



## **Package impedance and termination effect on COM (update based on D3.3)**

Mike Dudek      Cavium  
Nikhil Patel      Cavium

802.3bs electrical ad hoc Aug 28.

- **This is an update to work presented in dudek\_3bs\_02\_0517 and dudek\_3bs\_01\_0717. Significant changes were made to the specification in 802.3bs Draft 3.3 and this presentation shows the result.**
- **The presentation explores the impact of varying package impedance ( $Z_c$ ) and  $R_d$  termination on for the 400GAUI-8 (Clause 120D) chip to chip specification.**
- **COM uses a particular package trace impedance and die impedance for its calculations, and it has been shown in these previous presentations and by Yasuo Hidaka in 802.3cd (e.g. hidaka\_3cd\_01a\_0317) that there is no one combination that gives worse case results for all channels.**

# Key changes in Draft 3.3

- **A tight return loss specification was added to the interference tolerance test system.**
  - This is expected to reduce variability in the interference tolerance test and also will mean that Receivers that have poorer return loss will need to have better other performance to compensate. For this reason for this presentation only the Tx die and package impedance were changed.
- **A return loss specification was added to the channel for marginal channels (COM <4.0dB). The channel with the worst variability in the previous work (Mellitz\_3bs\_04\_0714) fails this specification, and therefore does not need to be considered.**
- **The die impedance and package trace impedance were changed to nominal values of 50 Ohm and 95 Ohm respectively with changes to Av, Afe, and Ane to keep the steady state voltage at 0.4V.**

- **Four variations of Tx package and die impedances are evaluated to cover manufacturing tolerances and potential different target impedance values. In addition another package option based on Mellitz\_3bs\_01a\_0717 was included. (Relative to the Mellitz\_3bs\_01a0717 package it had somewhat lower capacitance in order to meet the Tx return loss specification.)**
- **All COM parameters, other than those shown in tables, are the same as in IEEE P802.3bs/D3.3 spec. The Rx package and die impedances were kept at the values in the D3.3 spec.**
- **Av was adjusted so that the steady state voltage Vf is kept equal to 0.4V for all the combinations.**
- **The first eight channels evaluated are found at <http://grouper.ieee.org/groups/802/3/bs/public/channel/index.shtml>. The additional two channels have smaller capacitive discontinuities and higher impedance (but not higher than 110 ohms). Three additional channels provided to 802.3cd by Cisco were included in this analysis. <http://grouper.ieee.org/groups/802/3/cd/public/channel/index.html>**

# Effect of Changing Tx package and die impedance

	CHANNELS AS IS						Delta D3.2 to D3.3	Delta mod1 to D3.3	Delta mod2 to D3.3	Delta mod5 to D3.3	Delta mod6 to D3.3
	D3.3	D3.2	CAVM mod1	CAVM mod2	CAVM mod5	CAVM mod6 (similar to Mellitz_3bs_01a_0717)					
package_Zc (ohms) [Tx Rx]	[95 95]	[90 90]	[100 95]	[110 95]	[85 95]	[110 95]					
Av/Afe (V)	0.418	0.44	0.418	0.394	0.45	0.394					
Ane (V)	0.604	0.63	0.604	0.604	0.604	0.604					
Cd (nF)	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.00E-04		Largest negative difference			
Cp(nF)	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.8 1.1]E-4		Largest positive difference			
Rd (ohms) [Tx Rx]	[50 50]	[55 55]	[50 50]	[45 50]	[55 50]	[45 50]					
Channels											
mellitz_3bs_02_0714	3.67	3.68	3.68	3.55	3.74	3.63	0.01	0.01	-0.12	0.07	-0.04
mellitz_3bs_03_0714	4.35	4.1	4.3	4.1	4.23	4.27	-0.25	-0.05	-0.25	-0.12	-0.08
mellitz_3bs_04_0714	4.54	4.42	4.46	4.33	4.46	4.56	-0.12	-0.08	-0.21	-0.08	0.02
mellitz_3bs_05_0714	3.42	3.29	3.42	3.14	3.45	3.31	-0.13	0	-0.28	0.03	-0.11
mellitz_3bs_06_0714	2.75	2.73	2.71	2.64	2.85	2.88	-0.02	-0.04	-0.11	0.1	0.13
mellitz_3bs_07_0714	4.28	4.16	4.23	4.04	4.24	4.32	-0.12	-0.05	-0.24	-0.04	0.04
mellitz_3bs_08_0714	4.2	4.09	4.13	3.98	4.14	4.22	-0.11	-0.07	-0.22	-0.06	0.02
shanhbag_01_0914	5.08	4.91	5.02	4.77	5.05	4.95	-0.17	-0.06	-0.31	-0.03	-0.13
Cavium_20dB_HghZ /w reduced xtlk	3.17	2.66	3.24	3.08	2.95	3.18	-0.51	0.07	-0.09	-0.22	0.01
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	3.36	2.91	3.42	3.22	3.15	3.29	-0.45	0.06	-0.14	-0.21	-0.07
Cisco CH1	3.72	3.08	3.77	3.67	3.27	3.91	-0.64	0.05	-0.05	-0.45	0.19
Cisco CH3	3.15	2.53	3.22	3.12	2.77	3.38	-0.62	0.07	-0.03	-0.38	0.23
Cisco CH4	2.67	2.21	2.69	2.44	2.45	2.6	-0.46	0.02	-0.23	-0.22	-0.07

- **The changes made to the specification in D3.3 have significantly improved the situation.**
- **The changes to the COM parameters going from D3.2 to D3.3 have improved the results by over 0.2dB for many channels.**
- **There is still about 0.2dB hole in the specification. i.e. The performance of a compliant Tx plus channel can be 0.2dB worse COM than that calculated in the Channel COM test.**
- **The COM requirement for the channel should be changed to 3.2dB while leaving the COM for the Interference tolerance test at 3.0dB.**

# Backup

# Effect of Changing Tx package and die impedance – CHANNELS REVERSED

	CHANNELS REVERSED						Delta D3.2 to D3.3	Delta mod1 to D3.3	Delta mod2 to D3.3	Delta mod5 to D3.3	Delta mod6 to D3.3
	D3.3	D3.2	CAVM mod1	CAVM mod2	CAVM mod5	CAVM mod6 (similar to Mellitz_3bs_01a_0717)					
package_Zc (ohms) [Tx Rx]	[95 95]	[90 90]	[100 95]	[110 95]	[85 95]	[110 95]					
Av/Afe (V)	0.418	0.44	0.418	0.394	0.45	0.394					
Ane (V)	0.604	0.63	0.604	0.604	0.604	0.604					
Cd (nF)	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.00E-04		Largest negative difference			
Cp(nF)	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.1 1.1]E-4	[1.8 1.1]E-4		Largest positive difference			
Rd (ohms) [Tx Rx]	[50 50]	[55 55]	[50 50]	[45 50]	[55 50]	[45 50]					
Channels											
mellitz_3bs_02_0714	3.67	3.68	3.67	3.51	3.69	3.67	0.01	0	-0.16	0.02	0
mellitz_3bs_03_0714	4.35	4.12	4.28	4.11	4.18	4.04	-0.23	-0.07	-0.24	-0.17	-0.31
mellitz_3bs_04_0714	4.54	4.42	4.41	4.17	4.51	4.21	-0.12	-0.13	-0.37	-0.03	-0.33
mellitz_3bs_05_0714	3.42	3.29	3.38	3.24	3.44	3.21	-0.13	-0.04	-0.18	0.02	-0.21
mellitz_3bs_06_0714	2.75	2.73	2.65	2.59	2.89	2.8	-0.02	-0.1	-0.16	0.14	0.05
mellitz_3bs_07_0714	4.28	4.16	4.19	3.92	4.22	4.2	-0.12	-0.09	-0.36	-0.06	-0.08
mellitz_3bs_08_0714	4.2	4.09	4.08	3.83	4.18	3.96	-0.11	-0.12	-0.37	-0.02	-0.24
shanbhag_01_0914	5.08	4.91	5.02	4.76	5.06	4.94	-0.17	-0.06	-0.32	-0.02	-0.14
Cavium_20dB_HghZ /w reduced xtlk	3.21	2.66	3.28	3.08	2.94	3.17	-0.55	0.07	-0.13	-0.27	-0.04
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	3.38	2.92	3.42	3.26	3.17	3.32	-0.46	0.04	-0.12	-0.21	-0.06
Cisco CH1	3.71	3.08	3.76	3.76	3.24	3.98	-0.63	0.05	0.05	-0.47	0.27
Cisco CH3	3.16	2.51	3.21	3.21	2.74	3.49	-0.65	0.05	0.05	-0.42	0.33
Cisco CH4	2.67	2.2	2.7	2.53	2.38	2.84	-0.47	0.03	-0.14	-0.29	0.17



# Effect of lower package impedance (Mod 4) that fails Tx SNR<sub>ISI</sub>

## Slide from Dudek\_3bs\_01\_0717

	D3.1 ORIGINAL	D3.1 CAVM mod1	D3.1 CAVM mod2	D3.1 CAVM mod3	D3.1 CAVM mod4	Delta mod1 to original	Delta mod2 to original	Delta mod3 to original	Delta mod4 to original
package_Zc (ohms)	90	100	110	95	80				
Av/Afe (V)	0.45	0.418	0.394	0.416	0.441				
Cd (nF)	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04		Largest negative difference		
Rd (ohms)	[55 55]	[50 50]	[45 45]	[50 50]	[55 55]		Largest positive difference		
Channels									
mellitz_3bs_02_0714	3.54	3.51	3.27	3.6	2.63	-0.03	-0.27	0.06	-0.91
mellitz_3bs_03_0714	4.02	4.17	3.81	4.2	3.1	0.15	-0.21	0.18	-0.92
mellitz_3bs_04_0714	4.39	4.08	3.53	4.24	3.53	-0.31	-0.86	-0.15	-0.86
mellitz_3bs_05_0714	3.13	3.35	2.96	3.19	2.43	0.22	-0.17	0.06	-0.7
mellitz_3bs_06_0714	2.7	2.65	2.47	2.71	2.25	-0.05	-0.23	0.01	-0.45
mellitz_3bs_07_0714	4.11	4.07	3.68	4.21	3.31	-0.04	-0.43	0.1	-0.8
mellitz_3bs_08_0714	4.02	3.92	3.52	4.13	3.29	-0.1	-0.5	0.11	-0.73
shanbhag_01_0914	4.93	4.98	4.61	5.08	4	0.05	-0.32	0.15	-0.93
Cavium_20dB_HghZ /w reduced xtlk	2.7	3.28	2.92	3.17	1.57	0.58	0.22	0.47	-1.13
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	2.96	3.46	3.11	3.36	1.94	0.5	0.15	0.4	-1.02

# COM comparison to Mod3 (OIF adopted) - Mod4 added

## Slide from Dudek\_3bs\_01\_0717

	D3.1 ORIGINAL	D3.1 CAVM mod1	D3.1 CAVM mod2	D3.1 CAVM mod3	D3.1 CAVM mod4	Delta original to mod3	Delta mod1 to mod3	Delta mod2 to mod3	Delta mod4 to mod3
package_Zc (ohms)	90	100	110	95	80				
Av/Afe (V)	0.45	0.418	0.394	0.416	0.441				
Cd (nF)	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04		Largest negative difference		
Rd (ohms)	[55 55]	[50 50]	[45 45]	[50 50]	[55 55]		Largest positive difference		
Channels									
mellitz_3bs_02_0714	3.54	3.51	3.27	3.6	2.63	-0.06	-0.09	-0.33	-0.97
mellitz_3bs_03_0714	4.02	4.17	3.81	4.2	3.1	-0.18	-0.03	-0.39	-1.1
mellitz_3bs_04_0714	4.39	4.08	3.53	4.24	3.53	0.15	-0.16	-0.71	-0.71
mellitz_3bs_05_0714	3.13	3.35	2.96	3.19	2.43	-0.06	0.16	-0.23	-0.76
mellitz_3bs_06_0714	2.7	2.65	2.47	2.71	2.25	-0.01	-0.06	-0.24	-0.46
mellitz_3bs_07_0714	4.11	4.07	3.68	4.21	3.31	-0.1	-0.14	-0.53	-0.9
mellitz_3bs_08_0714	4.02	3.92	3.52	4.13	3.29	-0.11	-0.21	-0.61	-0.84
shanbhag_01_0914	4.93	4.98	4.61	5.08	4	-0.15	-0.1	-0.47	-1.08
Cavium_20dB_HghZ /w reduced xtlk	2.7	3.28	2.92	3.17	1.57	-0.47	0.11	-0.25	-1.6
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	2.96	3.46	3.11	3.36	1.94	-0.4	0.1	-0.25	-1.42