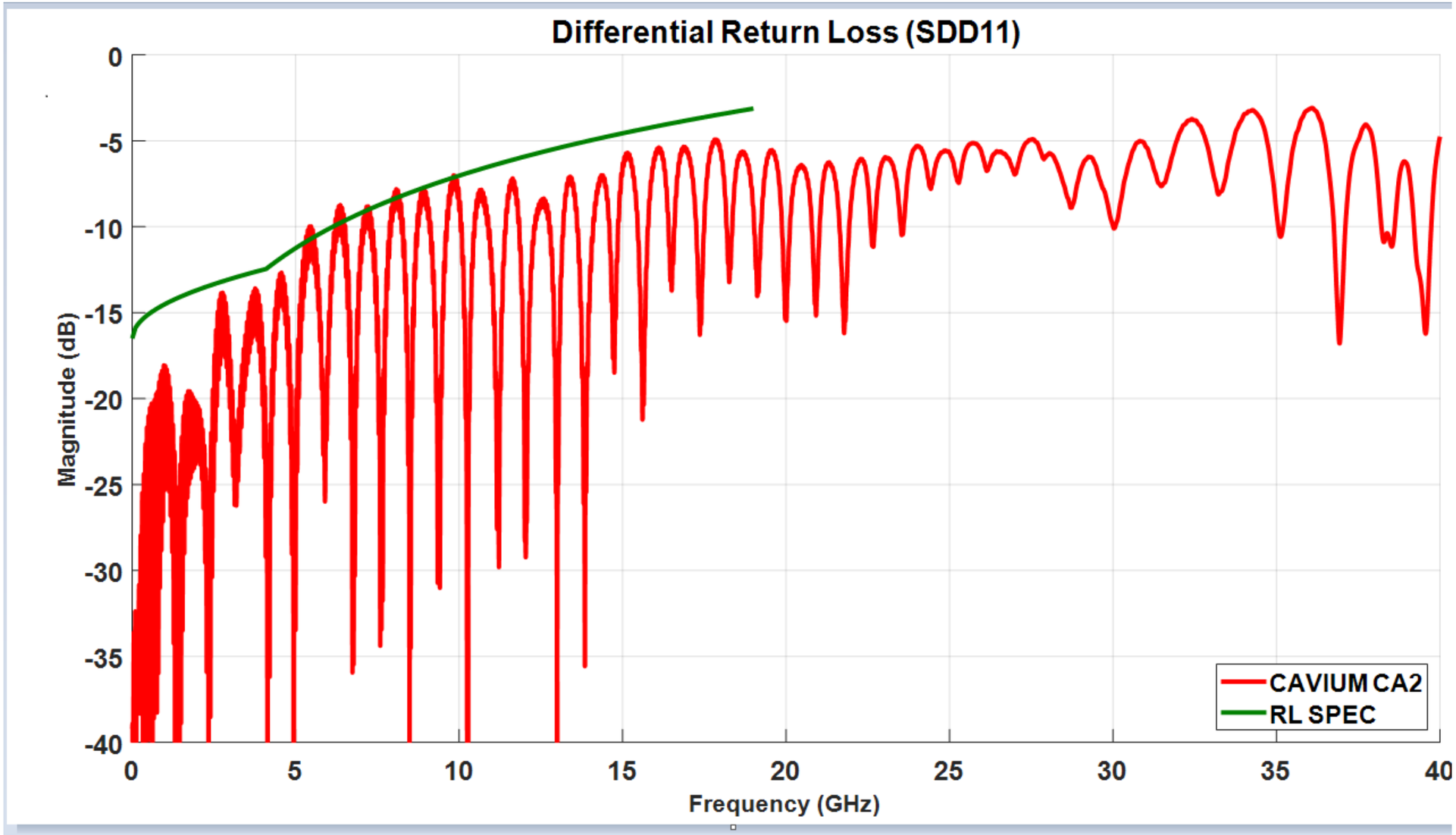

Input...
Diff Port Reference
1 and 3
Channel Spec
ILD - 802.3 Test
Baud Rate Gsym/sec
26.5625
Re-Plot
Single-Ended Plots
Touchstone File Name
TE_3m28AWG_QSFP_4SFP_P2_TX1_P1_RX1_THRU.s4p
Add
Port Assign
Port 1
1
Port 2
2
Port 3
3
Port 4
4
Differential Insertion Loss
Nyquist (13.28GHz,-17.16dB)
Amplitude (dB)
Frequency (Hz)
SDD21
SDD12
ILFITTED
Differential Return Loss
SDD11
SDD22
Insertion Loss Deviation
ILD
ILD Coeff
a0
-0.219 dB
-0.318 dB
a1
20.841 dB
4.231 dB/GHz
a2
0.000 dB
-0.077 dB/GHz
a4
11.954 dB
0.019 dB/GHz
ILD RMS
0.228

Cavium CA2 cable

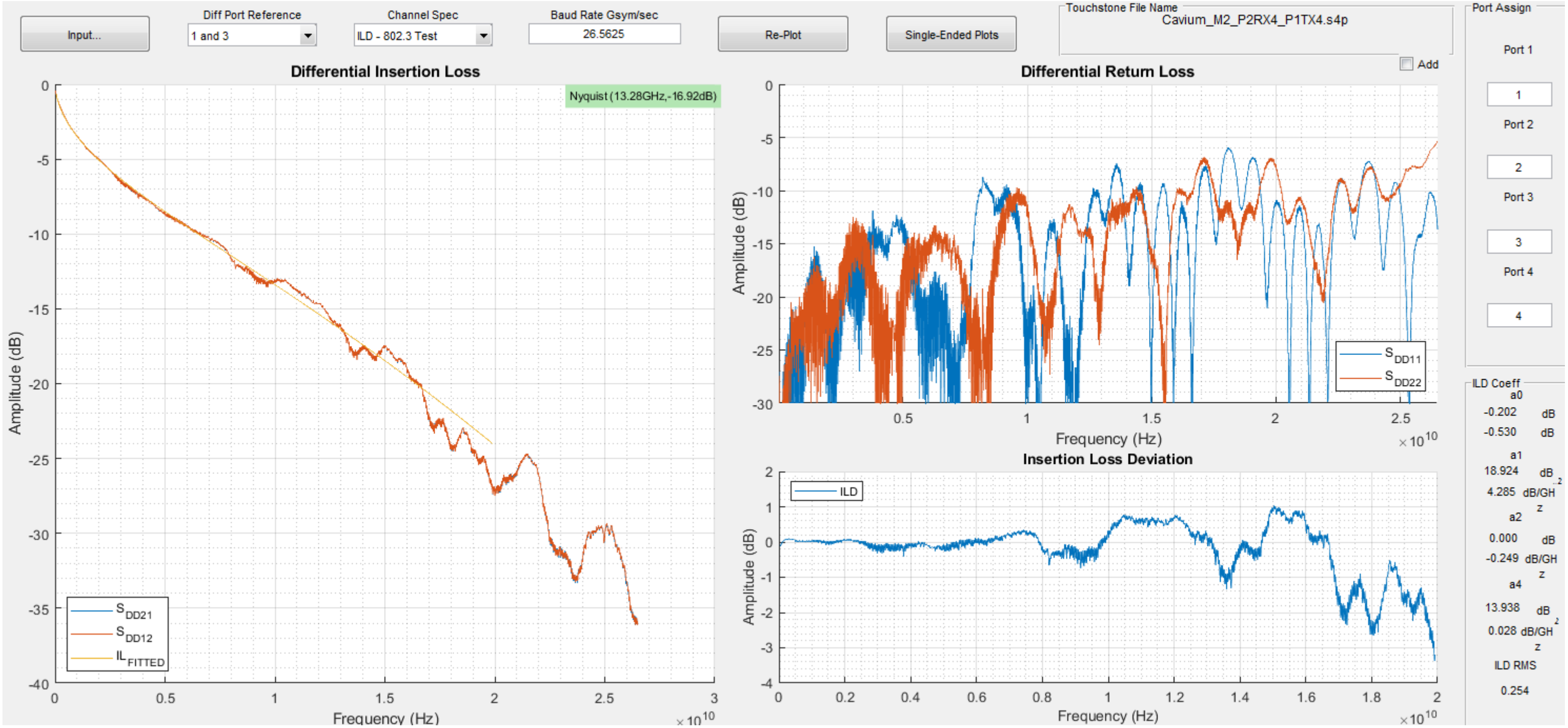


CaviumCA2 cable (ERL 10.7dB using new parameters) comparison to draft 3.2 informative return loss 92.10.3.

QLOGIC
a Cavium company



Cavium M2 cable



Cavium M3 cable