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shaping tomorrow with you

Mitigating Interaction Problems of Impedance Matching between Channel and Rx (#r02-10/14/55)

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Overview

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- Interaction Problems of Z Matching between Channel and Rx
  - Difficult to test Channel in the worst case for unknown Rx impedance
  - Difficult to test Rx in the worst case for unknown Channel impedance
    - Impedance matching significantly affects the performance (e.g. COM value)
    - Impedance variation is inevitable in actual manufacturing
  - These problems have been discussed in P802.3cd since last November

- Two Proposals to Mitigate these Problems (need both)
  - Use nominal values for COM impedance parameters (i.e. Rd and Zc)
    - Tighten Channel Variation
  - Specify return loss (RL) of test channel for Rx Interference Tolerance Test
    - Tighten Rx Variation
    - Ensure some margin for interoperability

- This presentation is a summary of three presentations in Ad Hoc
  - hidaka_061417_3cd_01_adhoc.pdf : nominal values for COM Z parameters
  - hidaka_061417_3cd_02_adhoc-v2.pdf, hidaka_070517_3cd_01_adhoc.pdf : RL of test channel for Rx ITT

Nominal Values for COM Z Parameters (Rd, Zc)

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- Regardless of whether interoperability margin is enough or not, there are problems to use high Rd and low Zc
  - Problems to use high Rd and low Zc
    - It is not the worst case at all
    - It is biased positive (favoring) to some channels, negative (penalizing) to some channels, and neither positive nor negative to many channels
      - It increases variation of channel characteristics, degrading margin for interoperability
    - It gives misleading impression and illusion of max impedance tolerance
  - Advantages to use nominal Rd and nominal Zc
    - It is not biased to any channels
      - It reduces variation of channel characteristics, improving margin for interoperability
    - It gives a warning that max impedance tolerance is not specified
- COM value will be slightly adjusted so that change of Rd and Zc generally will not affect pass/fail status of existing channels

Tightening Variation by Nominal Reference

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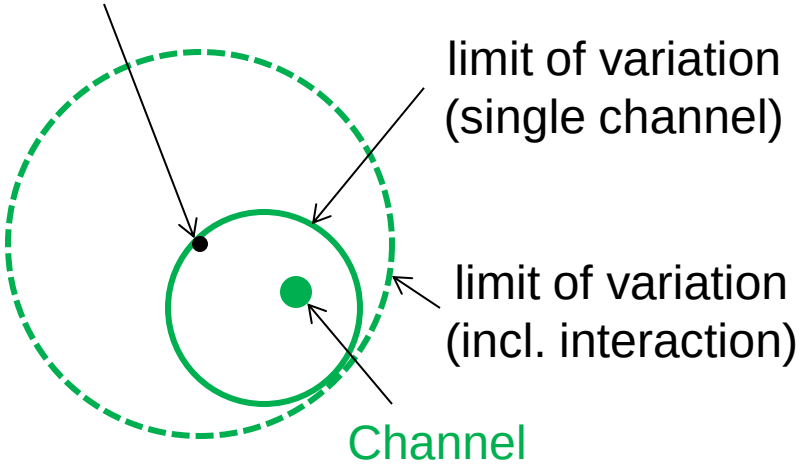
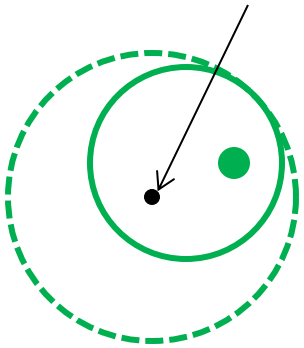
Hyper Space of
Channel Characteristics

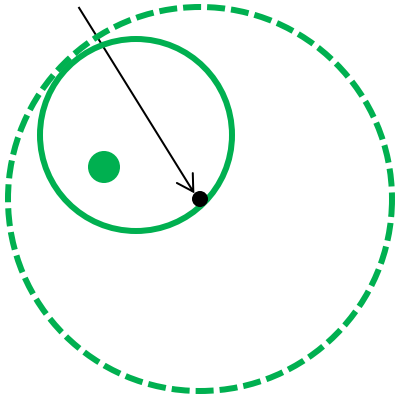
high Rd and high Zc (reference point)



low Rd and high Zc

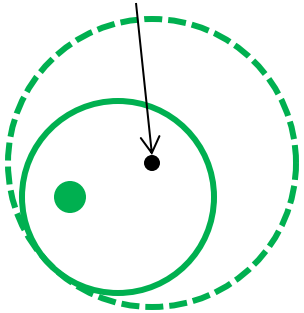


low Rd and low Zc



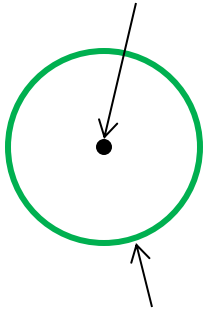
Current Spec

high Rd and low Zc



Proposal

nominal Rd and Zc



limit of variation
(single channel
as well as
incl. interaction)

Return Loss (RL) of Test Channel for Rx ITT

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- In Clause 93, RL of test channel for Rx ITT was specified to meet EQ (93-2)
  - EQ (93-2) is RL of test fixture, that is rather good
  - With good RL of test channel, broadband noise (BBN) is always injected
  - *Overstress* of BBN may be one reason of ample interoperability margin of existing 25G NRZ SerDes
    - BBN (a.k.a. Gaussian noise) has *infinite* range of noise-amplitude distribution
    - Reflection and crosstalk have *limited* range of noise-amplitude distribution
- Lack of RL spec of test channel for Rx ITT may seriously degrade interoperability margin of 50G PAM4 SerDes
- Since we defined RL of test channel as test-fixture grade for Clause 93, we should do the same in Annex 120D, Clause 137, and Clause 136
  - It is also feasible, because we just re-use the same RL mask

Conclusion

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- Proposal 1 : Use nominal Rd and Zc values
  - Adjust Ave, Afe, Ane not to change vf value at TP0a
  - Adjust Channel COM generally not to affect pass/fail of existing channels

	Annex 120D	Clause 137	Clause 136
Rd	50 Ω	50 Ω	50 Ω
PKG Zc	95 Ω	95 Ω	95 Ω
PCB Zc	N/A	N/A	100 Ω
Av	0.418 V	0.415 V	0.415 V
Afe	0.418 V	0.415 V	0.415 V
Ane	0.604 V	0.604 V	0.604 V
Channel COM	3.1dB	3.0dB	3.3dB

- Proposal 2 : Specify return loss of test channel for Rx ITT by
  - EQ (93-2) for Annex 120D and Clause 137
  - EQ (92-38) for Clause 136

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Back up Slides

- Effects of nominal Rd and Zc values on COM values
  - Simulation results not to affect pass/fail of existing channels
  - Reported in hidaka_061417_3cd_01_adhoc.pdf

COM Parameters for Annex 120D (Common)

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)	[30]	mm	[test cases]
z_p (NEXT)	[12]	mm	[test cases]
z_p (FEXT)	[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	[55 55]	Ohm	[TX RX]
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.15:0.05:0]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-15:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	53.125	GHz	
A_v	0.44	V	
A_fe	0.44	V	
A_ne	0.63	V	
L	4		
M	32		
N_b	10	UI	
b_max(1)	0.5		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	2.60E-08	V^2/GHz	
SNR_TX	31	dB	
R_LM	0.95		
DER_0	1.00E-05		
Operational control			
COM Pass threshold	3	dB	
Include PCB	0	Value	0, 1, 2
g_DC_HP	[-4:1:0]		[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\V165_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	V164	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	1.30E-02	ns
T_r_meas_point	0	logical
T_r_filter_type	1	logical
Non standard control options		
INC_PACKAGE	1	logical
IDEAL_RX_TERM	0	logical
INCLUDE_CTLE	1	logical
INCLUDE_TX_RX_FILTER	1	logical
COM_CONTRIBUTION	0	logical

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	90	Ohm

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	110	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	72	mm
z_bp (FEXT)	72	mm
z_bp (RX)	151	mm

- Yellow cells were changed as the following slide

COM Parameters for Annex 120D (Difference)

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- Based on slide 9 of hidaka_060717_3cd_adhoc-v2.pdf
  - Tx Amplitude for Zc90/93/95/100 were calibrated at TP0a

Label	D3.0	D3.1	D3.2	Zc90	Zc93	Zc95	Zc100
R_d	55	55	55	50	50	50	50
Z_c	85	90	90	90	93	95	100
A_v	0.45	0.45	0.44	0.419	0.418	0.418	0.417
A_fe	0.45	0.45	0.44	0.419	0.418	0.418	0.417
A_ne	0.63	0.63	0.63	0.604	0.604	0.604	0.604
C_d	2.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4
f_p2	1E+99	2*f_b	2*f_b	2*f_b	2*f_b	2*f_b	2*f_b
z_p	30	30	30	30	30	30	30

18 Channels for Simulation for Annex 120D

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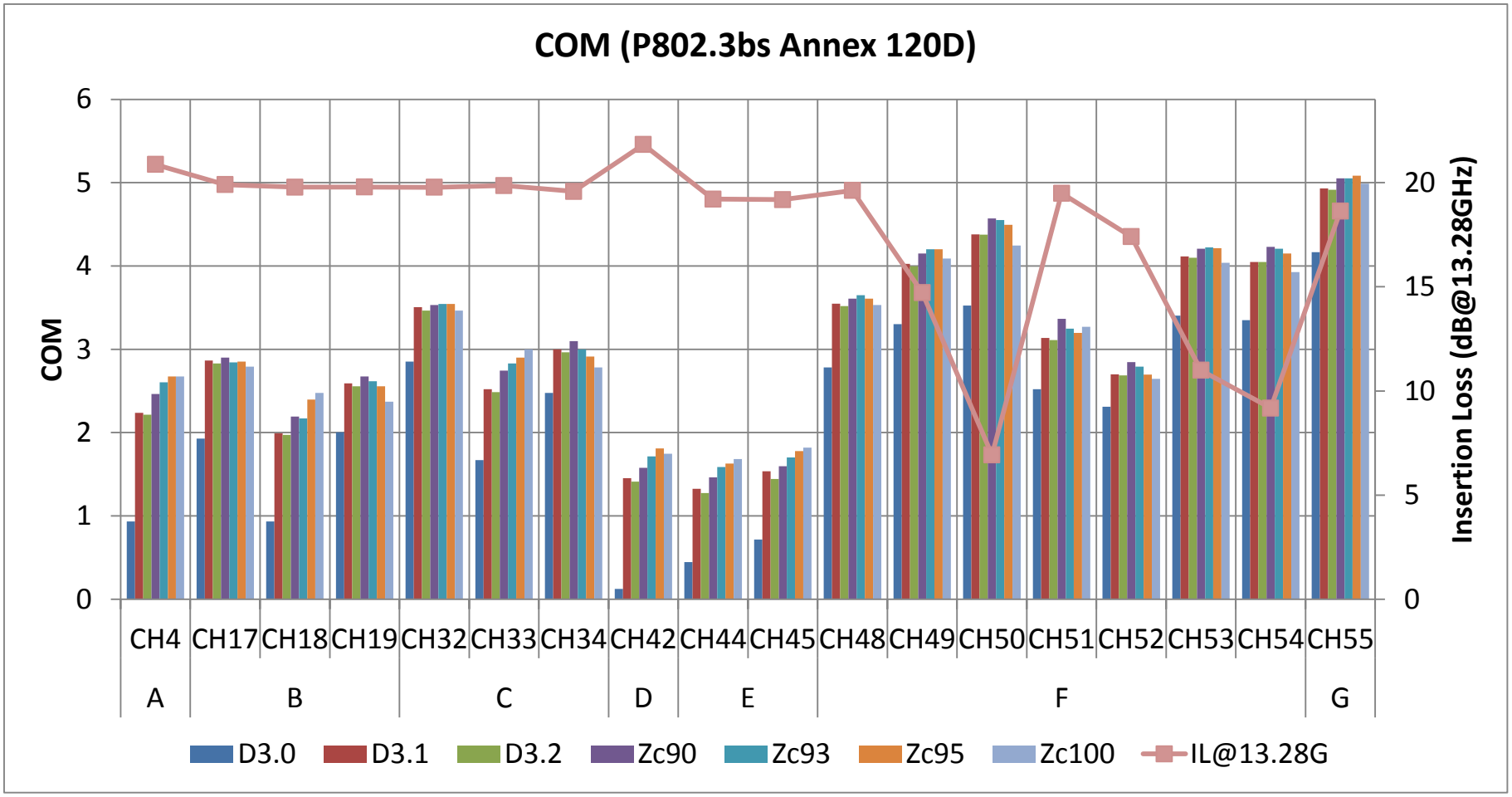
Category	CH #	IL 13.28G	Description	Channel Data Source
A	4	20.9dB	Cisco Backplane	P802.3cd 50/100/200GbE TF (Cisco_Backplane_channel_data.zip)
B	17,18,19	~20dB	Intel 100Ω Backplane	50G/NGOATH Study Group (mellitz_01_021716_20dB_6_channels.zip)
C	32,33,34	~20dB	Intel 85Ω Backplane	
D	42	21.8dB	TE Backplane	P802.3cd 50/100/200GbE TF (TEC_STRADAWhisper27in_Meg6_*.zip)
E	44, 45	~19dB	Cavium Backplane	P802.3cd 50/100/200GbE TF (Cavium_20dB_H*.zip)
F	48	19.6dB	Intel Mezzanine Channel	P802.3bs 200/400GbE TF (mellitz_3bs_*_0714.zip)
	49	14.7dB		
	50	6.9dB		
	51	19.5dB		
	52	17.4dB		
	53	11.0dB		
	54	9.2dB		
G	55	18.6dB	TEC ARMOR Mezzanine	P802.3bs 200/400GbE TF (TEC/shanbhag_01_0914.zip)

Results for Annex 120D



- F and G have one mezzanine connector (relevant for 120D)
- A thru E have two backplane connectors (only for information)

Results for Annex 120D (ΔCOM from D3.0)

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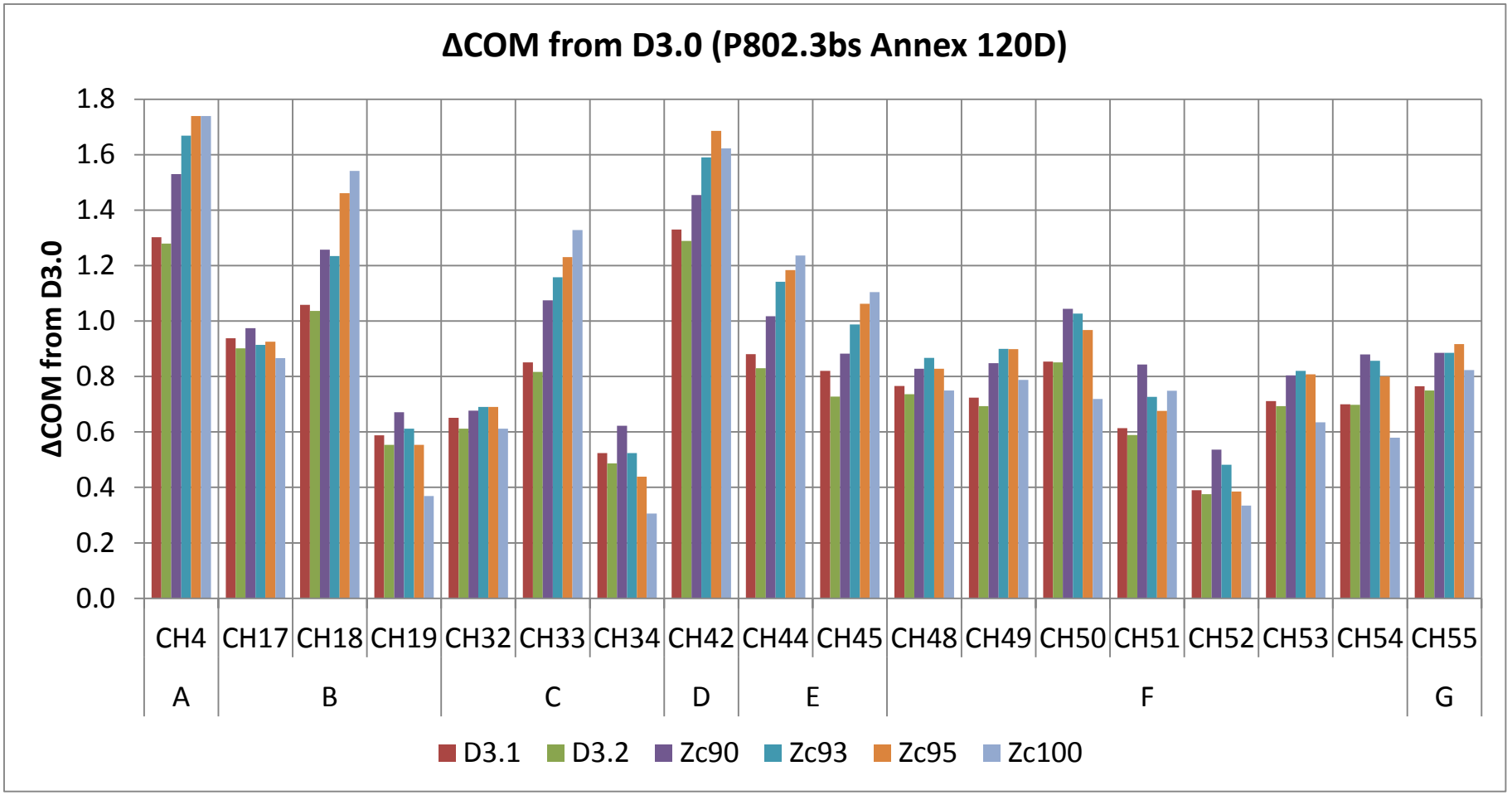

- Large improvement (~0.8dB) mainly due to Cd (280fF→180fF)
  - Since COM was not changed, it was budget transfer from Rx to channel
- This is only for information, and not used for my proposal

Results for Annex 120D (ΔCOM from D3.2)

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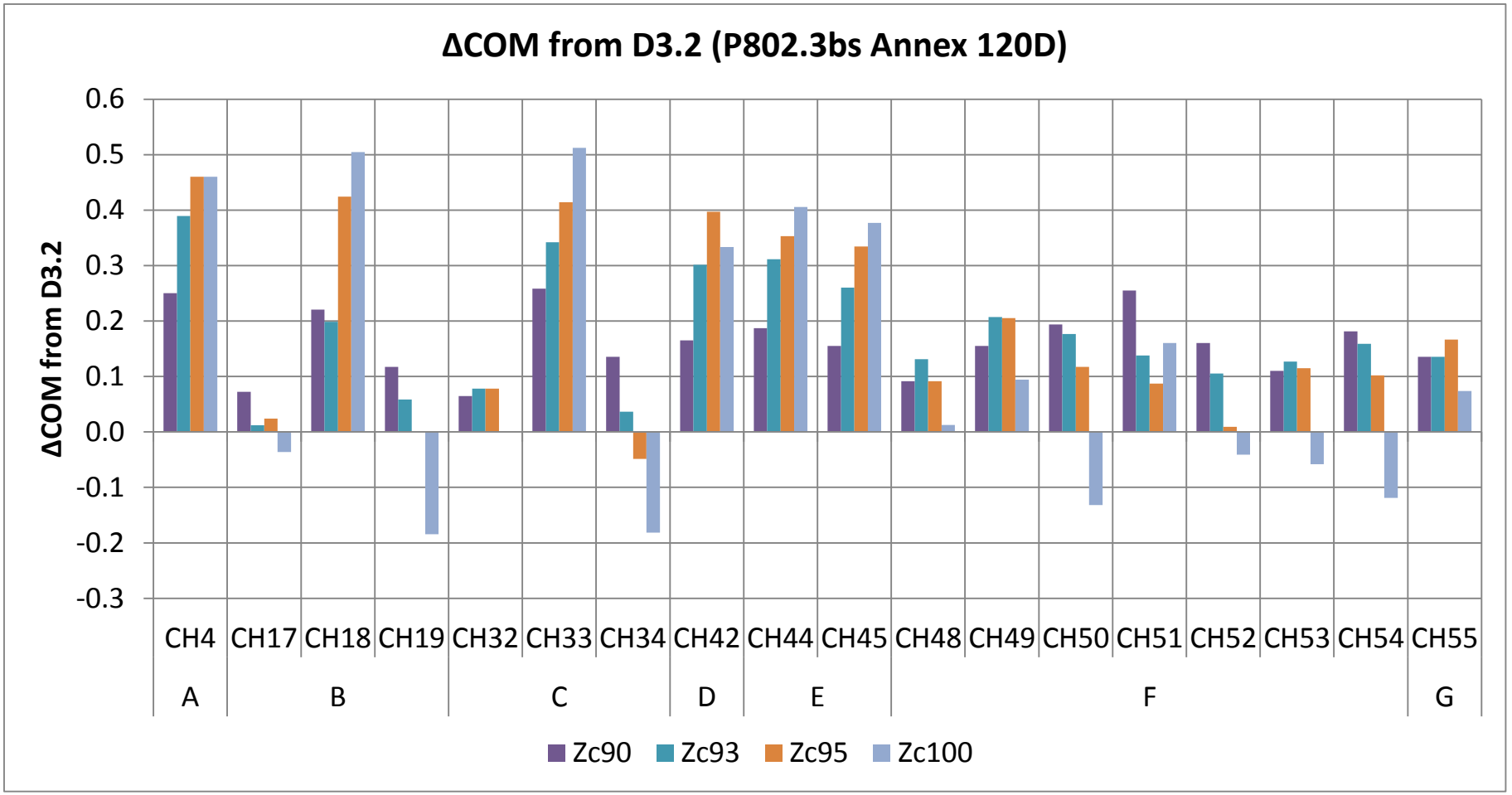

- Zc = 95Ω and COM = 3.1dB seems a reasonable choice
  - Looking at the results of F and G which are relevant for Annex 120D
  - My proposal for Annex 120D is based on this result

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Thank you