Transmit Power Spec

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Concerns Low Tx Power

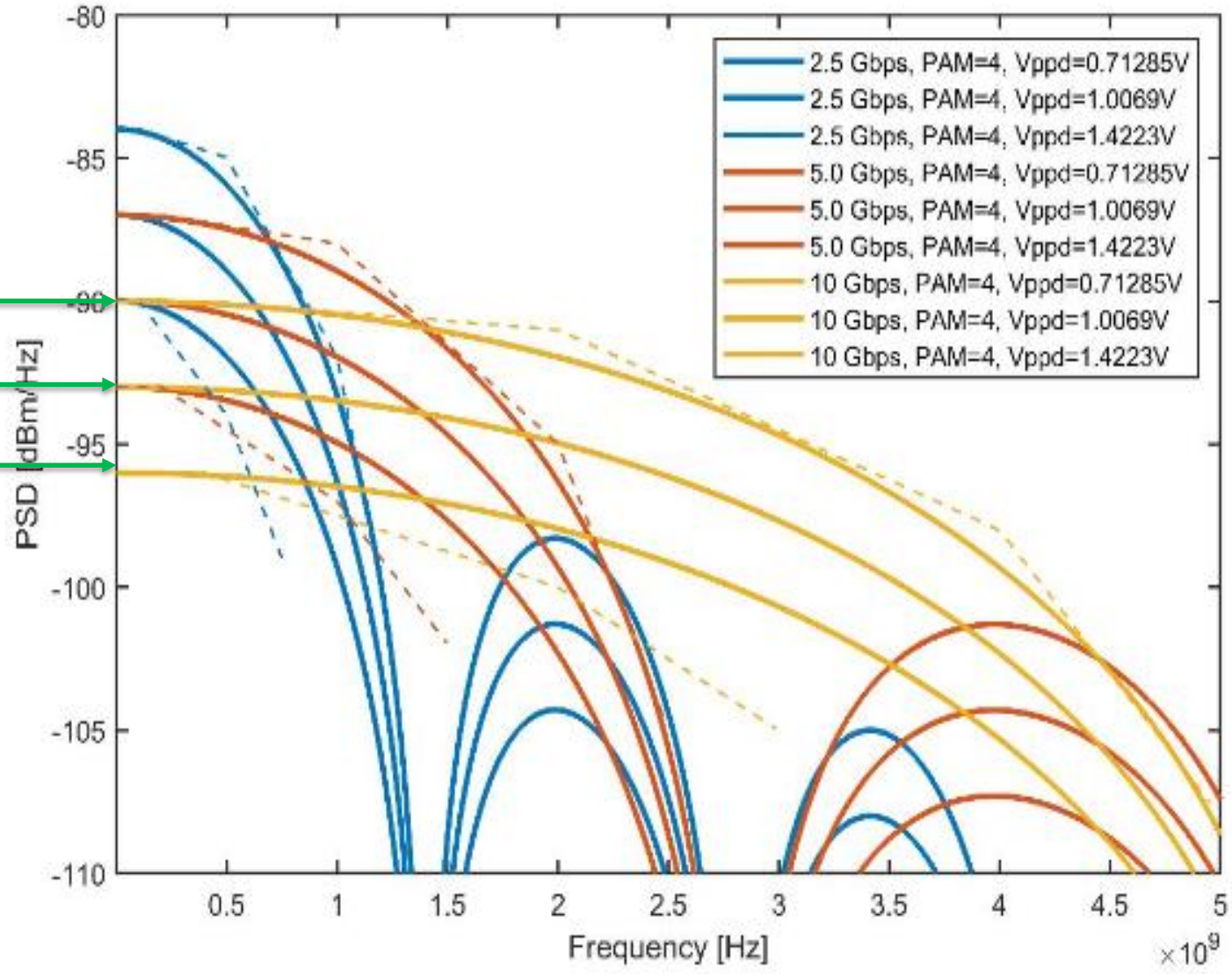
- Comment #265 by Gerrit on Increasing the Tx Power
- Concerns with Low Tx Power
  - Helps lower Tx driver power consumption but leads to higher increase in the receiver circuitry power consumption
    - A 3dB reduction in the Rx front-end noise → 100% increase in Rx power
  - Helps lower the EM emissions but increases vulnerability to EM radiation
    - The proper way to deal with EM emission is to shape the Tx PSD instead of lowering the whole power
      - Proper filtering can reduce emissions with several dBs, but 1dB lower total power only changes emission by 1dB
    - The DSP to deal with EM vulnerability increases Rx power even further
      - 1dB signal power improvement in Rx is very valuable to improve link performance against all sorts of noises

Transmit PSD for 2.5G/5G/10G (No Filtering)

+4.5dBm

+1.5dBm

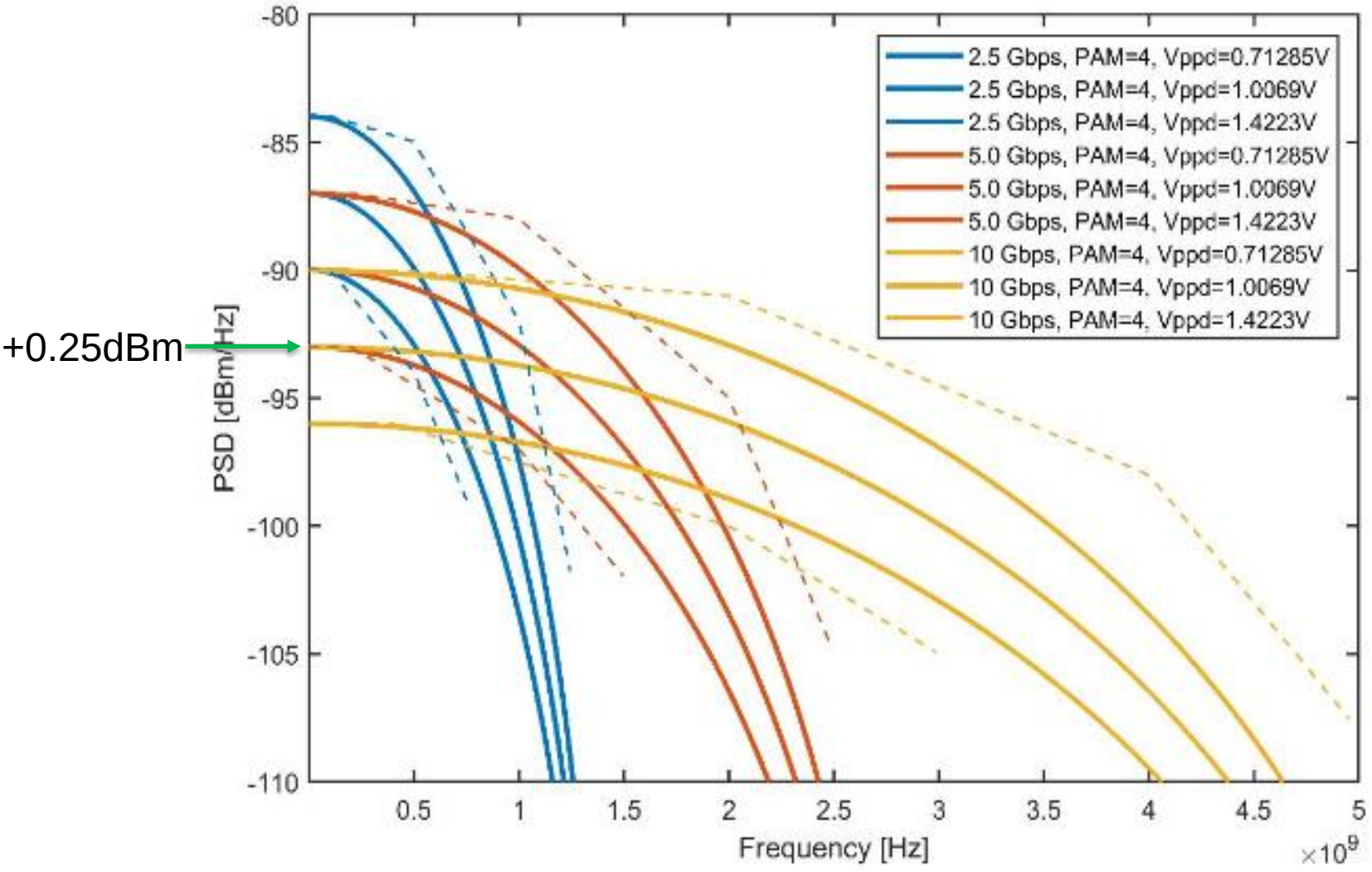
-1.5dBm



- Based on Tx Typical Output Swing of 1Vpkpk
  - Tx Power centered at ~1.5dBm
- Original Spec (Draft 1.1)
  - **0.0dBm to 3dBm**

Plot from: DenBesten_3ch_02a_0319.pdf

Transmit PSD for 2.5G/5G/10G (Highly Low-Pass Filtered)



Plot from: DenBesten_3ch_02a_0319.pdf

- Even with Max Filtering Tx Out Power (1Vpkpk) still meets Original Spec
  - **0dBm to +3dBm**
- Draft1.2 lowered Tx Power Spec to provide large margin for the filtering effect
  - **-1dBm to +2dBm**
- Draft lowered it even further
  - **-1.5dBm to +1.5dBm**

Concerns for Tx Implementation Losses

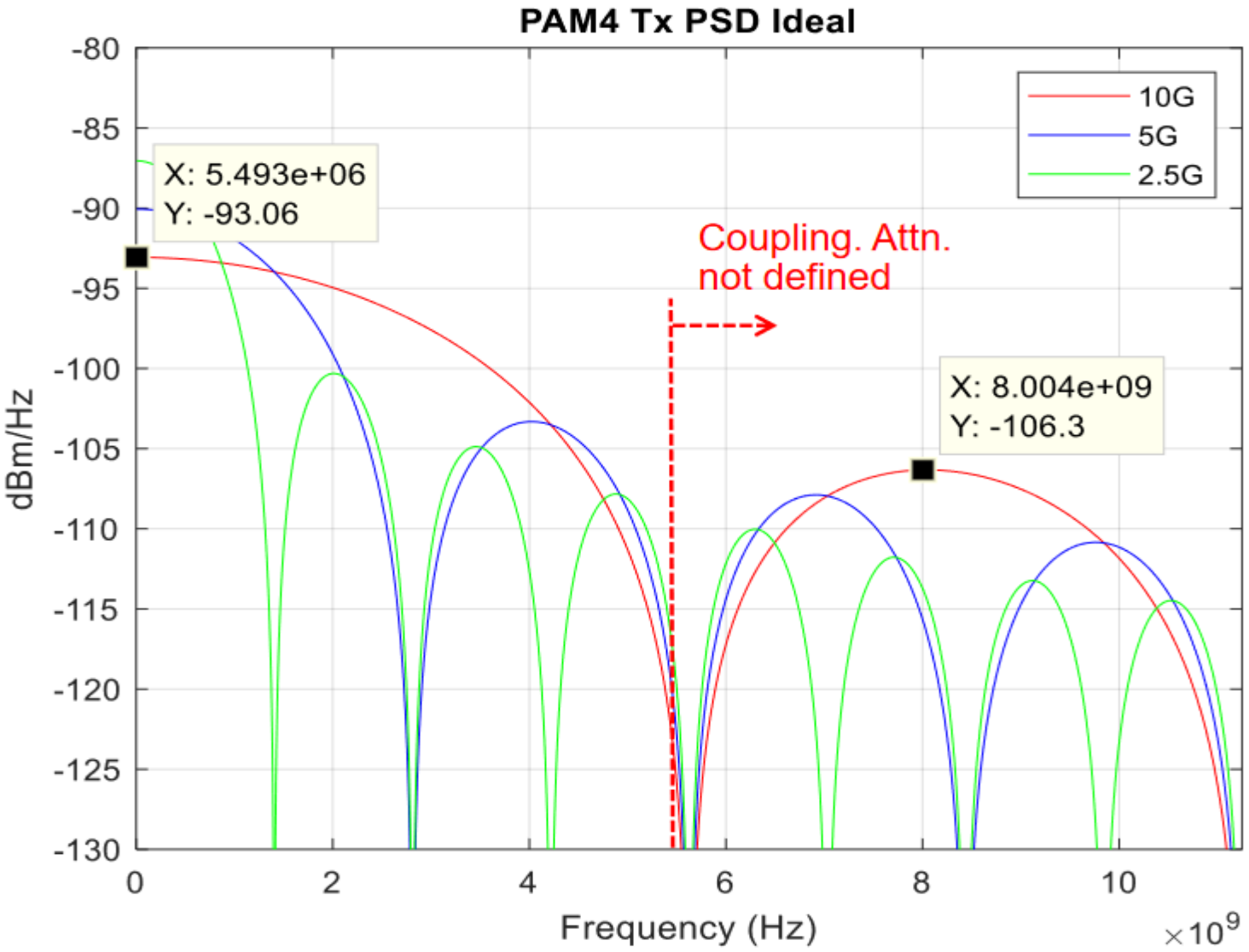
- Ideal Tx power: 1.43dBm
- Tx power with 0.5pF capacitance at MDI
  - 10G: 1.11dBm
  - 5G: 1.26dBm
  - 2.5G: 1.33dBm
- 5% Vdd variations, and 10% Rterm variations
  - -0.87dB to 0.87dB
- Impacts of additional DAC switching parasitic
  - ~ -0.3dB
- Trace and connector losses
  - At least -0.5dB, worst case -1dB
- Overall Tx power
  - 10G: -1.06dBm to 1.18dBm
  - 5G: -0.91dBm to 1.33dBm
  - 2.5G: -0.84dBm to 1.40dBm

tu_3ch_03_0419.pdf

- Analysis shows up to 2.5dB drop in Tx output power caused by different losses in the system
- Centering Tx power at 0.2dBm with tolerance +/-1.26dB covers all these losses
- But most of these loss factors are **fixed** thus can be easily tuned out. Conservatively we assume only half the loss is tuned out
  - MDI/PHY parasitic caps are fairly fixed per system, so half their effect can be tuned out by adjusting Tx amplitude → Reduce range 0.3dB
  - Rterm variations can easily be calibrated out (reference resistors) → Reduce range 0.44dB
  - Trace losses are fixed per system and can be calibrated out: → Reduce range 0.5dB

- **Tx power range due to different factors can be easily reduced by at least: 0.3+0.44+0.5= 1.24dB (+/-0.62dB)**

EMC Emission Concern for TX PSD High-Freq Lobes



Plot from: tu_3ch_03_0419.pdf

- The presented magnitude for the 1st lobes, does not consider the filtering effect of the MDI/PHY caps or the PCB loss that were used to show the low Tx Power
- In a fair analysis, at the minimum, we should use the same loss effects for emission too
- Only considering the MDI/PHY caps effect, the 1st lobe for 10GBASE-T1 drops by ~9dB
  - From -106.3 dBm/Hz to -115 dBm/Hz
  - Increasing total Tx power level by ~1dB changes 1st lobe peak to -114dBm/Hz

Proposal for Tx Output Power

- Combining all the loss effect in the system as presented by tu_3ch_03_0419.pdf shows a Tx output power → ~0.2dBm+/-1.26dB
- Tuning out some of the **fixed** variations/losses in the system that affect Tx output power is a simple/easy solution to address concerns of additional system loss that led to lower power range
  - Tuning out only half the system variations/losses tightens the range from +/-1.26dB to +/-0.64dB
  - By tuning out half the losses/variations, we can also increase Tx center power form +0.2dBm by 0.62dBm to +0.82dBm, so we can achieve Tx output power range of
    - +0.82dBm +/- 0.64dB
    - Add safety margin of 1.2dB (+/-0.6dB) → +0.82dBm +/-1.24dB → **0.42dBm – 2.06dBm**

- Propose Updated Tx Output Power (rounding the numbers)
  - **-0.5dBm to +2.0dBm**