



## Package impedance and termination effect on COM (update 2)

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802.3 Plenary meeting May 2017 Berlin

- **This is an update to dudek\_3bs\_02\_0517. Key changes.**
  - Corrects a typo (and consequential changes) for the Mellitz 04 channel COM with the D3.1 package and die parameters.
  - As requested at the New Orleans meeting investigates the effect of leaving  $A_v$  unchanged when the die  $R_d$  value is changed.
- **Much of this material was presented at the joint 802.3cd/bs ad hoc on June 26<sup>th</sup> 2017,**
- **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.**
- **Yasuo Hidaka in 802.3cd (e.g.) hidaka\_3cd\_01a\_0317 has shown that for a large number of backplane channels the COM varies significantly (on the order of +/- 0.5dB) depending on the choice of package trace impedance and die impedance within a 10% manufacturing tolerance and that no one choice of impedances gives the worst case.**

- **Four variations from the IEEE P802.3bs/D3.1 COM parameters are evaluated to cover manufacturing tolerances and potential different target impedance values.**
- **All COM parameters, other than those shown in tables, are the same as in IEEE P802.3bs/D3.1 (and D3.2) spec. Most other parameters were not varied because they are used to derive “single sided” specifications and it is expected that changes to these parameters within specification (e.g. TXSNR) would only improve the result. Changing the values of Cd and Cp (while still meeting the return loss and SNR<sub>isi</sub> specification) might have a similar effect but this was not investigated.**
- **Av was adjusted so that the steady state voltage Vf is kept equal to 0.4V for all the combinations. However comparisons are also included when Vf is not changed.**
- **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).**

# COM comparison to D3.1 ORIGINAL

Changed

	D3.1 ORIGINAL	D3.1 CAVM mod1	D3.1 CAVM mod2	D3.1 CAVM mod3	Delta mod1 to original	Delta mod2 to original	Delta mod3 to original
package_Zc (ohms)	90	100	110	95			
Av/Afe (V)	0.45	0.418	0.394	0.416			
Cd (nF)	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]		Largest positive difference	
Channels							
mellitz_3bs_02_0714	3.54	3.51	3.27	3.6	-0.03	-0.27	0.06
mellitz_3bs_03_0714	4.02	4.17	3.81	4.2	0.15	-0.21	0.18
mellitz_3bs_04_0714	4.39	4.08	3.53	4.24	-0.31	-0.86	-0.15
mellitz_3bs_05_0714	3.13	3.35	2.96	3.19	0.22	-0.17	0.06
mellitz_3bs_06_0714	2.7	2.65	2.47	2.71	-0.05	-0.23	0.01
mellitz_3bs_07_0714	4.11	4.07	3.68	4.21	-0.04	-0.43	0.1
mellitz_3bs_08_0714	4.02	3.92	3.52	4.13	-0.1	-0.5	0.11
shanbhag_01_0914	4.93	4.98	4.61	5.08	0.05	-0.32	0.15
Cavium_20dB_HghZ /w reduced xtlk	2.7	3.28	2.92	3.17	0.58	0.22	0.47
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	2.96	3.46	3.11	3.36	0.5	0.15	0.4



# COM comparison to Mod3 (OIF adopted)

Changed

	D3.1 ORIGINAL	D3.1 CAVM mod1	D3.1 CAVM mod2	D3.1 CAVM mod3	Delta original to mod3	Delta mod1 to mod3	Delta mod2 to mod3
package_Zc (ohms)	90	100	110	95			
Av/Afe (V)	0.45	0.418	0.394	0.416			
Cd (nF)	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]		Largest positive difference	
Channels							
mellitz_3bs_02_0714	3.54	3.51	3.27	3.6	-0.06	-0.09	-0.33
mellitz_3bs_03_0714	4.02	4.17	3.81	4.2	-0.18	-0.03	-0.39
mellitz_3bs_04_0714	4.39	4.08	3.53	4.24	0.15	-0.16	-0.71
mellitz_3bs_05_0714	3.13	3.35	2.96	3.19	-0.06	0.16	-0.23
mellitz_3bs_06_0714	2.7	2.65	2.47	2.71	-0.01	-0.06	-0.24
mellitz_3bs_07_0714	4.11	4.07	3.68	4.21	-0.1	-0.14	-0.53
mellitz_3bs_08_0714	4.02	3.92	3.52	4.13	-0.11	-0.21	-0.61
shanbhag_01_0914	4.93	4.98	4.61	5.08	-0.15	-0.1	-0.47
Cavium_20dB_HghZ /w reduced xtlk	2.7	3.28	2.92	3.17	-0.47	0.11	-0.25
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	2.96	3.46	3.11	3.36	-0.4	0.1	-0.25

# Effect of not changing Av.

	D3.1 ORIGINAL	D3.1 CAVM mod1	D3.1 CAVM mod2	D3.1 CAVM mod3	D3.1 CAVM mod1 /w Av = 0.45	D3.1 CAVM mod2 /w Av = 0.45	D3.1 CAVM mod3 /w Av = 0.45	Delta due to AV change Mod 1	Delta due to AV change Mod 2	Delta due to AV change Mod 3
package_Zc (ohms)	90	100	110	95	100	110	95			
Av/Afe (V)	0.45	0.418	0.394	0.416	0.45	0.45	0.45			
Cd (nF)	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04			
Rd (ohms)	[55 55]	[50 50]	[45 45]	[50 50]	[50 50]	[45 45]	[50 50]			
Channels										
mellitz_3bs_02_0714	3.54	3.51	3.27	3.6	3.63	3.42	3.65	-0.12	-0.15	-0.05
mellitz_3bs_03_0714	4.02	4.17	3.81	4.2	4.22	3.91	4.33	-0.05	-0.1	-0.13
mellitz_3bs_04_0714	4.39	4.08	3.53	4.24	4.31	3.55	4.2	-0.23	-0.02	0.04
mellitz_3bs_05_0714	3.13	3.35	2.96	3.19	3.27	3.08	3.38	0.08	-0.12	-0.19
mellitz_3bs_06_0714	2.7	2.65	2.47	2.71	2.7	2.53	2.7	-0.05	-0.06	0.01
mellitz_3bs_07_0714	4.11	4.07	3.68	4.21	4.1	3.73	4.27	-0.03	-0.05	-0.06
mellitz_3bs_08_0714	4.02	3.92	3.52	4.13	3.96	3.55	4.17	-0.04	-0.03	-0.04
shanbhag_01_0914	4.93	4.98	4.61	5.08	5.08	4.74	5.13	-0.1	-0.13	-0.05
Cavium_20dB_HghZ /w reduced xtlk	2.7	3.28	2.92	3.17	3.41	3.16	3.33	-0.13	-0.24	-0.16
Cavium_20dB_HghZ_Nom_HighZ /w reduced xtlk	2.96	3.46	3.11	3.36	3.59	3.35	3.5	-0.13	-0.24	-0.14

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

	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

- **With realistic Tx package/die impedances the COM can be significantly worse (0.7dB) than with the values presently used in COM. This creates a “hole” in the specification that should be filled. Raising the COM requirement for the channel to 0.5dB above the COM used for the interference tolerance test will close the majority of the “hole” except for  $Z_c=80$  ohms  $R_d=55$  ohms.**
- **$Z_c=80$  ohms  $R_d=55$  ohms has the worst COM of all cases and is not recommended. Additional analysis has shown that with  $Z_c=80$  ohms the package will not pass  $SNR_{isi}$  (it is 33.42dB). Therefore the bad COM is not an issue so long as the  $SNR_{isi}$  specification isn't relaxed.**
- **Leaving  $A_v$  unchanged changes the COM by less than 0.25dB. It is not the dominant effect.**
- **Changing to  $Z_c=95$  ohms  $R_d=50$  ohms (nominal values) has improved COM over  $Z_c=100$  ohms and  $Z_c=90$  ohms for majority of channels and has reduced the variability somewhat. The original supposed worst case values tended to “favor” some channels while “penalizing” others.**



- **Change to  $Z_c=95$  ohms  $R_d=50$  ohms (nominal values) to make the results less dependent on the impedance of the channels. Change  $A_v$  and  $A_{fe}$  to 0.416V to keep the  $A_v$  at 0.4V (comment r02\_55).**
- **In order to close the majority of the “hole” in the specification, increase the COM for measuring the channel to 3.5dB. (comment r02\_56). (Note that it would also be possible to close the “hole” by tightening the specification on the Rx instead of on the channel. Any combination that has the channel COM 0.5dB higher than the interference tolerance test COM closes the hole. E.g. the Channel COM could remain at 3.0dB with the Interference tolerance test COM at 2.5dB).**

# Backup

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

	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