Measurements on PoC Noise and Coupling

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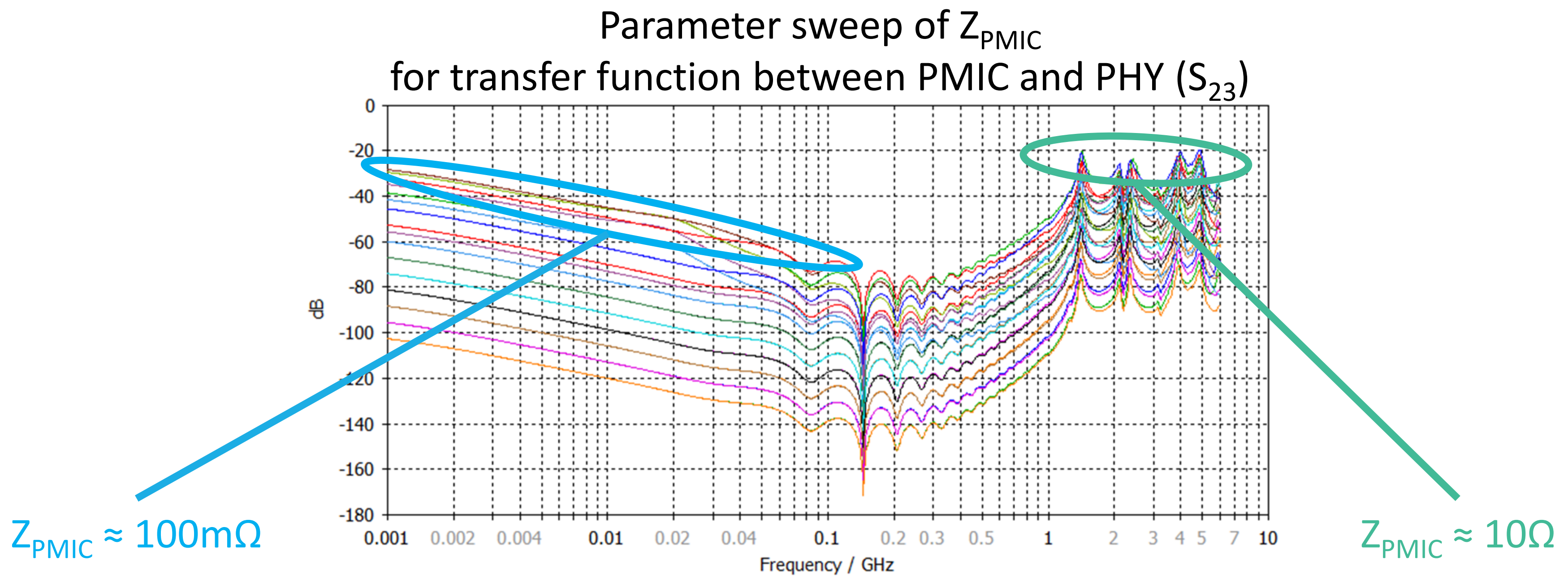
Presentations considered

- Measurements and Simulations on MDI Return Loss including PoC/PoDL (Heiko Strohmeier)
  - PMIC input impedance was unknown.
- Combined PSE and PD Injected PoC Noise Limit for IEEE 802.3dm (Sujan Pandey)
  - NBI (Narrowband Interference) and absolute noise levels.
- 802.3 Powering & MPoE (George Zimmerman)
  - Discusses PMIC noise and measurement points.

Motivation

- Initial approach: Simulated the PMIC-to-PHY noise transfer function on the camera node to estimate expected noise coupling.
- Key limitation: Results are highly sensitive to the dynamic input impedance of the active DC/DC converter, making static simulations unreliable.



Measurement Setup – Powered Device

- Active transfer function of the 2.2 µH PoC inductor measured via spectrum analyzer and custom transmission line probes.
- Captured under real-world conditions (camera supplied, 2.3 MHz spread-spectrum PMIC with 2W load)
- No load jumps, no active communication on MDI

- Custom Probe Characteristics:
  - Single probe attenuation: 1:21 (≈ 26.4dB)
  - Bandwidth: ≈ 50kHz – 300 MHz

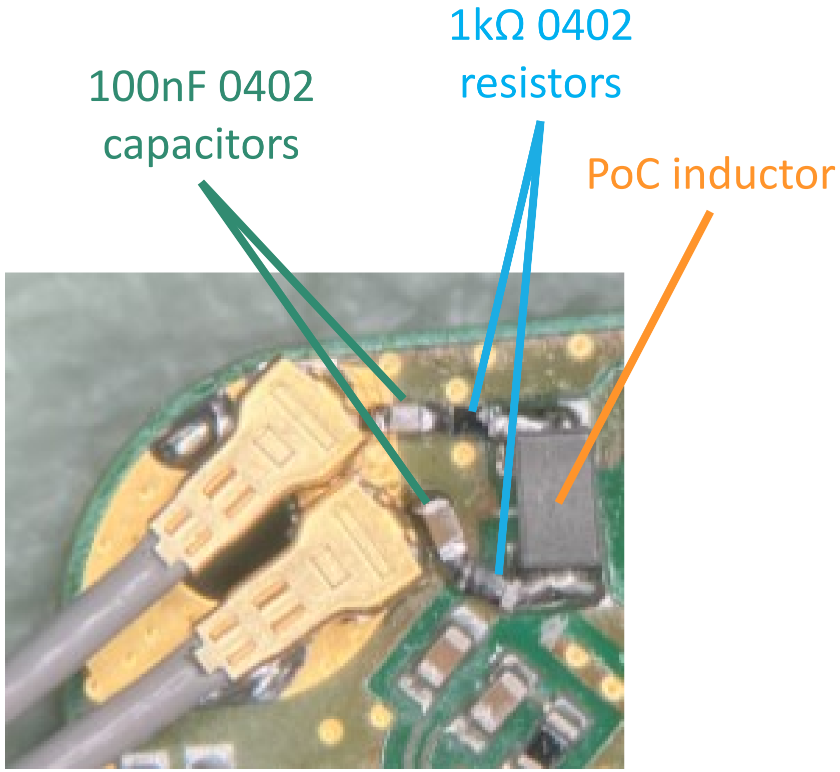
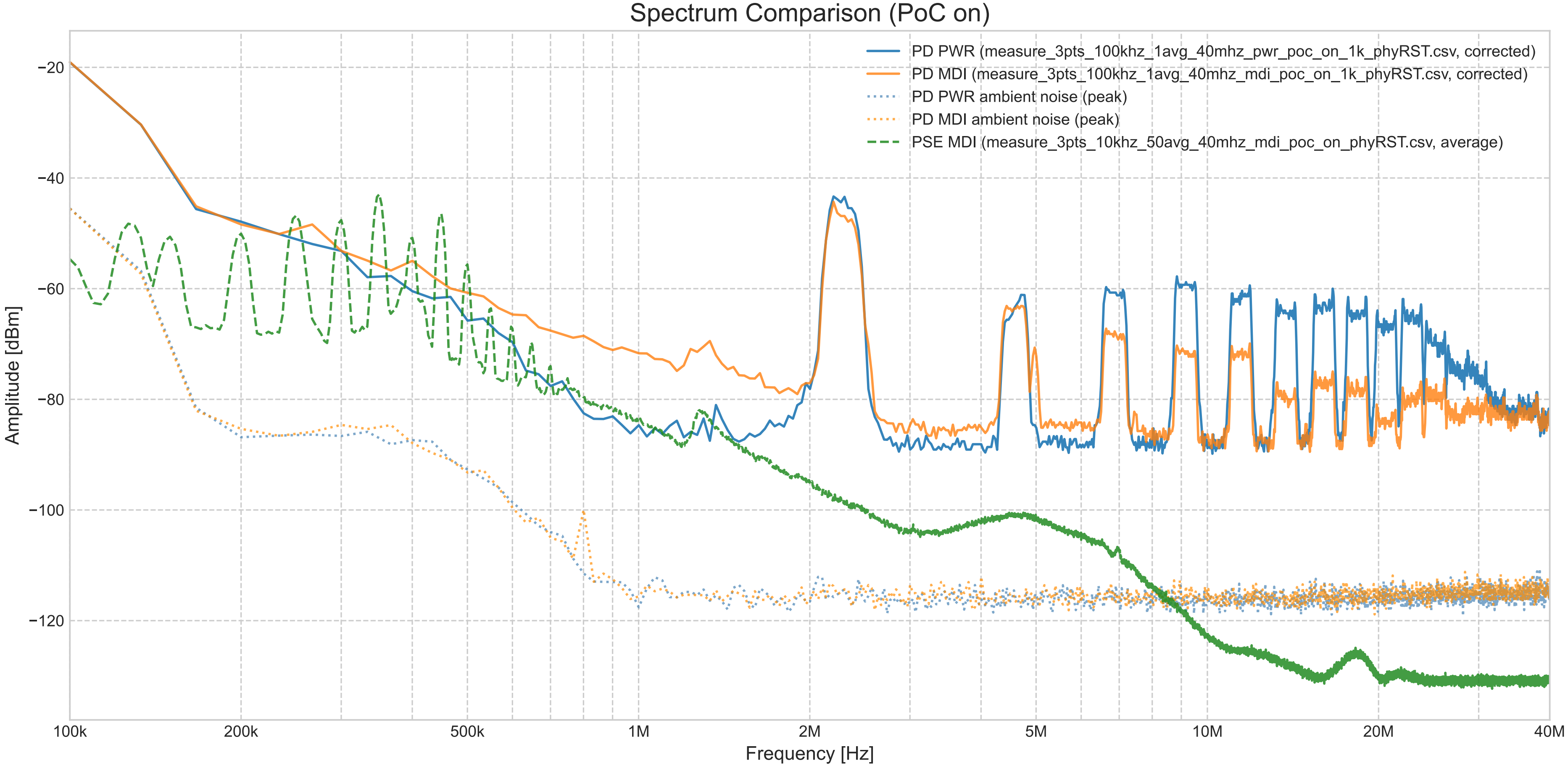


Photo of transmission line probe

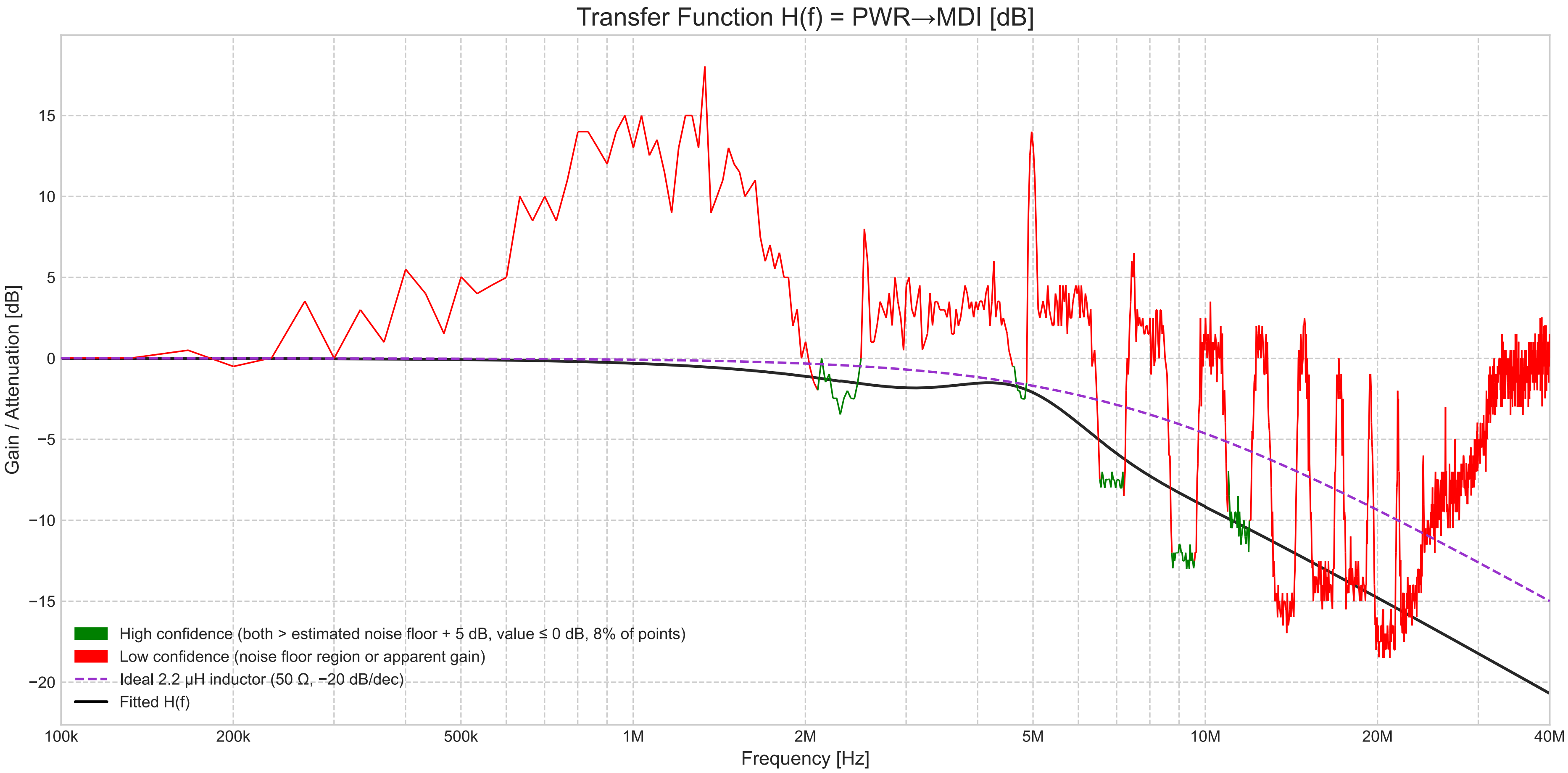
Spectrum-Analyzer Results – Powered Device

- Spread-spectrum clock requires long capture time and peak values
- RBW = 100 kHz
- PSE is very noisy, not representative (also average, not peak)



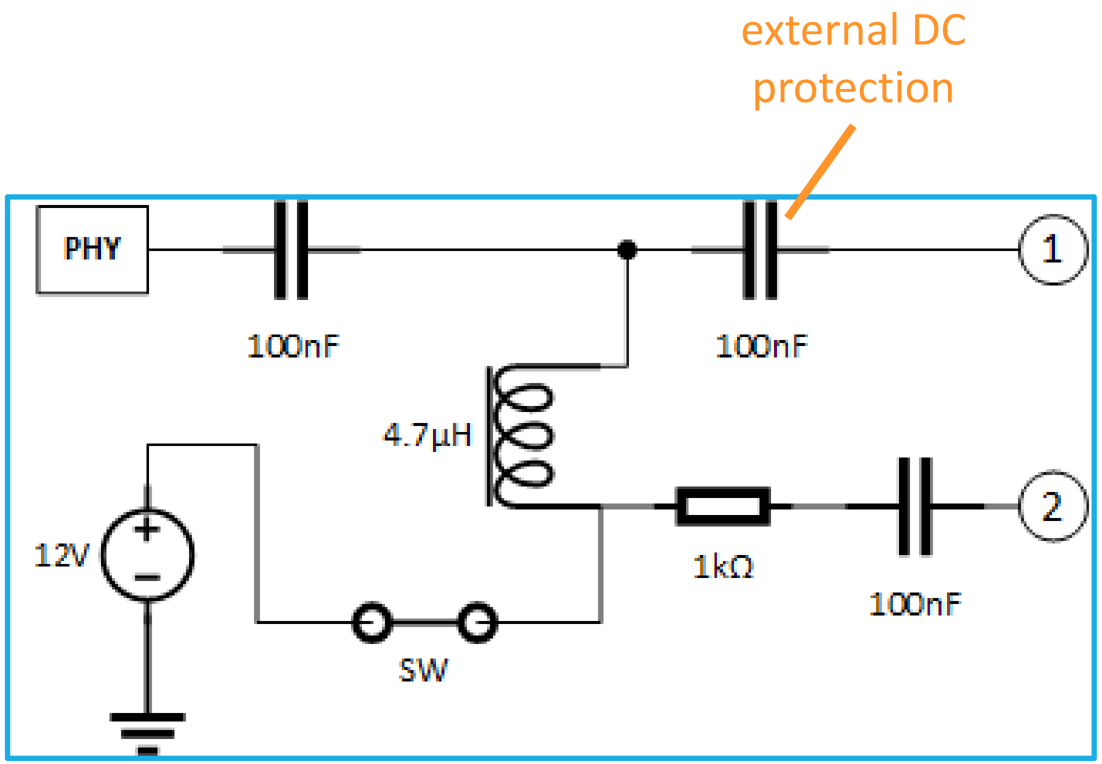
Estimated Transfer Function of PWR → MDI

- Due to passive measurement, transfer function is only valid where measured noise is above noise floor.
- 2.2 µH inductor transfer function also depends on source/sink impedance.



How to measure?
Power Sourcing Equipment

- Advantage: Self-supplied PSE architecture simplifies direct in-line noise measurement.
- Relevant for testing is only Port 1 (with external DC protection).
- But local PHY of PSE will also see additional noise from PD side.



Simplified Schematic of PSE Measurement Setup for Coax channel

How to measure?
Powered Device

- Disadvantage: PD must be supplied on MDI (preferably via a PSE with realistic output impedance).

- Differential Probe + Oscilloscope could be used to estimate noise level at PHY (as in Clause 104.5.7.4), should be high-impedance (> 1kOhm) and resolution should be sub-millivolt.

- Local PHY of PSE will also see additional noise from PD side.

Noise in Time Domain at PMIC

- -47 dBm (peak at 2.3 MHz) ≈ 1 mV_{RMS}
- The peak-to-peak voltage can only be estimated as worst for the spectrum and the true value must be measured in time domain.

Measurement setup adjustments:

- Bypassed 1kΩ resistor.
- Measurement with 30 MHz LPF.

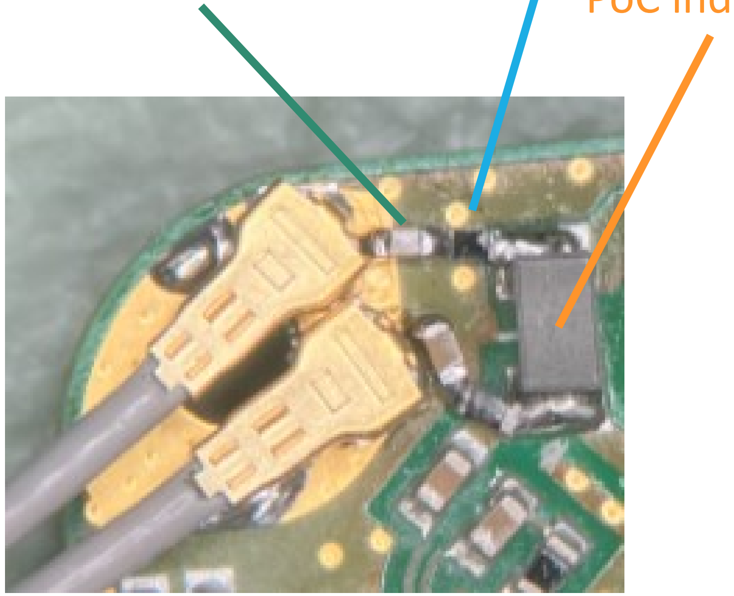
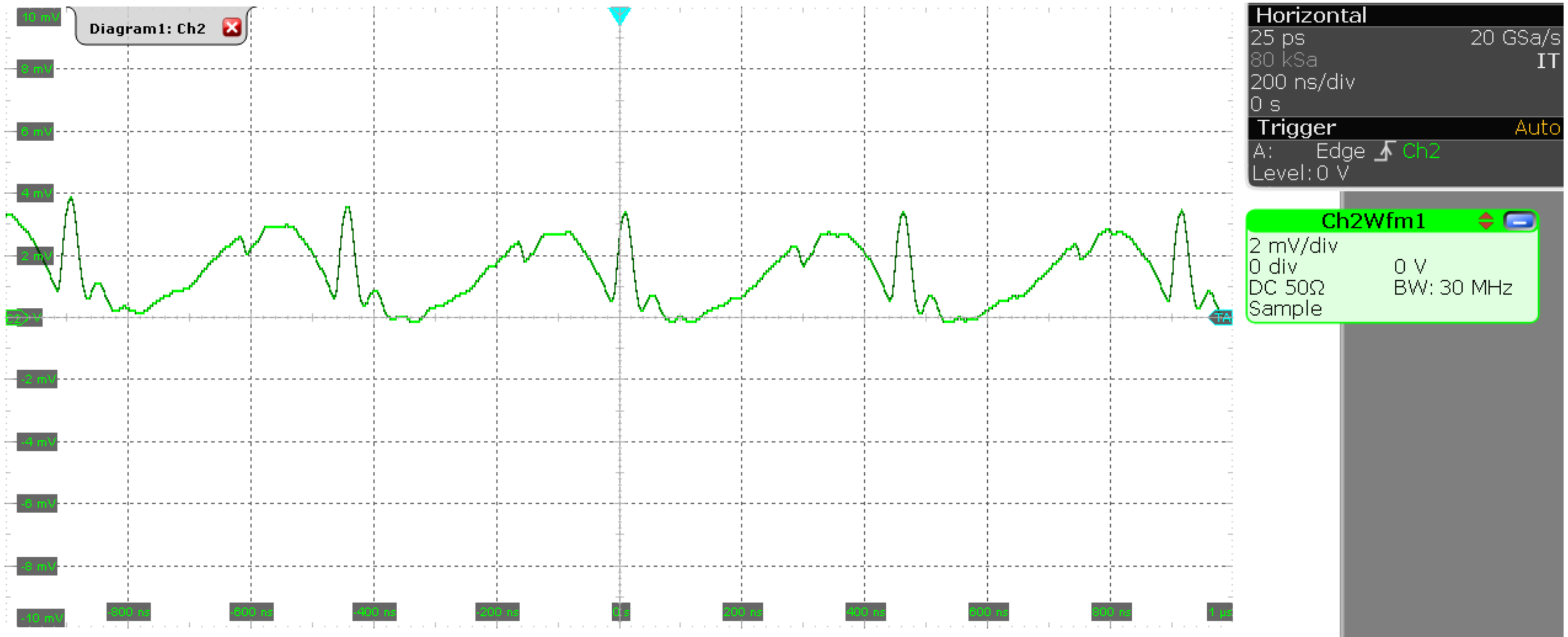


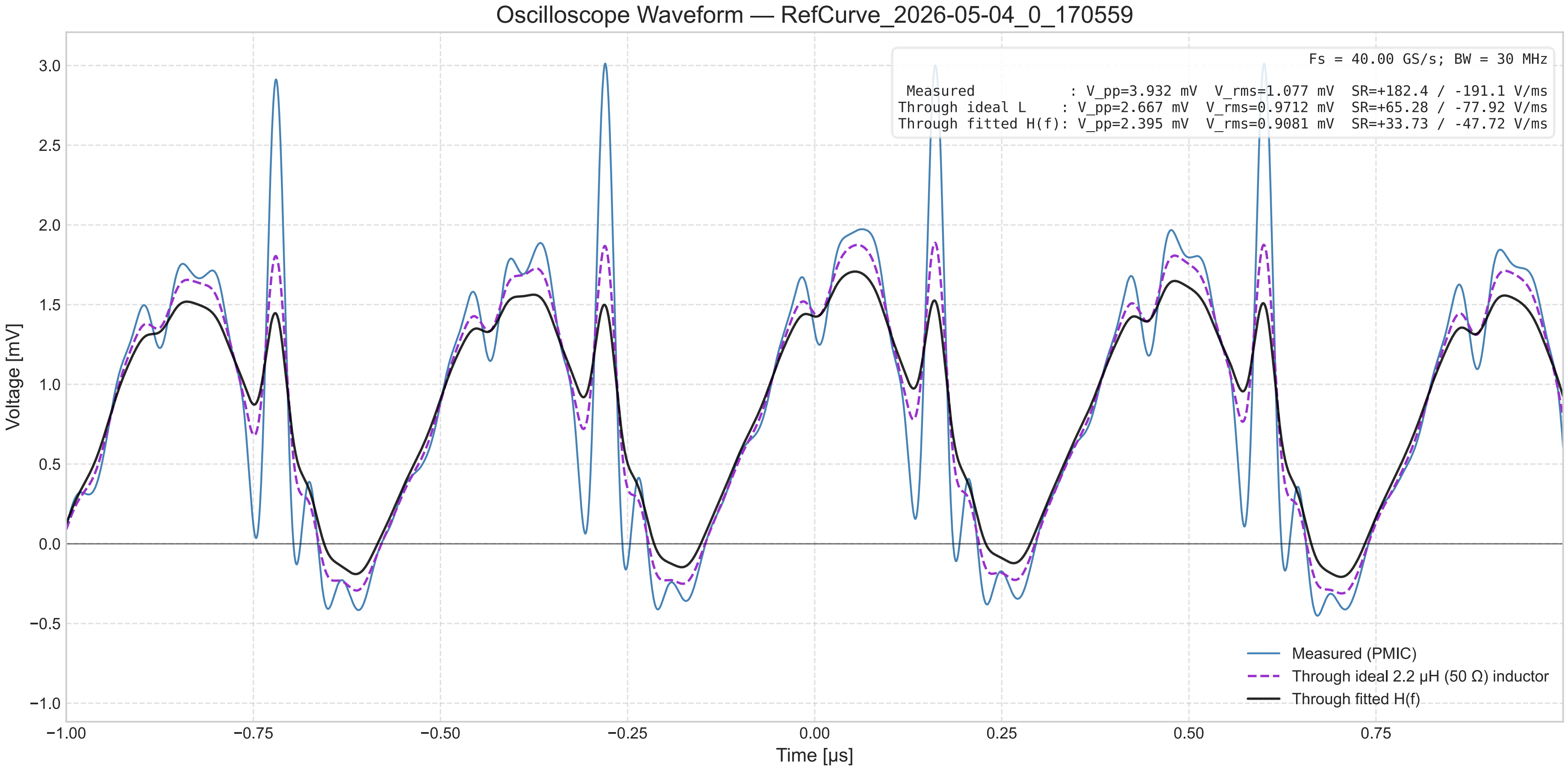
Photo of transmission line probe

Oscilloscope Measurement

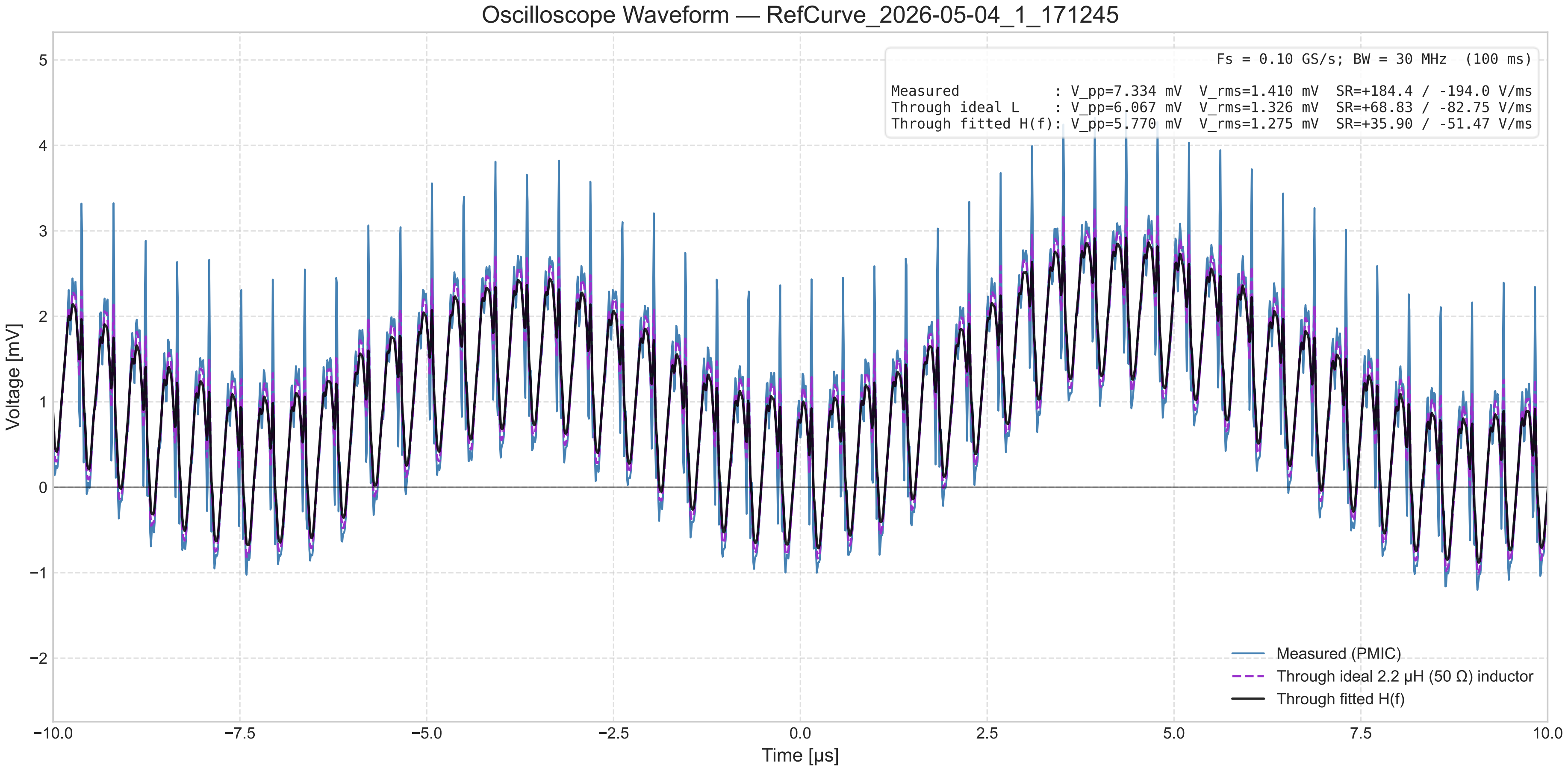


Meas Group 1	Current	Max	Min	Mean	RMS	σ (S-dev)	Event count	Wave count
Peak to peak	4.052 mV	4.4485 mV	3.8148 mV	4.1319 mV	4.1348 mV	161.08 µV	15	15
RMS	1.7595 mV	1.7595 mV	964.7 µV	1.2987 mV	1.3178 mV	231.14 µV	15	15
Frequency	17.715 MHz	19.474 MHz	2.2143 MHz	6.9142 MHz	8.9006 MHz	5.6179 MHz	216	15
Slew rate rising	8.908 V/ms	211.46 V/ms	7.224 V/ms	29.641 V/ms	63.022 V/ms	56.077 V/ms	61	15
Slew rate falling	-29.385 V/ms	-29.385 V/ms	-180.57 V/ms	-96.228 V/ms	111.52 V/ms	56.845 V/ms	60	15

Time Domain – Applied Transfer Function #1



Time Domain – Applied Transfer Function #2



Conclusion

- Attenuation of the PoC filter is lower than first simulations suggested.

- Noise coupling shown from PMIC to MDI is still only an estimate and depends on Z_{PSE} and Z_{PD}.

- We should either adopt the noise specifications from Clause 104 or specify a dedicated MDI voltage ripple limit over frequency.

Thank You!