Combined PSE and PD Injected PoC Noise Limit for IEEE 802.3dm

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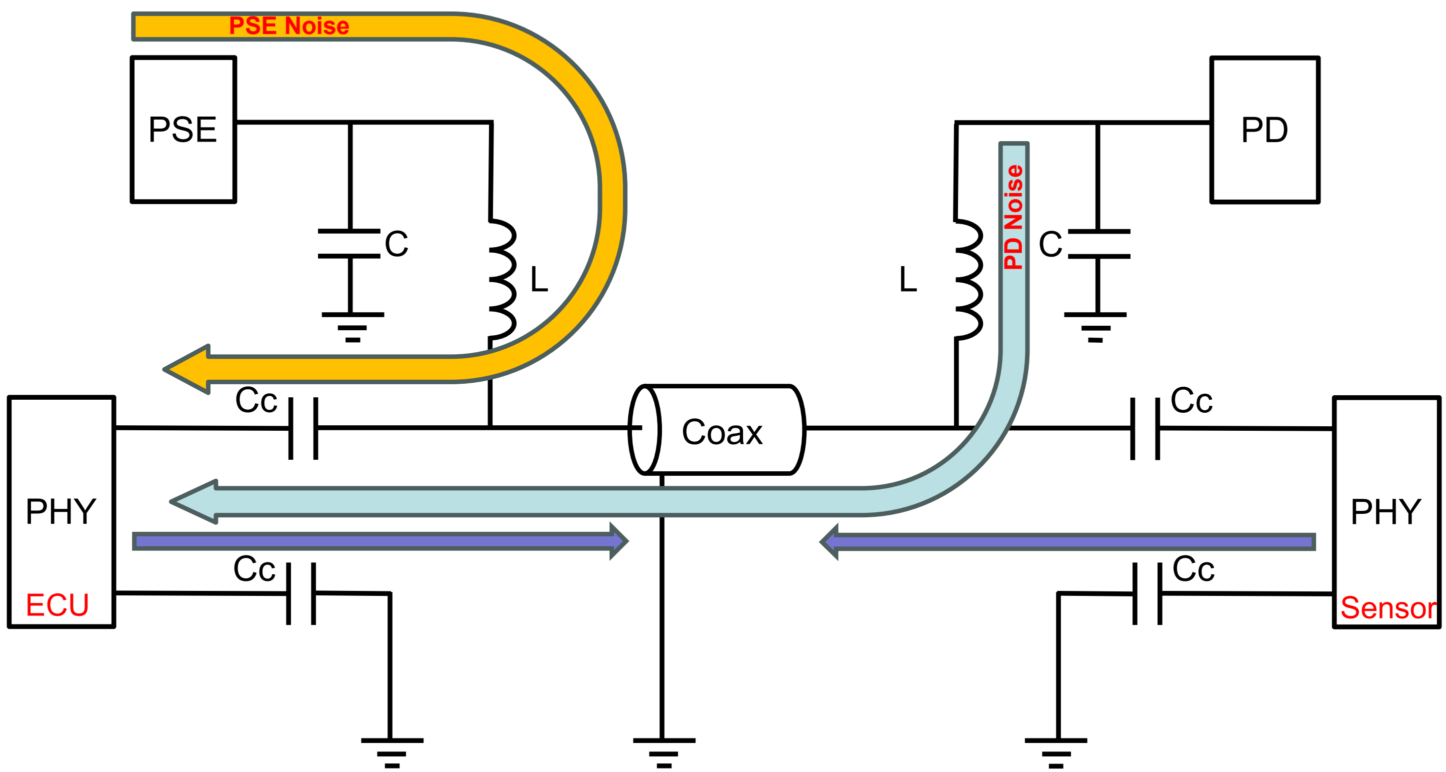
Motivation

- Previous contribution [3] have explored effects of PoC inductor influenced high pass filter and its limitation to droop in terms of receiver SNR degradation
- In [5] PSE (Power Sourcing Equipment) injected ripple noise limit based on Clause 33 for receiver noise tolerance is studied
- In actual use case, the total ripple noise seen at the receiver input is sum of PSE and PD (Powered Device) injected noise
- Receiver at ECU side is more vulnerable to ripple noise compared to receiver at camera side
- This contribution explores combined PSE and PD injected ripple noise limit based on Clause 33 as a baseline for PHY noise tolerance

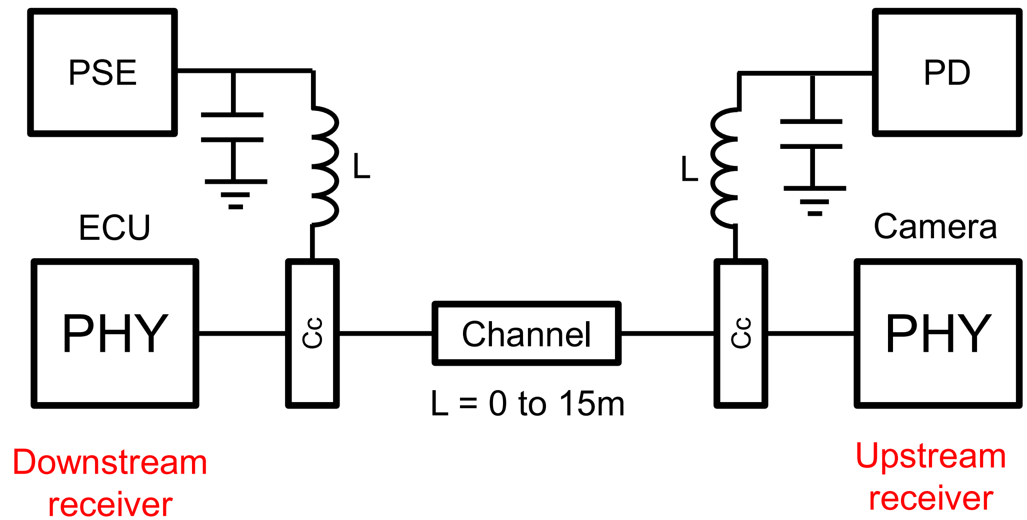
Power-over-Coax System

- Receiver at sensor side is more immune to noise than the receiver at ECU side
  - Channel loss is significantly low
- Channel length 0m to 15m
  - DC resistance = 0Ω to 10Ω



Worst- and Best-Case Noise

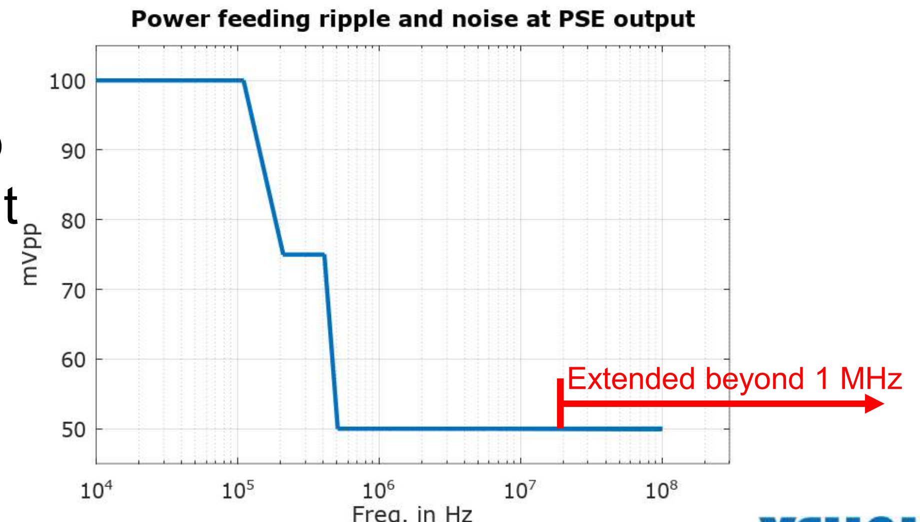
- Cable length L = 0
  - PD noise will not be attenuated since DC resistance = 0
  - Receivers do not see any channel losses, and it is much more immune to injected noise
- Cable length L = 15m
  - PD noise will be attenuated with a finite DS resistance of channel
  - Receiver at ECU side sees high channel losses, and it has limited immunity to injected noise



Clause 33: Power Feeding Ripple Noise

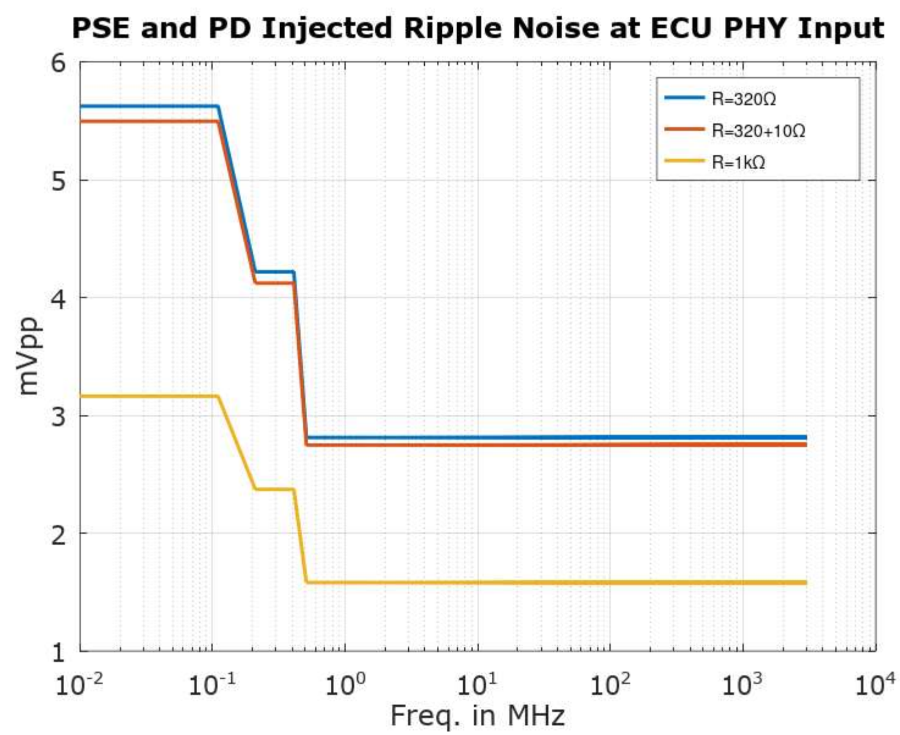
- Clause 33 [4] gives power feeding ripple noise for 100Ω termination up to 1MHz
- Below figure shows the equivalent ripple noise limit for 50Ω termination
- The power ripple noise limit at 1MHz is extended from 1MHz up to 3GHz with the same noise limit

Power feeding ripple and noise:				
f < 500 Hz		V_{pp}		0.500
500 Hz to 150 kHz				0.200
150 kHz to 500 kHz				0.150
500 kHz to 1 MHz				0.100



PSE and PD Ripple Noise at ECU Receiver Input

- For 1kΩ of impedance gives about 1.5mVpp of PSE ripple noise at the receiver input
- For 320Ω of impedance results in about 2.9mVpp of ripple noise at the receiver input
  - With 10Ω added DC resistance ripple noise decreases to ~2.7mVpp
- In case PSE and PD noise are in phase
  - Broadband PSE+PD ripple noise will be in between 3mVpp to <6mVpp



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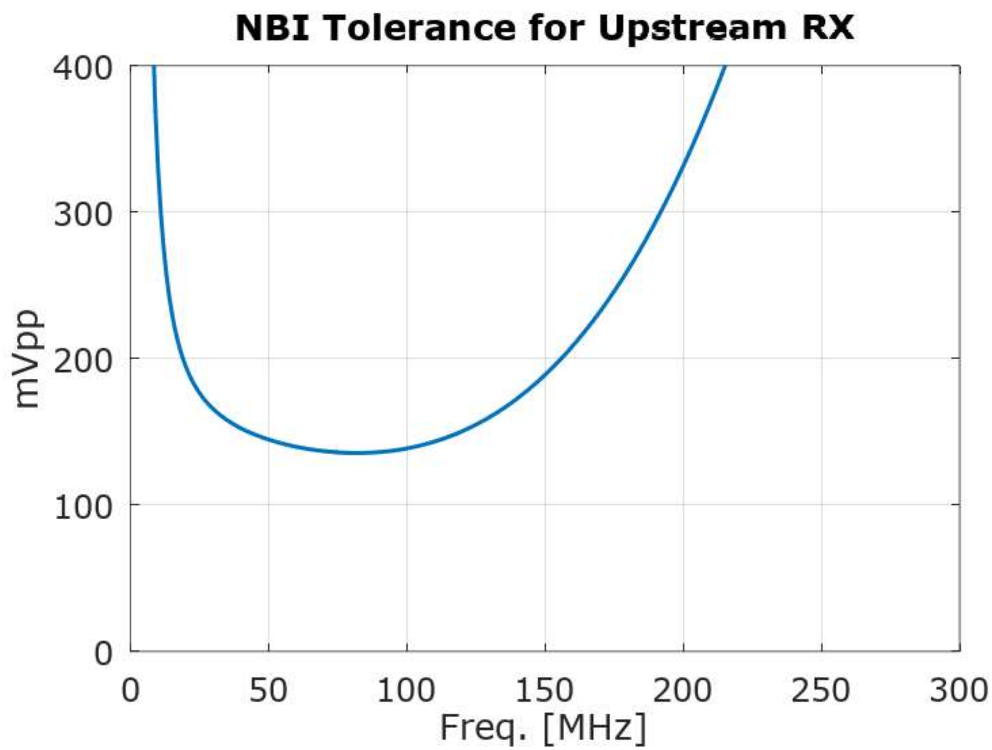
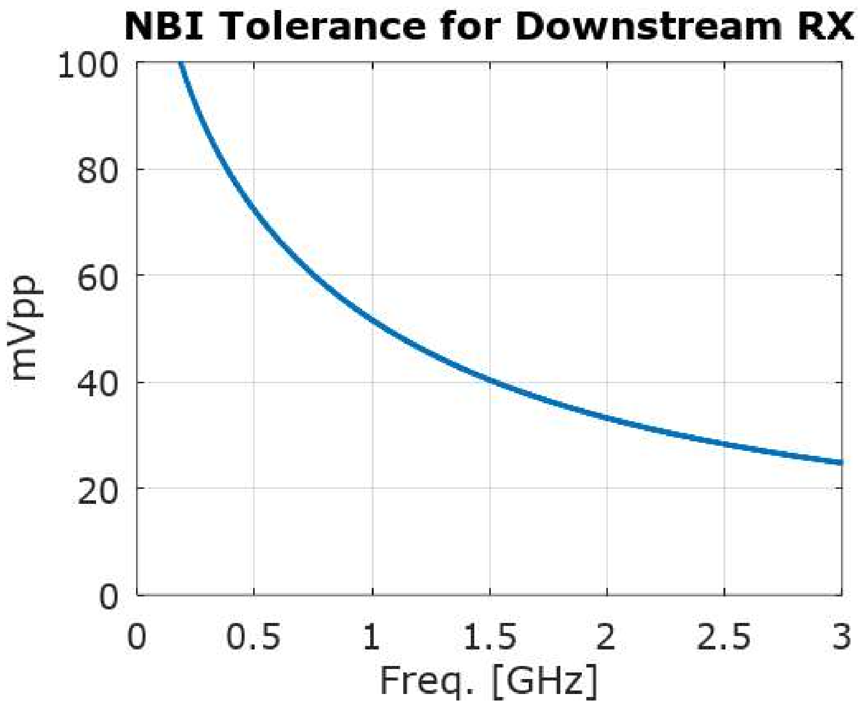
NBI Tolerance for Upstream

- Corner freq. of HPF and LPF
  - 10MHz and 117MHz
- Analysis leaves uncancelled far-end echo as noise
- Hybrid cancellation is assumed to be 10dB
- NBI tolerance of 135mVpp at 100MHz frequency range
- Analysis excludes the coding gain from RS encoding



NBI Tolerance for Downstream

- Corner freq. of HPF and LPF
  - 10MHz and 2.8GHz
- Analysis leaves uncancelled far-end echo as noise
- Good Hybrid cancellation with no residual echo
- NBI tolerance of ~20mVpp at 2.8GHz frequency range
- Analysis excludes the coding gain from RS encoding



High Pass Filter Effects on SNR

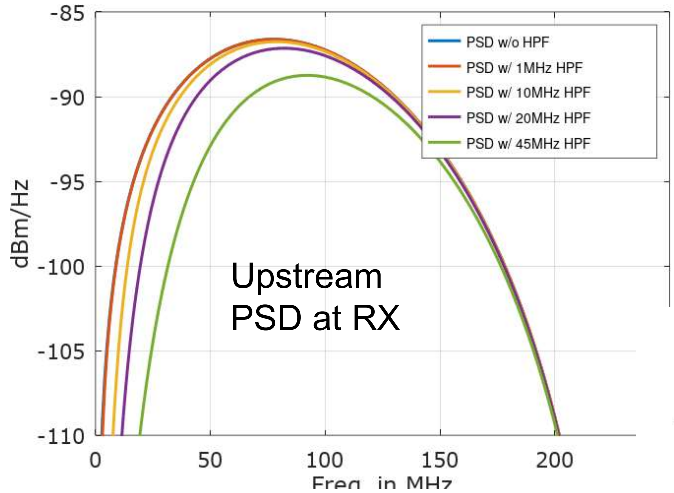
	Inductor value	Upstream SNR Degradation	NBI tolerance for ½ dB SNR	Downstream SNR Degradation	NBI tolerance for ½ dB SNR
No PoC	None	0 dB	15mVpp	0 dB	2mVpp
1MHz	8uH	0 dB	15mVpp	0 dB	2mVpp
10MHz	800nH	0.2 dB	15mVpp	0.3 dB	2mVpp
20MHz	400nH	0.7 dB	15mVpp	0.7 dB	2mVpp
45MHz	175nH	2.6 dB	15mVpp	1.4 dB	2mVpp

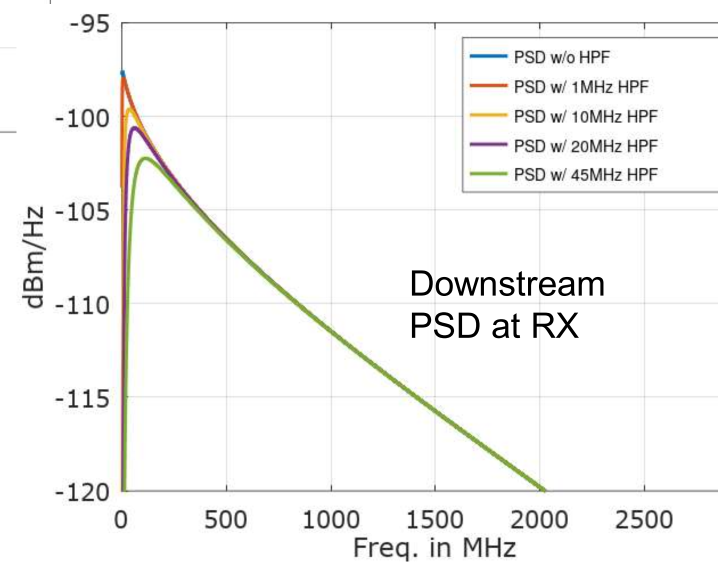
Summary

- Power feeding ripple noise limit line based on Clause 33 can be a good start and can be used as a baseline
- Ripple noise suppression due to DC resistance of 15m cable length does not seem to be significant enough <10Ω
- If 50mVpp ripple noise limit line is extended from 1MHz till 3GHz then PSE + PD ripple noise seen at the input of receiver at ECU side is between 3mVpp to <6mVpp for worst case scenario
- Given the upstream receiver has significant SNR margin, it can live with the ripple noise without any issue
- While the downstream receiver can also live with allocation of ~1dB SNR for broadband power ripple noise

High Pass Filter Effect on PSDs (PHY to PHY)

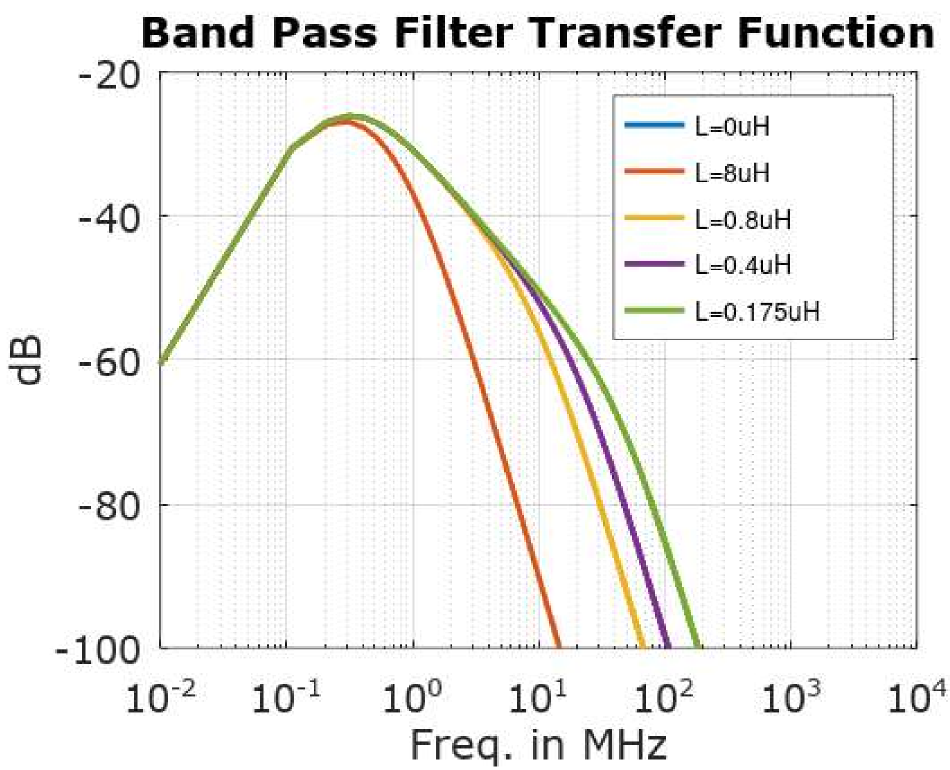
- Since most of the signal power of Differential Manchester Encoding (DME) is concentrated around fundamental frequency, the effect of received signal attenuation and baseline wander effects will be less compared to baseband signal starts from close to DC





A Band Pass Filter Effect on Noise (PSE to PHY)

- All low frequencies ripple noise from PSE are attenuated by high pass filter due to coupling capacitor in the link segment
- While all high frequencies ripple noise from PSE are attenuated by low pass filter due to PoC inductor
- Obviously, as the PoC inductor value decreases the corner frequency increases



References

- [1] Power-Over-Coax Complexity and System Impact, Conrad Zerna.
- [2] Power over Coaxial Cable Optimization and Signaling Trade-off, Ahmad Chini and Mehmet Tazebay.
- [3] Power-over-Coax Related High Pass Filter Parameters for IEEE 802.3dm, Sujan Pandey, Sept. 2025.
- [4] Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI), IEEE Standard for Ethernet Section Two.
- [5] Power-over-Coax Injected Noise Limit for IEEE 802.3dm PHY, Sujan Pandey, Nov. 2025.

Thank You!