Can ERL replace SNRisi for 50GBASE-CR? - updated

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Introduction

- **This presentation is in support of comment r01-84**
- **It is an update to the presentation made at the 2-20-18 ad-hoc.**
- **Key changes.**
  - It was discovered that the value of Nb used to calculate ERL for that presentation was zero, which is not what is being proposed. This presentation adds results with the proposed value Nb=12, retaining the Nb=0 results for comparison. The change to Nb=12 did not change the general conclusions.
  - It uses COM version 2.2.4 rather than 2.2.1 which was used for the previous presentation.
  - It includes information on an additional cable.
  - A proposal is made for a specification that better reflects system performance than ERL alone and replaces the proposal for ERL in r01-84. (this was affected by the change to Nb)

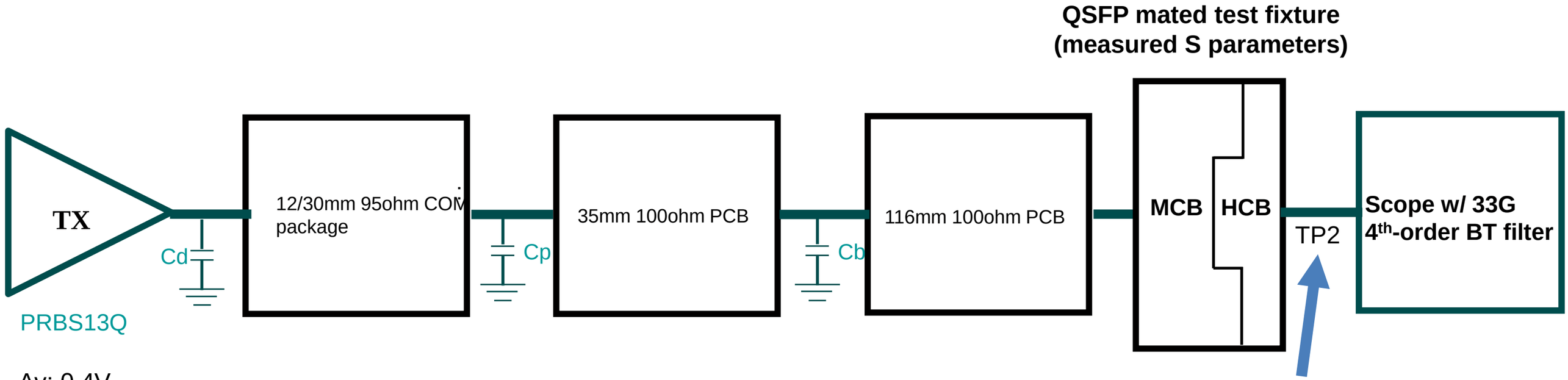
Original Introduction

- It has been suggested that ERL could replace both Return loss specifications and SNRisi.
- The replacement of Return loss would appear to be a significant improvement as this measurement takes into account the time domain effects of reflections, the effects of the DFE equalizer and allows for removing some of the effects of the test fixtures. The Frequency domain masks of the existing return loss specifications are a very blunt instrument.
- The suggested replacement of SNRisi is a different matter as SNRisi is already a time domain measurement and includes the effect of the DFE equalizer. Also it is measuring the through response of multiple reflections which is what mainly matters to the receiver whereas ERL measures the return response.
- This presentation investigates the correlation between SNRisi, ERL and system performance as measured by COM for 50GBASE-CR.

Methodology

- TX parameters including ERL are simulated at TP2 for the long package and short package with a 100 Ohm standard host trace as now used in the Cable COM calculation.
- With the short package these Tx parameters were re-simulated while sweeping Cb, a capacitor added part way along the host board trace. This represents one particular potential host system impairment.
- The predicted system performance as a function of Cb was simulated for a representative cable by running COM for 50GBASE-CR while using the same host Tx as simulated above. The Rx used is the standard COM receiver configuration with the long package. This was repeated for a different cable that had a COM closer to the 3dB pass/fail criterion, although this cable would have failed the attenuation specification.
- Some additional host configurations were investigated to see what ERL, SNRisi and COM they created. In particular ones with the host PCB much shorter.

Transmitter parameters at TP2



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

Sweep Cb 0 to 1pF w/0.1pF step

Extract transmitter parameters at TP2:

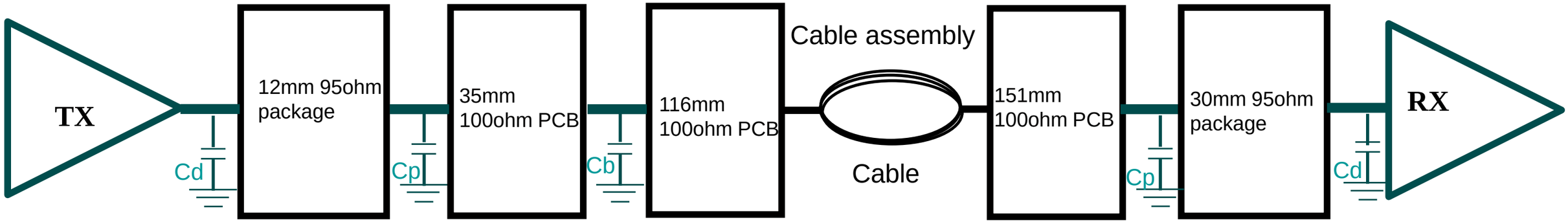
- SNDR
- SNRisi
- Pmax/Vf
- ERL

TX parameters vs. Cb

TX package length(mm)	Cb(pF)	Rlm	Vf(V)	Pmax(V)	Pmax/Vf	SNRisi	SNDR(TX_SNR=32.5dB)(dB)	ERL22(dB) Nb=0	ERL22(dB) Nb=12
30	**0**	**0.997**	**0.36**	**0.174**	**0.484**	**32.229**	**32.498**	**11.731**	**21.2**
12	0	0.997	0.368	0.188	0.512	34.273	32.498	11.611	20.925
12	0.1	0.997	0.369	0.187	0.508	32.756	32.498	11.28	20.096
12	0.2	0.997	0.37	0.184	0.498	30.129	32.498	10.458	18.496
12	0.3	0.996	0.37	0.179	0.484	28.091	32.498	9.635	17.096
12	0.4	0.996	0.371	0.174	0.469	26.393	32.498	8.93	15.983
12	0.5	0.996	0.371	0.168	0.454	25.32	32.498	8.309	15.041
12	0.6	0.996	0.371	0.163	0.438	24.606	32.497	7.8	14.262
12	0.7	0.996	0.372	0.157	0.423	24.083	32.497	7.379	13.647
12	0.8	0.995	0.372	0.152	0.408	23.671	32.497	7.017	13.073

Notes:
- Cb is only significantly affecting Pmax (and Pmax/Vf), SRNisi and ERL.
- For Cb<=0.3pF the configurations pass all specs except SNRisi and a very marginal fail for Pmax/Vf that matches the marginal fail for the standard COM Tx.
- SNRisi fails for Cb>0.1pF
- ERL with Nb=0 passes the recommended 9dB for Cb<=0.3pF
- ERL with Nb=12 passes the recommended 9dB with large margin for all values of Cb.

COM



Av: 0.415V
Afe：0.415V
Ane：0.604V
Rd: 50ohm
Zc_pkg=95ohm
Zc_brd =100ohm

Thru channel includes Cb on TX host trace. XTALK channels don’t include Cb.
Run COM by sweeping Cb 0 to 1.0pF w/0.1pF step
Other parameters refer to table 136-15
COM revision: 2.2.4

COM spreadsheet

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Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	26.5625	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.8e-4 1.8e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[12 30]	mm	[test cases]
z_p (NEXT)	[12 12]	mm	[test cases]
z_p (FEXT)	[12 30]	mm	[test cases]
z_p (RX)	[30]	mm	[test cases]
C_p	[1.1e-4 1.1e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX] or selected
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.25:0.05:0]		[min:step:max]
c(-2)	[0:0.025:0.1]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	53.125	GHz	
A_v	0.415	V	tdr selected
A_fe	0.415	V	tdr selected
A_ne	0.604	V	tdr selected
L	4		
M	32		
N_b	12	UI	
b_max(1)	0.7		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	1.64E-08	V^2/GHz	
SNR_TX	32.5	dB	tdr selected
R_LM	0.95		
DER_0	1.00E-04		
Operational control			
COM Pass threshold	3	dB	
Include PCB	1	Value	0, 1, 2
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\CR_50G_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	CR_50G_PAM4	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	0.012	ns
FORCE_TR	1	logical

Non standard control options		
COM_CONTRIBUTION	0	logical
TDR	1	logical
ERL	1	logical
Z_t	50	ohms
ERL_ONLY	0	logical
TR_TDR	0.0189	ns
TDR_duration	10	
TDR_f_BT_3db	19.921875	GHz
TDR_Butterworth	1	logical
beta_x	10700000000	
rho_x	**0.44**	
fixture delay time	1.10E-09	
Grr_limit	**0**	
ERL_FOM	**0**	

set to zero for no fixture. For a CR cable this is determined outside of this program

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 1.734e-3 1.455e-4]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	95	Ohm (tdr sel)

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 4.114e-4 2.547e-4]	
board_tl_tau	6.191E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	110	mm
z_bp (FEXT)	110	mm
z_bp (RX)	151	mm

COM vs. Cb w/ XTALK for TE cable

(http://www.ieee802.org/3/by/public/channel/TE_QSFP_4SFP_3m_28AWG.zip)

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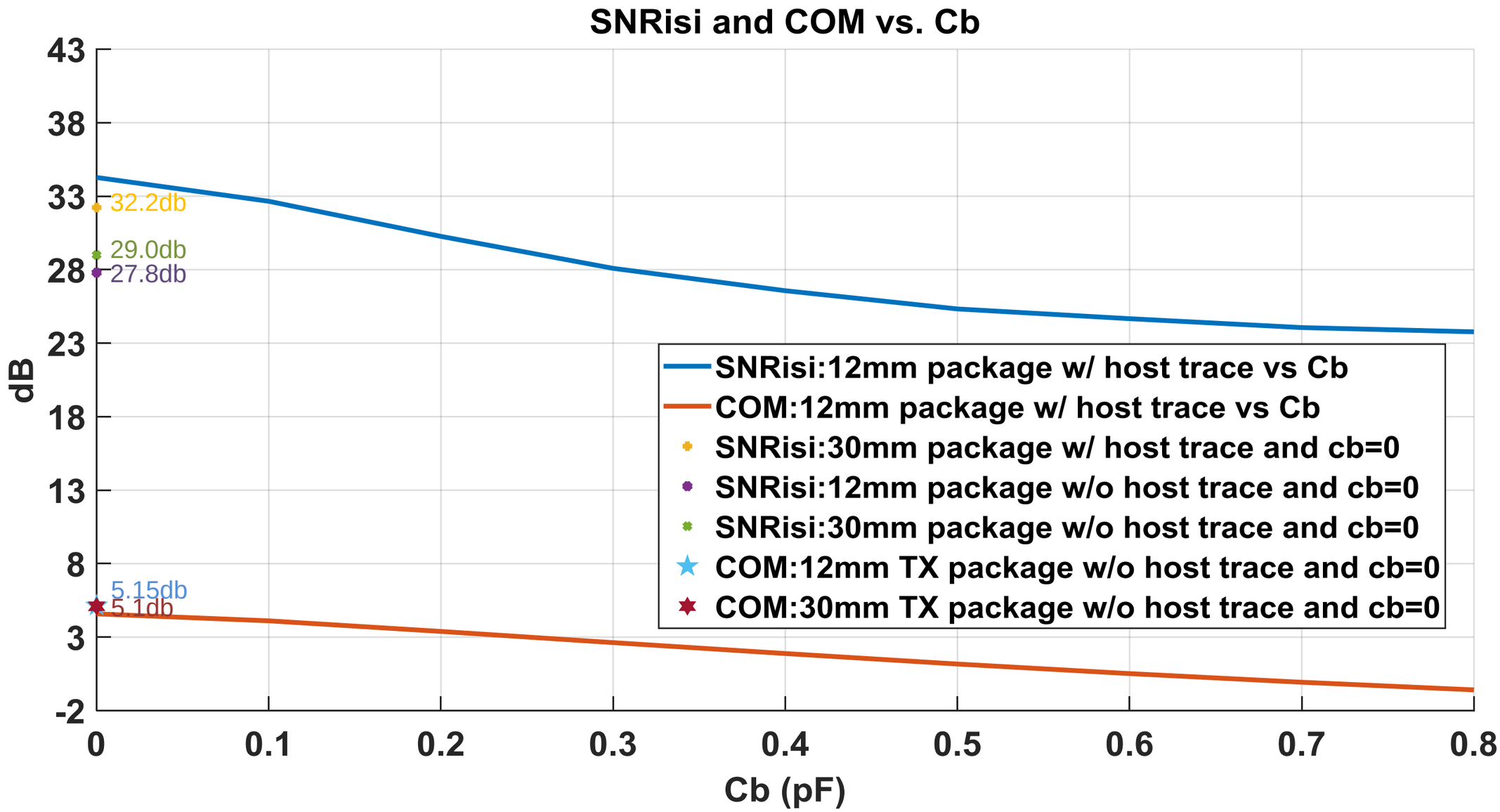
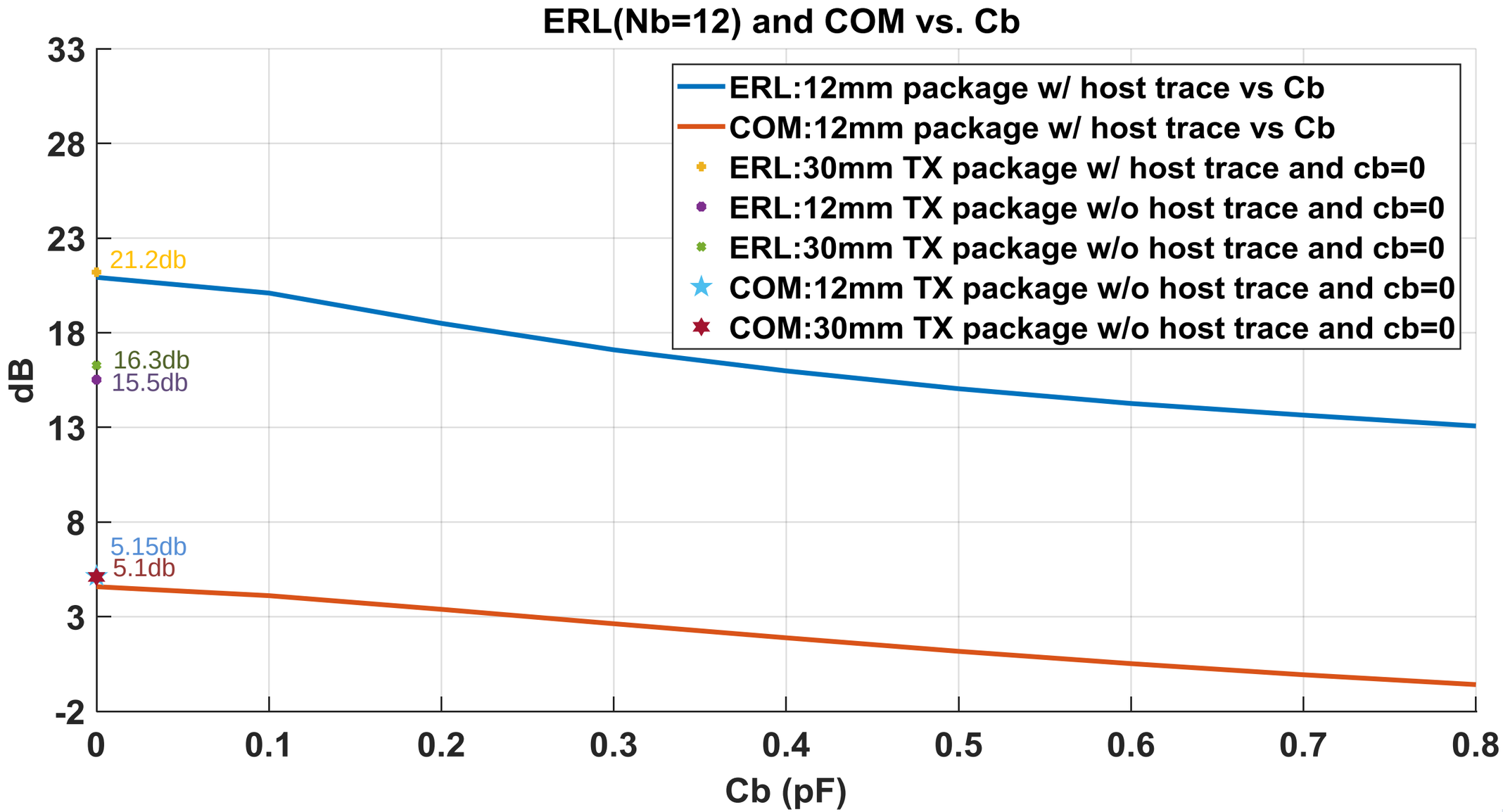
TX package length(mm)	Cb(pF)	COM(dB)
30	**0**	**4.19**
12	0	4.58
12	0.1	4.11
12	0.2	3.39
12	0.3	2.63
12	0.4	1.88
12	0.5	1.17
12	0.6	0.52
12	0.7	-0.07
12	0.8	-0.59
12	0.9	-1.05
12	1	-1.53

SNRisi and COM vs. Cb for TE cable



ERL(Nb=12) and COM vs. Cb for TE cable



Conclusions.

- **System performance (as measured by COM) is worse than the Cable test value for Cb>0.1pF. It is a definite fail for Cb=0.3pF**
- **SNRisi is correlating with this system performance and would fail the hosts with Cb>0.1pF.**
- **We have an issue that with our existing parameters including ERL we can not discriminate between good hosts (No additional host PCB giving very good COM) and bad hosts (with Cb = 0.3 that has bad COM)**
  - The proposed ERL specification would have to be significantly tightened (to around 19dB with Nb=12) to fail the hosts with COM worse than the reference transmitter, and this would fail hosts that have good system performance.
  - SNRisi has some similar but not as bad issues.
  - The last slide proposes a specification based on ERL (with Nb=12) and Pmax/Vf that appears to correlate with system performance. It is recommended that this is adopted for the cable Tx host specification as the metric to replace SNRisi and return loss rather than using ERL alone.
  - Further investigations on more hosts and cables should be made to confirm this is an adequate specification. Results for another cable follow.

COM vs. Cb w/ XTALK for FCI cable

(http://grouper.ieee.org/groups/802/3/by/public/channel/FCI_4xSFP_QSFP_3m_26AWG.zip)

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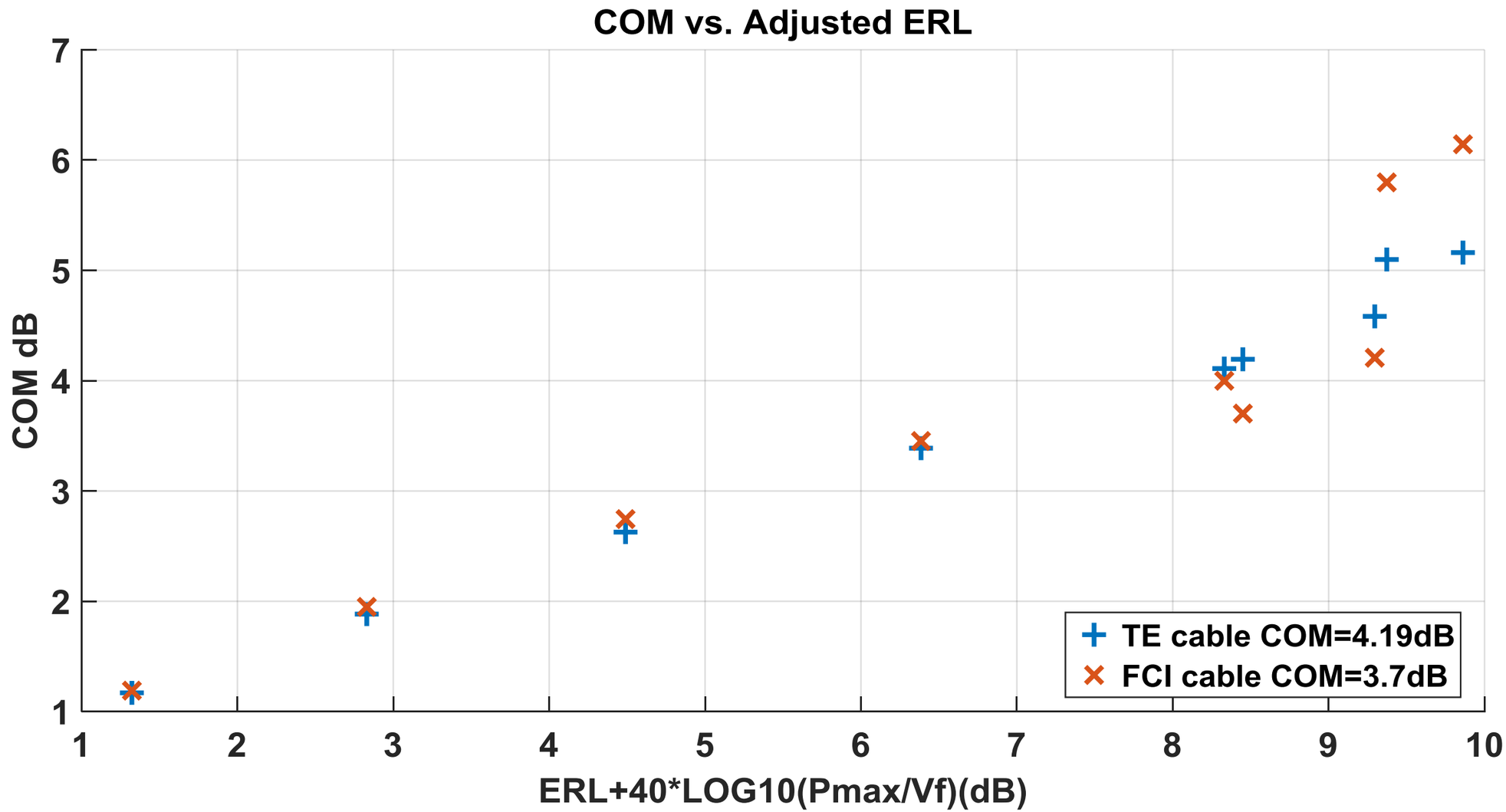
TX package length(mm)	Cb(pF)	COM(dB)
30	**0**	3.70
12	0	4.21
12	0.1	4.00
12	0.2	3.45
12	0.3	2.75
12	0.4	1.95
12	0.5	1.19
12	0.6	0.42
12	0.7	-0.13
12	0.8	-0.75
12	0.9	-1.28
12	1	-1.78

12mm TX package w/o host trace and Cb=0 COM=6.1dB
30mm TX package w/o host trace and Cb=0 COM=5.8dB

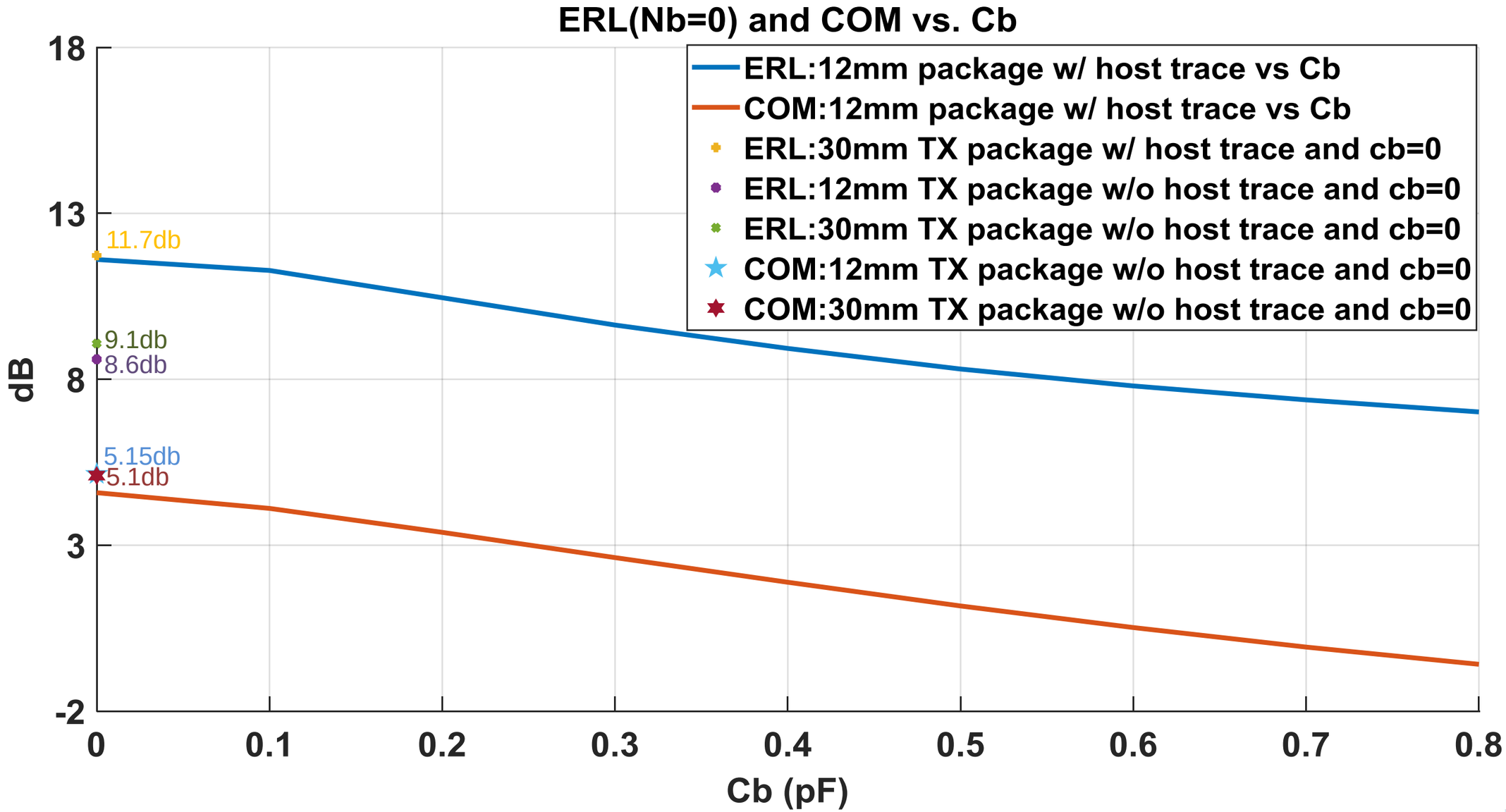
COM vs. Adjusted ERL



Recommended Specification. ERL >= 8dB – 40 *Log_{10}(Pmax/Vf)

Backup

ERL(Nb=0) and COM vs. Cb

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