



50G PAM4 C2M Effect of Impairments on eye opening.

Mike Dudek
Tao Hu
3/6/2017

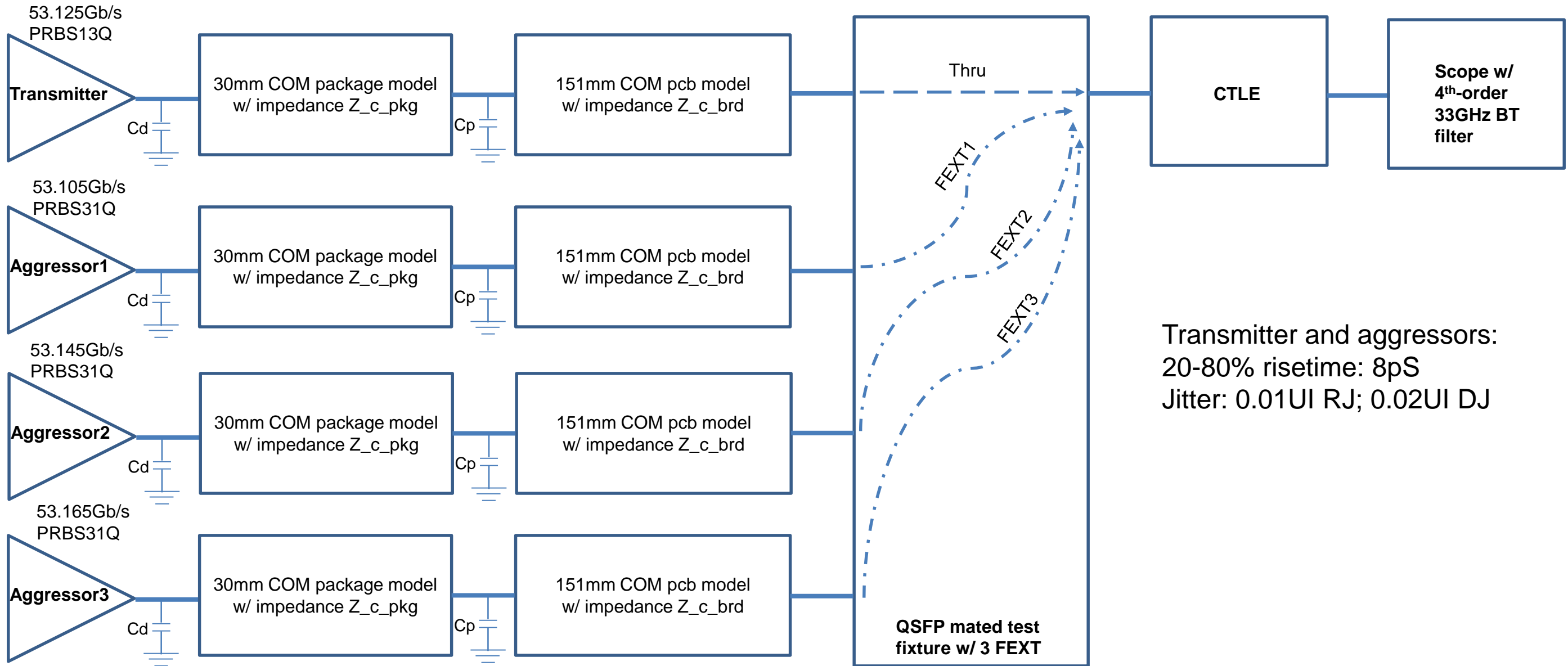
Cavium
Cavium

- **Purpose:** - To determine what the effects of channel impairments are on the chip to module link.
- **Perform simulation w/ various source impedance, package impedance, board impedance, Cd and Cp, jitter and noise.**
- **For each set of parameters adjust Av such that Vf=0.4V at TP0a with Np=13.**
- **For each Cd, Cp, package, board, source impedance combination, sweep TX FIR and CTLE**
 - pre1: -0.15 to 0 with step 0.05
 - post1: -0.25 to 0 with step 0.05
 - CTLE: peaking 5dB to 9dB with step 0.5dB
- **With optimal TX and CTLE, simulate chip to module BER 1E-5 eye at HCB with xtalk and jitter included**
- **For calculating the effect of Tx_SNR, noise was added to the receiver equal to the rms value of the noise created by the Tx_SNR when passed through the channel.**

Limitations.

- **Due to limitations in the simulation environment the effect of RLM was not investigated.**
- **Eye widths and Eye amplitudes are as reported by ADS not as specified by the 120E specification.**
- **Additional board degradations and reflections are not included.**

Chip to module block diagram



Eye @ BER 1E-5

Row	Av (V)	Rd (ohm)	Cd (pF)	Cp (pF)	Vf (Np=13) (V)	Package Zc (ohm)	Board Zc (ohm)	SNR_TX (dB)	Jitter On	CTLE peaking (dB)	TX FIR	Mated Board FEXT (mV)	Width1 (pS)	Width2 (pS)	Width3 (pS)	Height1 (mV)	Height2 (mV)	Height3 (mV)
1	0.4	50	0	0	0.385	100	100	No Tx noise	No	6.5	[-0.1 0.85 -0.05]	0	15.1	15.1	15.4	64	63	65
2	0.4	50	0	0	0.385	100	100	No Tx noise	No	6.5	[-0.1 0.85 -0.05]	2.7	14.7	14.7	15.1	62	61	63
3	0.416	50	0	0	0.4	100	100	No Tx noise	Yes	6.5	[-0.1 0.85 -0.05]	3.5	12.6	13.2	13.6	57	57	59
4	0.418	50	0.18	0.11	0.4	100	100	No Tx noise	Yes	6	[-0.1 0.8 -0.1]	3.5	11.5	11.7	11.5	47	50	49
5	0.418	50	0.28	0.11	0.4	100	100	No Tx noise	Yes	5	[-0.1 0.75 -0.15]	3.5	10.4	10.4	10.2	38	40	41
6	0.442	55	0.18	0.11	0.4	90	109.8	No Tx noise	Yes	6	[-0.1 0.8 -0.1]	3.5	11.3	11.5	11.5	46	45	48
7	0.445	55	0.28	0.11	0.4	85	109.8	No Tx noise	Yes	5	[-0.1 0.75 -0.15]	3.5	9.8	10.4	10.2	38	38	40
8	0.445	55	0.28	0.11	0.4	85	109.8	31	Yes	5	[-0.1 0.75 -0.15]	3.5	8.7	8.3	8.7	30	28	31
9	0.445	55	0.28	0.11	0.4	85	109.8	31	Yes	5	[-0.1 0.75 -0.15]	5.1	8.5	8.3	8.3	29	28	31
10	0.442	55	0.18	0.11	0.4	90	109.8	31	Yes	6	[-0.1 0.8 -0.1]	5.1	9.8	10.0	10.0	37	37	39
11	0.442	55	0.18	0.11	0.4	90	109.8	32.5	Yes	6	[-0.1 0.8 -0.1]	5.1	10.6	10.4	10.2	40	38	41

 802.3 bs draft 3.0 120D

 802.3 cd draft 1.2 clause 137

Note that 0.22UI eye width (120E draft 3.0 spec) = 8.28ps and it is expected that ADS eye width is optimistic compared to 120E test methodology.

Conclusions.

- **The 32mV eye amplitude specification is not achieved with the worst case 120D draft 3.0 transmitter even without including the effects of RLM and additional host PCB issues.**
- **The 32mV eye amplitude specification does look achievable with the 802.3cd draft 1.2 clause 137 transmitter.**
- **Key parameters are die capacitance, Tx_SNR,**
- **Transmitter noise appears to be swamping out the effect of the FEXT.**