Reference receiver proposal for CAUI-4 chip to chip

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Background: COM noise budget

- COM models total receiver noise as a combination of:
  - Channel-induced noise (unequalized ISI, crosstalk)
  - TX jitter
    - Assumed maximum values for BUJ and RJ
    - Converted to noise using cursor slopes
  - TX noise, attenuated by the thru channel
    - Assumed Gaussian; currently SNDR=29 dB
    - Represents internal xtalk, supply noise, etc.
  - System noise
    - Taken as 5.2e-8 V^2/GHz at the RX filter input
    - Represents thermal noise, EMI, etc.

Often ignored in simulations

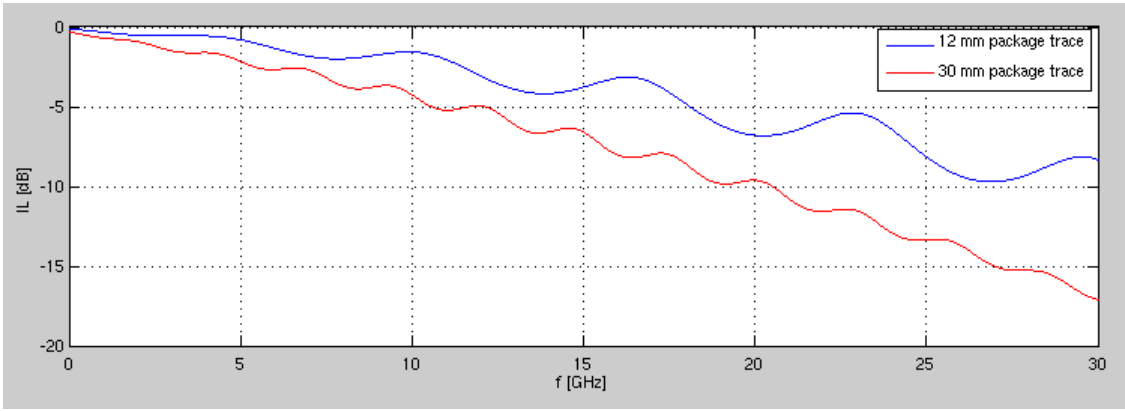
COM experiment

- Channel: 15 dB Meg6 LowSR (Rich Mellitz), THRU + 3 NEXT (small)
- TX: 12 mm package model from annex 93A; min amplitude
- RX: 3 scenarios
  - A: “CAUI-4 reference receiver”
    - Ideal termination
    - CTLE as in annex 93A (in D1.1 of 83D it is TBD)
    - Not technically feasible
  - B: “Realistic receiver”
    - 12 or 30 mm RX package + die cap + 55 Ω term (as in D2.2 of 802.3bj)
    - CTLE as in annex 93A
    - Technically feasible
  - C: “Improved realistic receiver”
    - Same as B, but RX has an additional 1-tap DFE
    - Also technically feasible

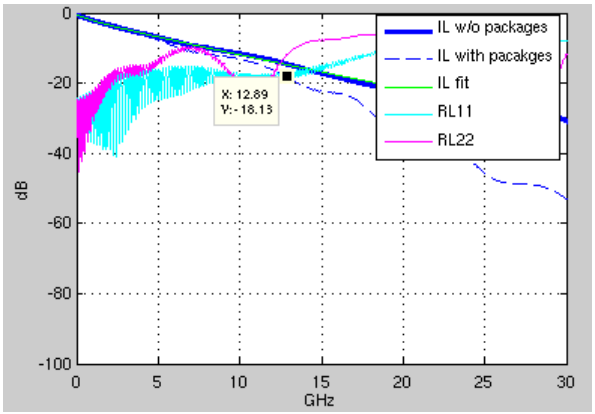
  In all cases, 2 packages assumed for remote part, 12 or 30 mm

Does RX termination matter at all?

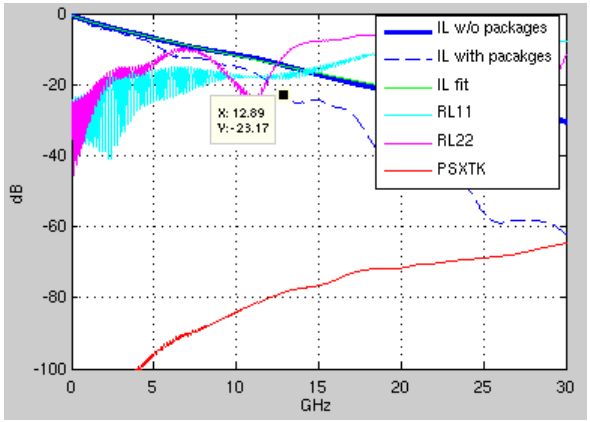
Here are the two package models used in 100GBASE-KR4 (concatenated to measured s-parameters)



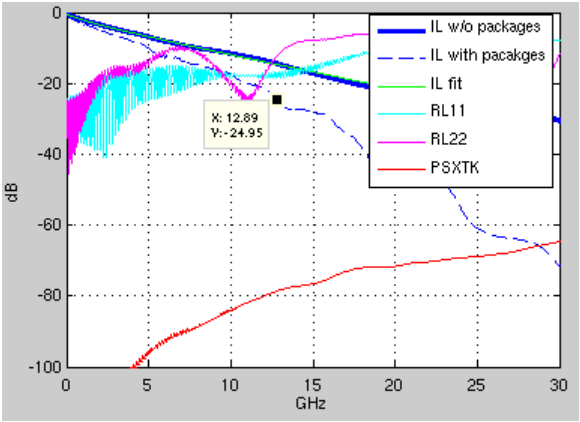
Effect of RX termination (TX always includes 12 mm package)



Ideal termination

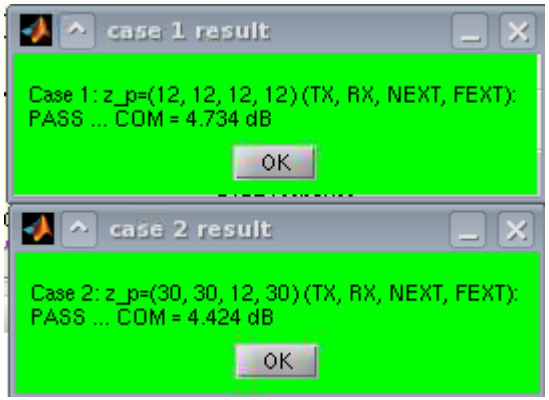


12 mm RX package



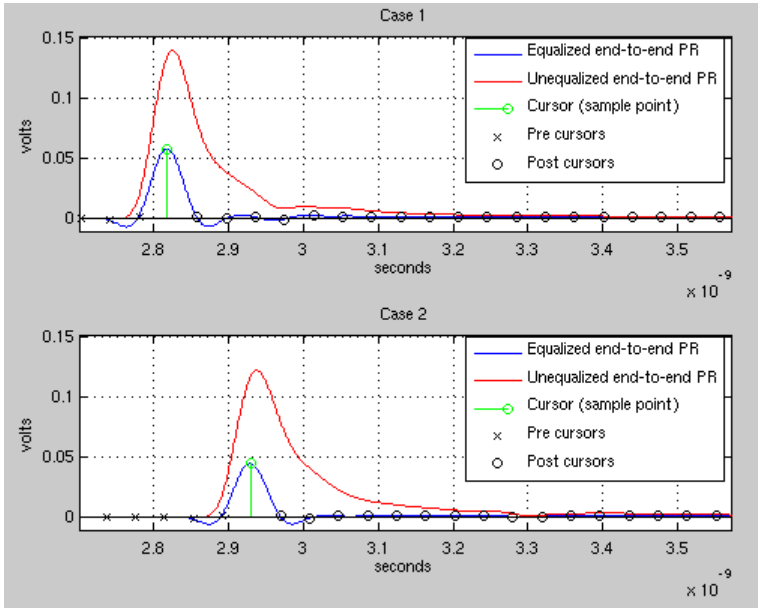
30 mm RX package

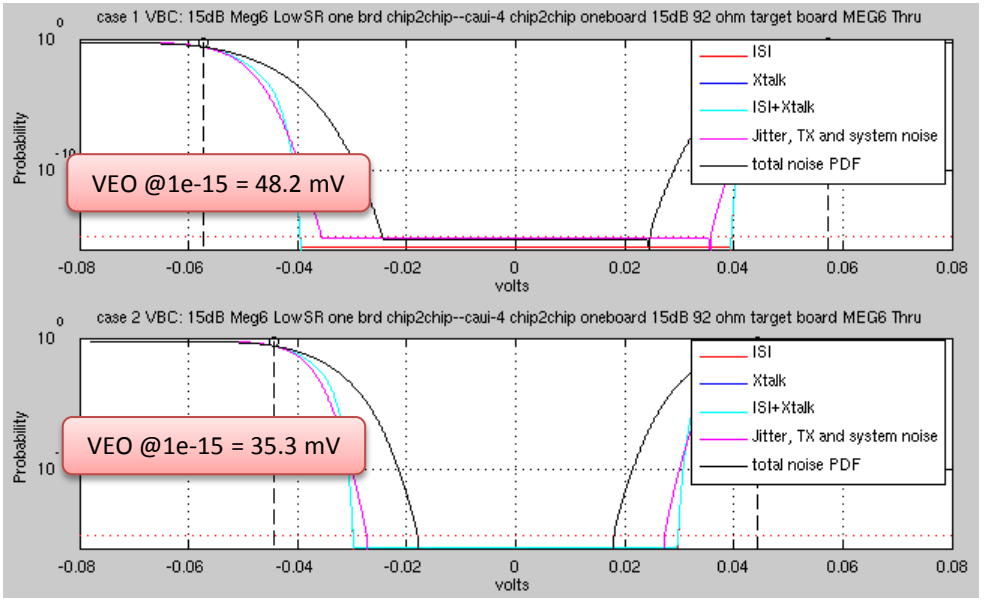
Scenario A results



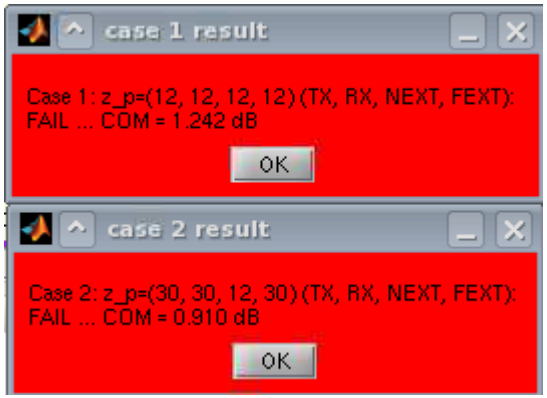
This (or something similar) is currently suggested as a reference receiver for RX interference compliance…

- Very minor ISI effect – seems to have lots of margin
- Unrealistic – no package is transparent
- Those of us who don't have a good package may use other means to compensate… (e.g. DFE?)



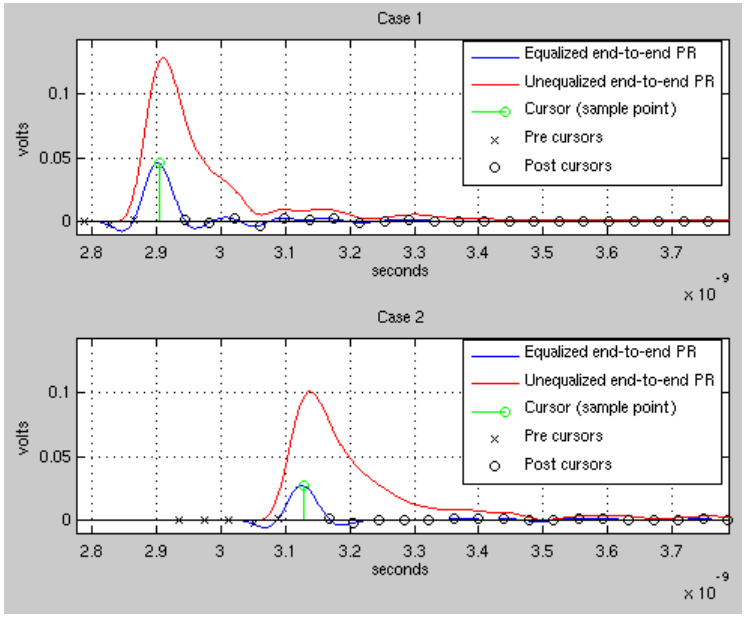


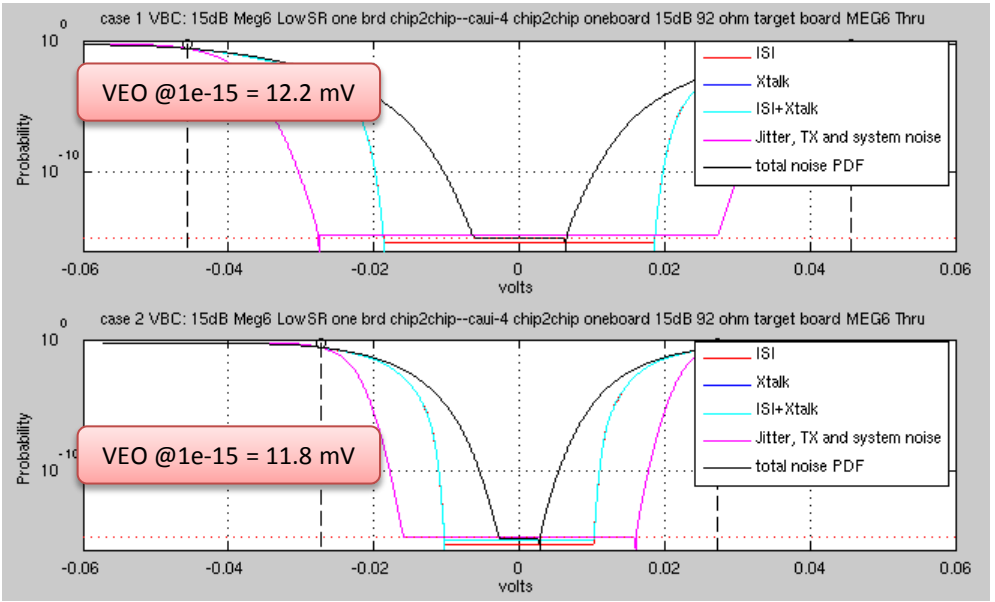
Scenario B results



This is “real life” for this channel, assuming DFE is not allowed

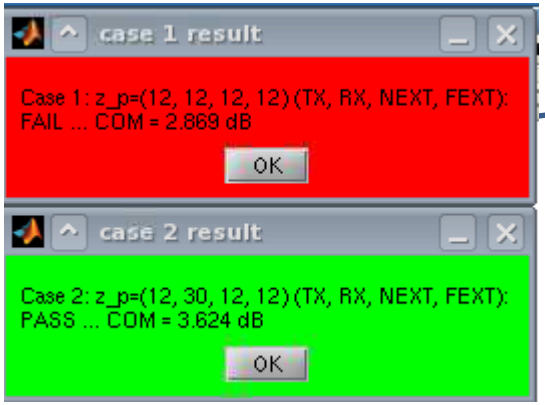
- Signal very attenuated
- ISI still dominant in noise budget
- Margin seems too low





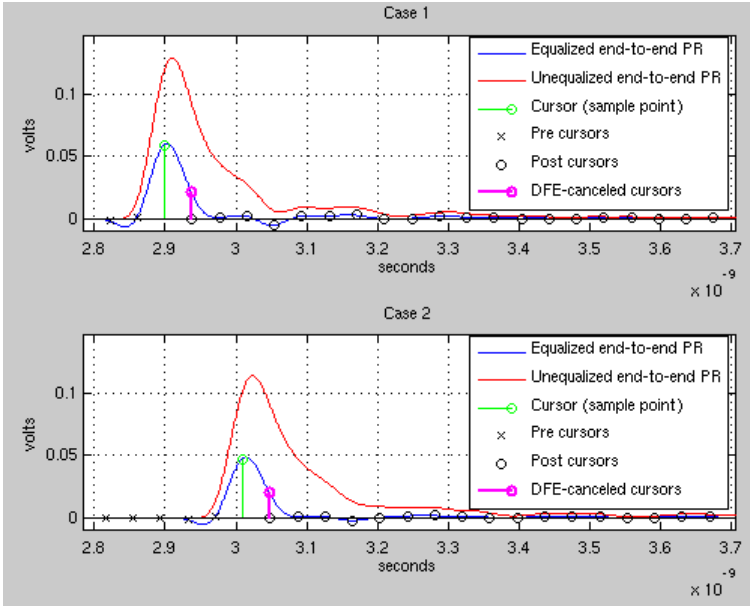
Scenario C results

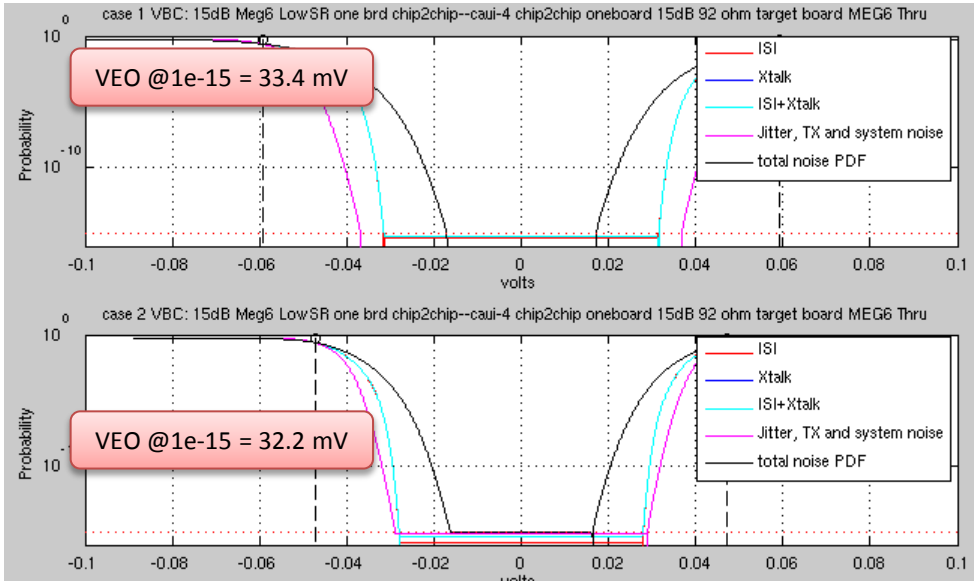
Suggest changing minimum COM for CAUI-4 to 2 dB – then both package assumptions provide healthy margin



If we assume one DFE tap, results improve considerably

- This is a realistic scenario!
- Those of us who don't have a 1-tap DFE may use other means to compensate… (e.g. a good package?)





DFE implications

- Cost and power impact
  - 1-tap DFE can be designed with negligible area
  - Estimated power delta: <1 pJ/bit; likely <<10% of device power
- Error propagation
  - Results above have a small tap weight (0.35)
  - With BER<1e-15, even with a higher tap value, probability of having a burst is negligible (compared to having a single error)
- MTTFPA
  - CAUI-4 data is 64b/66b encoded – no transcoding
  - Probability of having two bursts of length >1 in a single frame, with BER<1e-15, is even more negligible
  - Crude calculation: even if every bit error creates such a burst, MTTFPA is $>10^{17}$ years
  - Doesn't seem to be an issue

Proposal

- Use Annex 93A for channel specification of CAUI-4 chip-to-chip (Annex 83D)
- Invoke using exact same parameters as Clause 93, except for
  - BER <1e-15
  - 1-tap DFE, with maximum value of 0.75