C2M Redux

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Contents

- ❑ Thoughts
- ❑ Diff → full 4 port compare
- ❑ C2M CM Data
- ❑ Proposals

CM voltage thoughts

Common mode voltage has a number of sources

- ❑ Coherent imbalance examples
  - P/N not exactly complementary
  - Skew
  - Rise/fall time mismatch
  - Tend to be higher frequencies
- ❑ Non coherent imbalance examples
  - Power supply (tend to be lower frequencies
  - Bias wander (tend to be mixed frequencies)
  - Crosstalk (tend to be mixed frequencies)

The present AC RMS specification

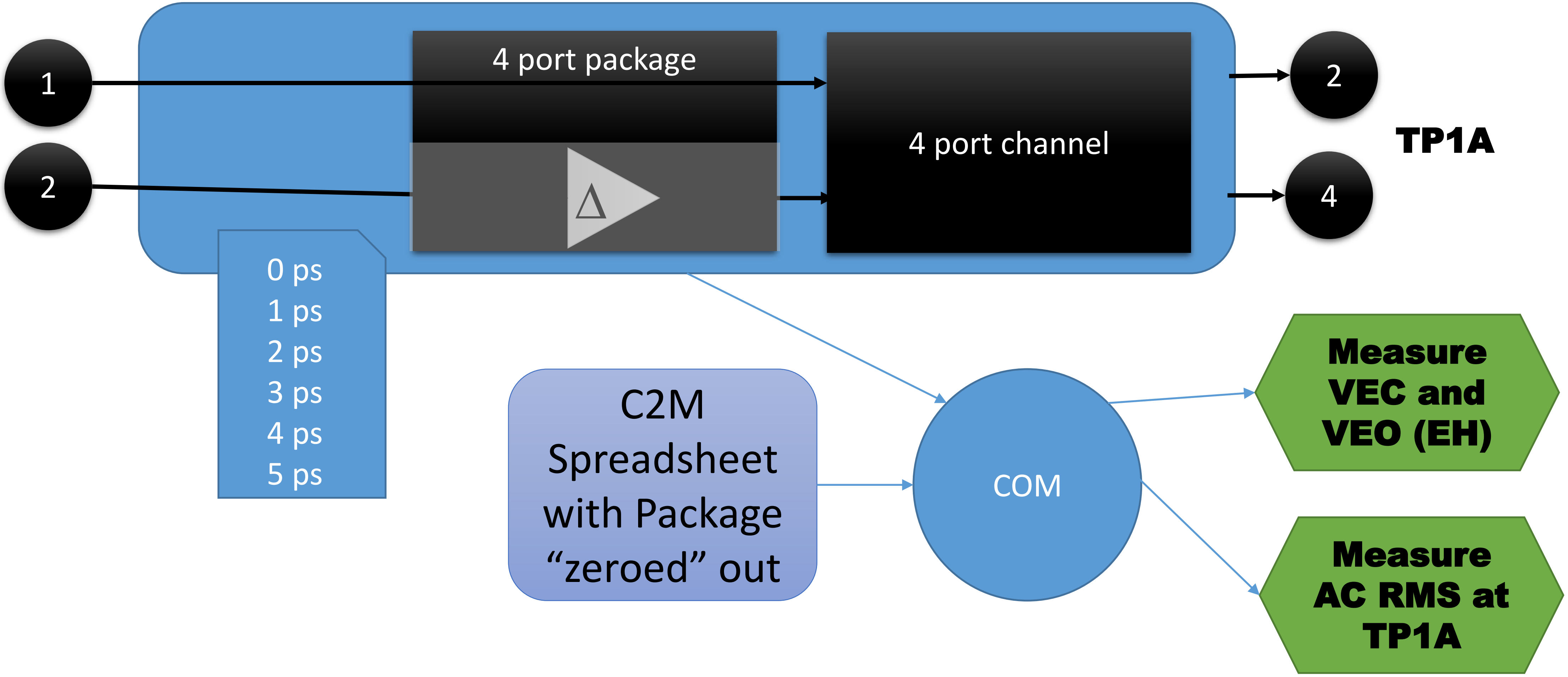
- ❑ May result in failing parts that in practice operate if the AC CM spec is too high
- ❑ May result in passing parts that to fail operate if the AC CM spec is too low

The present AC RMS method seems to put the coherent and non-coherent at odds

Follow-on to mellitz_3ck_01b_0721

- ❑ New data to focus on skew
  - See mellitz_3ck_01b_0721) slide 10
- ❑ Sweep skew from 0 to 5 ps
- ❑ Review TP1a data
- ❑ VEC, CM voltages, etc

Skew experiment use a synthesized s4p file which includes a modified reference package



Channels considered

C2M__Z100_IL13_BC-BOR_N_N_N_THRU_tmp’ (mellitz_3ck_01_0518)

Channel5_thru_small_pad_2inch_tmp’ (lim_3ck_adhoc_02_073119)

Channel5_thru_small_pad_3inch_tmp’’ (lim_3ck_adhoc_02_073119)

Channel5_thru_small_pad_4inch_tmp’’ (lim_3ck_adhoc_02_073119)

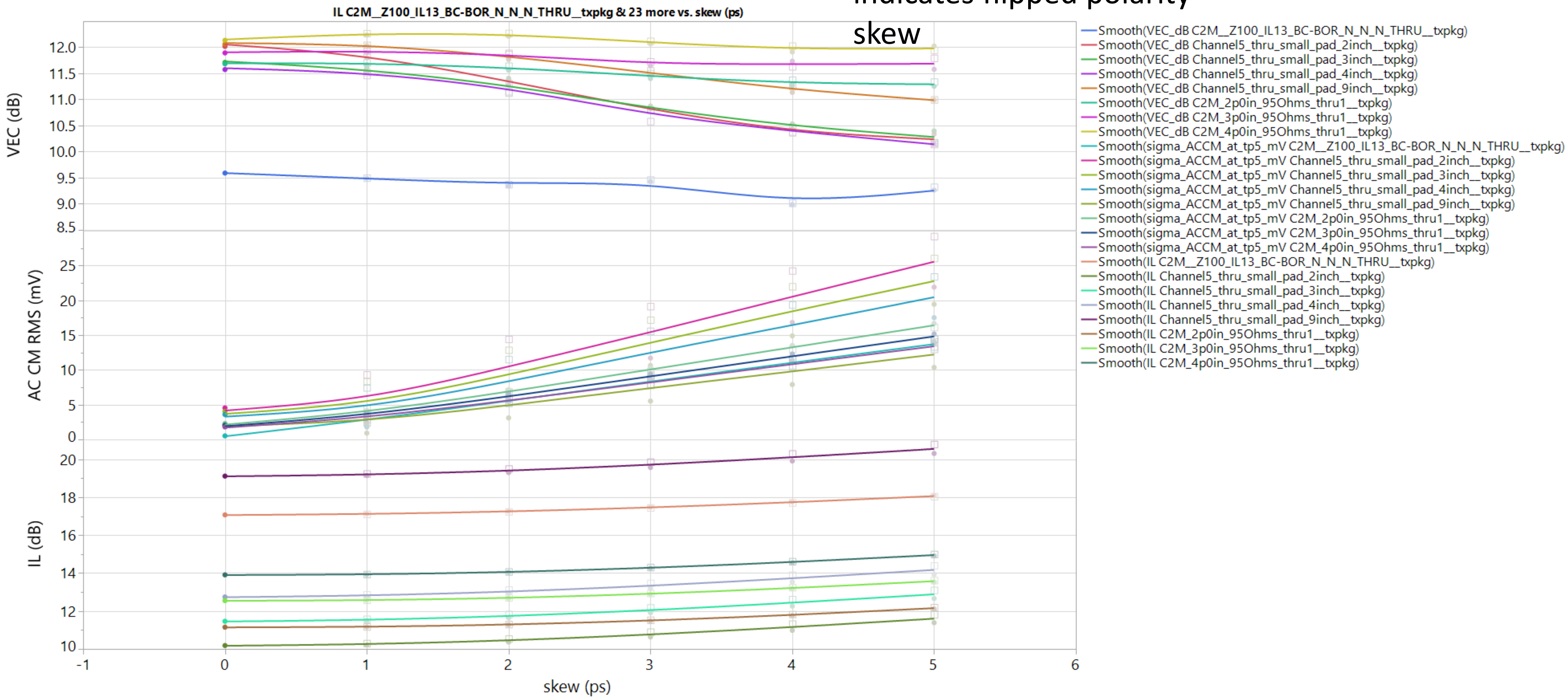
Channel5_thru_small_pad_9inch_tmp’’ (lim_3ck_adhoc_02_073119)

C2M_3p0in_95Ohms_thru1_tmp'’ (akinwale_3ck_C2M_08222019)

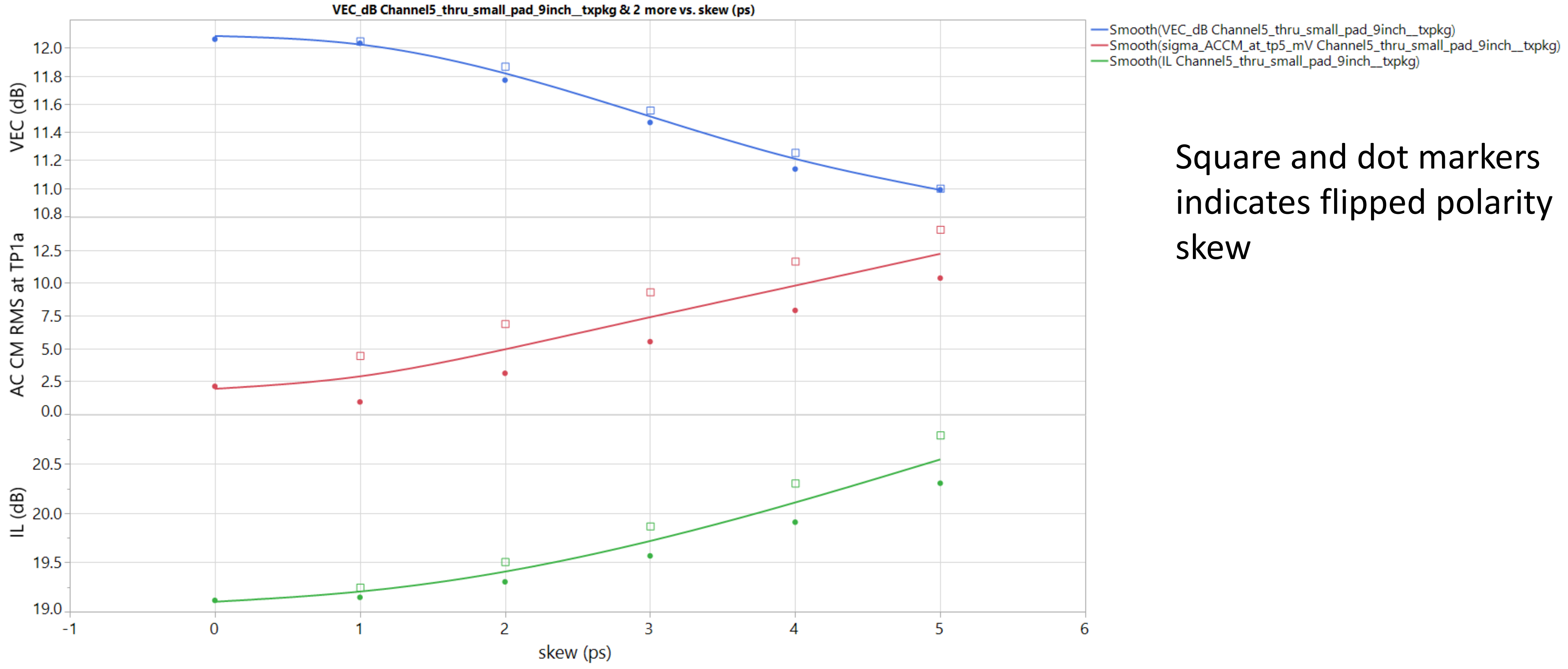
C2M_4p0in_95Ohms_thru1_tmp’ ’ (akinwale_3ck_C2M_08222019)

High AC CM RMS does not always mean worse (Higher) VEC

Square and dot markers indicates flipped polarity skew



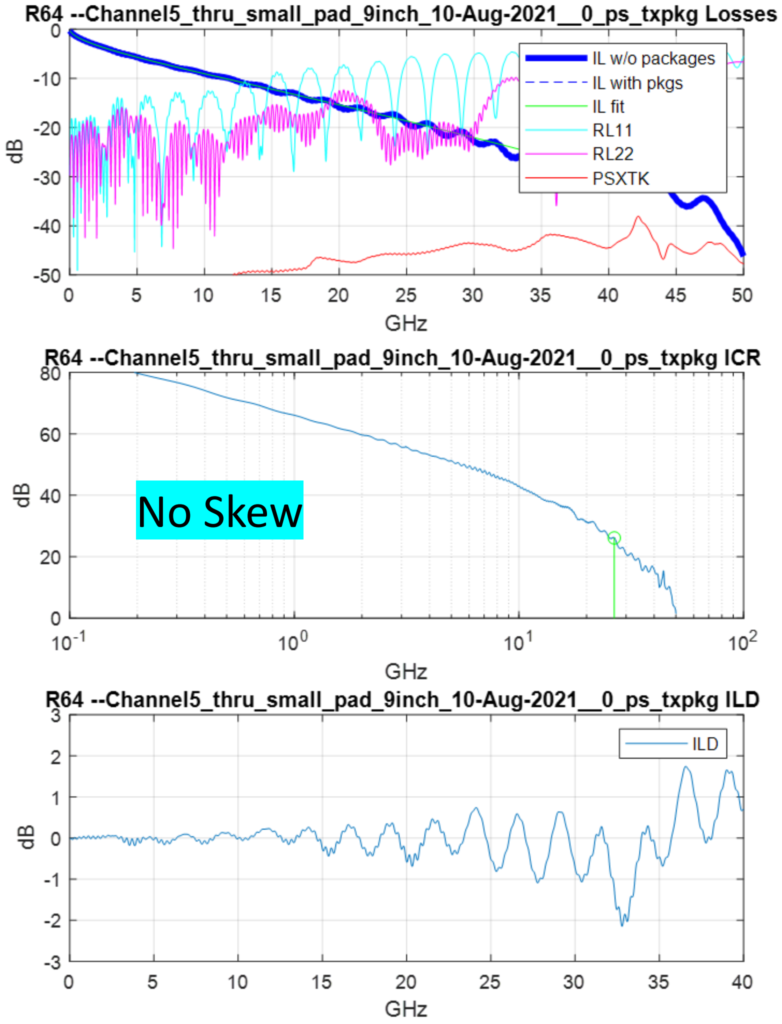
Skew improves VEC on "channel5_thru_small_pad_9inch" (lim_3ck_adhoc_02_073119)



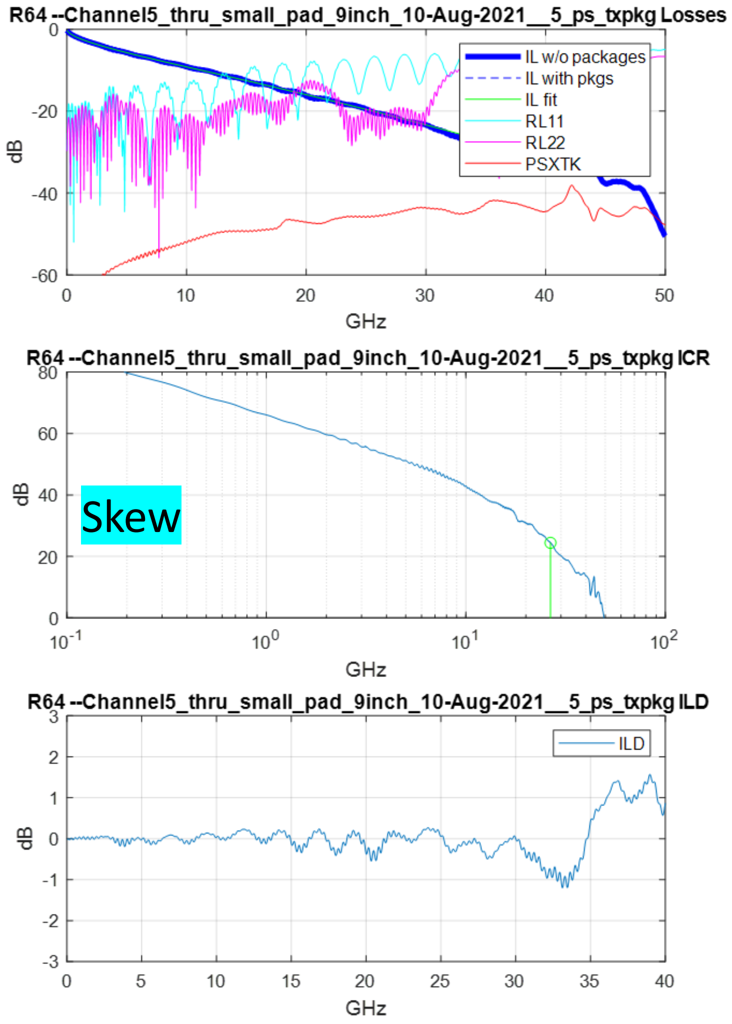
Square and dot markers indicates flipped polarity skew

Perhap coherent and non-coherent noise should be measured differently

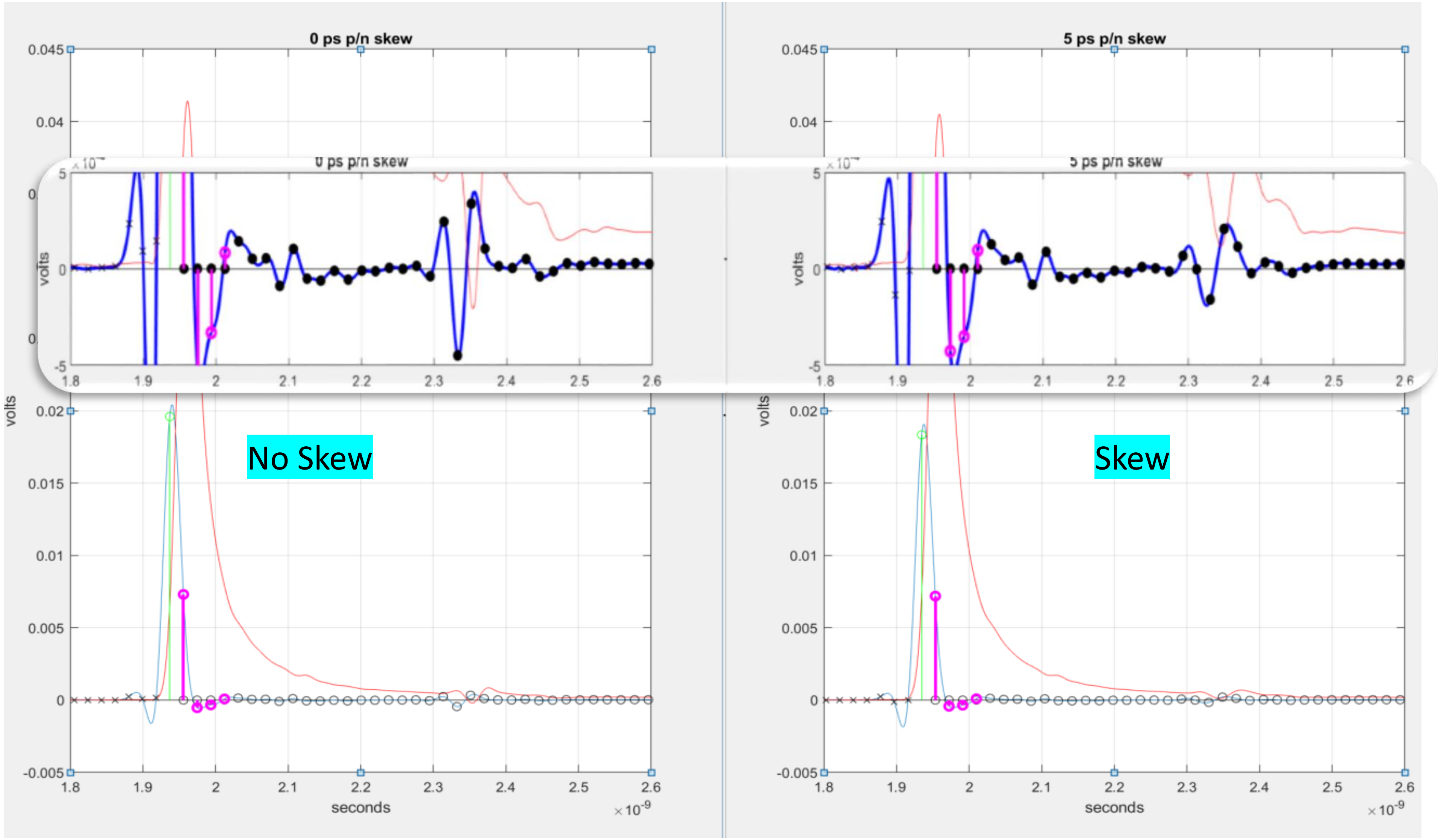
Frequency domain plot w/o package skew



Skew improved ILD

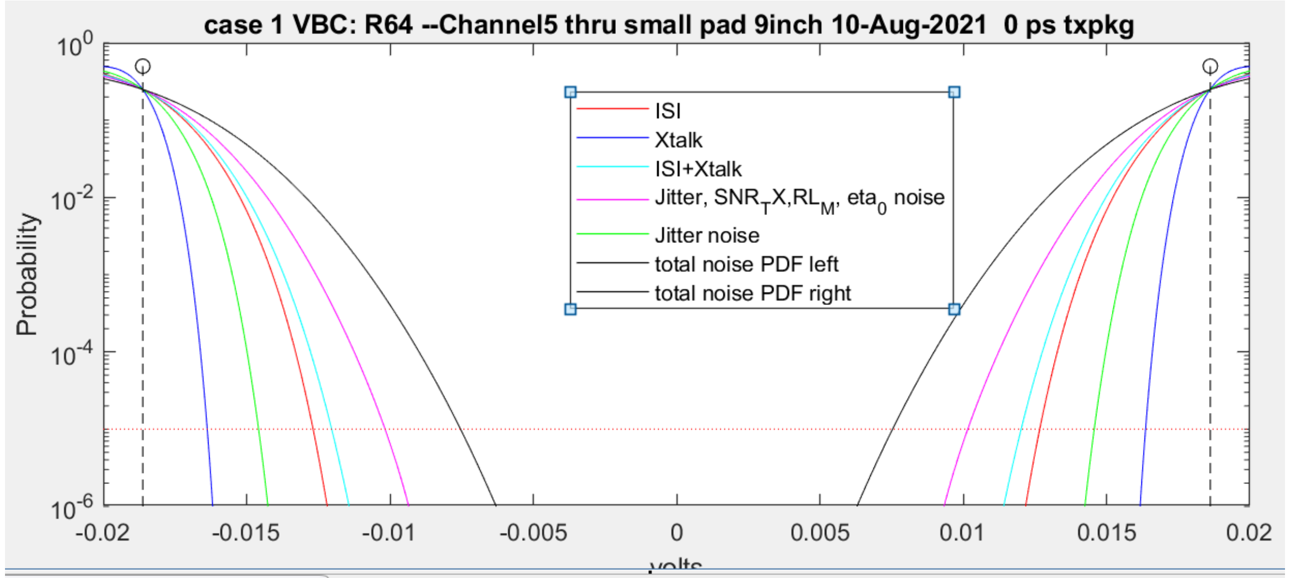


Pulse response comparison shows less reflection

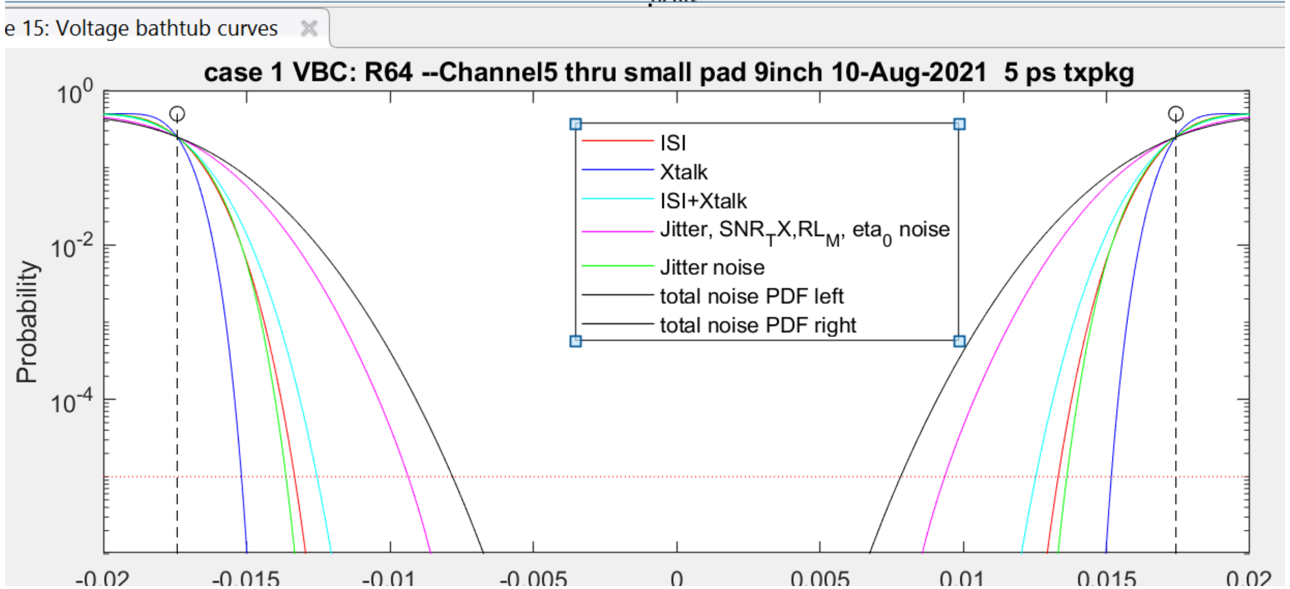


Bathtub curves show wider eye open with skew

No Skew



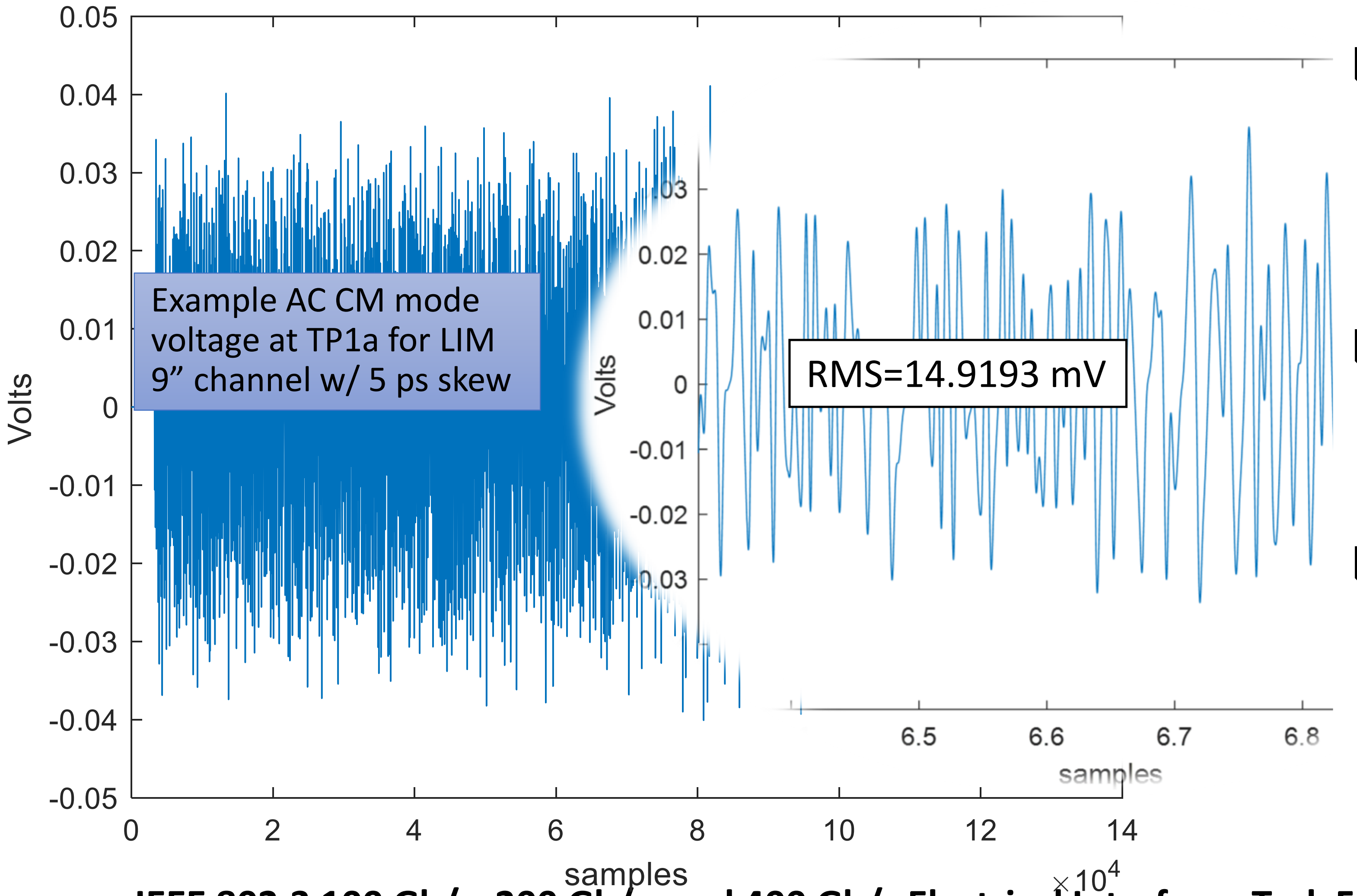
Skew



Observations

- ❑ In some instances skew can be used to cancel reflection
  - i.e. an interconnect design tool
- ❑ The skew may increase RMS of the common mode voltage waveform

Thinking about coherent CM noise



Consider

- ❑ Too much peak to peak AC CM voltage at TP1a may be detrimental Rx circuit operation
- ❑ Limiting p-p voltage could be the tact for coherent CM voltage
- ❑ Limiting non-coherent noise with a σ_e and σ_n computed for CM signal $Y_{CM}(k)$ instead of DM signal $Y(k)$

Options for coherent CM – limit peak CM voltage for 120G and 162

Specify : AC CM Peak (max) = 50 mV for 120G and 162

<u>CM measurement using averaging</u>

Option 1: Maximum| PX_1| < AC CM Peak (max)

- Use PX_1 from equation 85-8
- PX_1 is a "fitted CM waveform"

Option 2: Maximum| *Y* | < AC CM Peak (max)

- Y = averaged(*CM Waveform)*

<u>CM measurement not using averaging</u>

Option 3: Maximum| *CM Waveform* | < AC CM Peak (max)

- Includes both coherent and non-coherent signals

Recommend option 1

- Discussion needed

Considerations for clauses which use TP0v

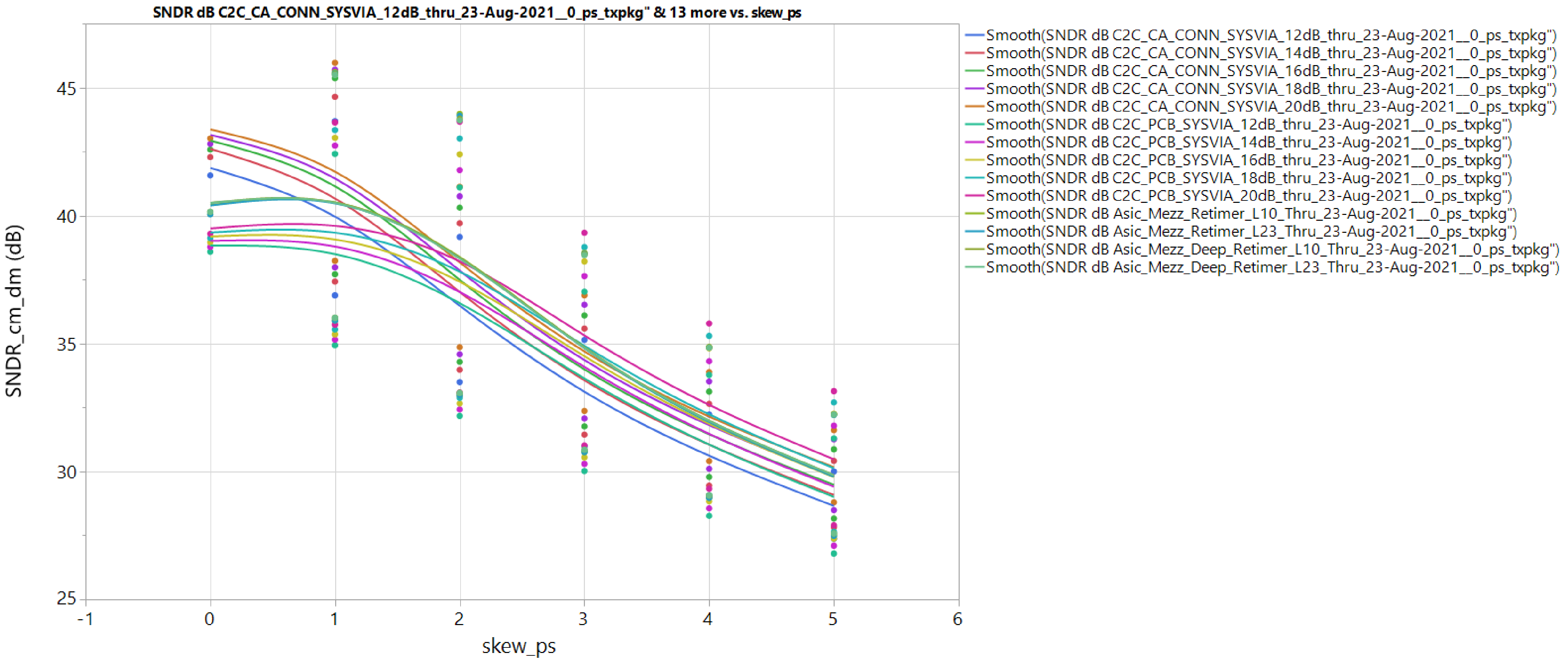
- ❑ Limit $SNDR_{CM}$ instead of specifying a AC CM RMS and peak voltage
- ❑ Simulation of CM voltage at TP0v is not well defined
- ❑ $SNDR_{CM}$ is somewhat tolerant of test fixtures.

Considerations for non-coherent and coherent CM for both 120G and sections which use TP0v

- Assuming
  - the p(k), and $p_{cm}(k)$ are time synchronous
  - CM and DM signal are sample synchronous
- Define $\sigma_{e\_}$: from 84.8.3.3.5
  - Replace Y with the common mode voltage and call Y_{CM}
  - Compute the linear fit to the captured waveform and the linear fit pulse response, $p_{CM}(k)$, and error, $e_{CM}(k)$,
    according to 120D.3.1.3. Denote the standard deviation of $e_{CM}(k)$ as σ_{e_CM}.
- Define σ_{n_CM} : from 120D.3.1.6 and

  "Using the same configuration of the transmitter equalizer, measure the RMS deviation from the mean of the CM voltage at a time point corresponding to where the DM signal is at a fixed low-slope point in runs of at least 6 consecutive identical PAM4 symbols. PRBS13Q includes such a run for each of the PAM4 levels. The average of the four measurements is denoted as σ_{n_CM}. "

SNDR_CM_CM data for 120G



SNDR

- ❑ Specify $\text{SNDR}_{\text{CM_DM}} = 10\, log_{10}\left(\frac{Pmax_{DM}^{2}}{\sigma_{e_CM}^{2}+\sigma_{n_CM}^{2}}\right) > $ 27 dB
  - From previous slide
- ❑ Specify $\text{SNDR}_{\text{CM_CM}} = 10\, log_{10}\left(\frac{Pmax_{CM}^{2}}{\sigma_{e_CM}^{2}+\sigma_{n_CM}^{2}}\right) > $ 12 dB
  - Covers the 30 mV specified in D3.2

Summary

- For Annex 120G and CL 162
  - Maximum | *Fitted DM Waveform* | < 50 mV
- For Annex 120G, 120F and Clause 162, 163
  - $SNDR_{CM\_DM}$ < 27 dB
  - $SNDR_{CM\_CM}$ < 12 dB

Thank you!