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Analysis of Radiated Emission from an Asymmetric Link

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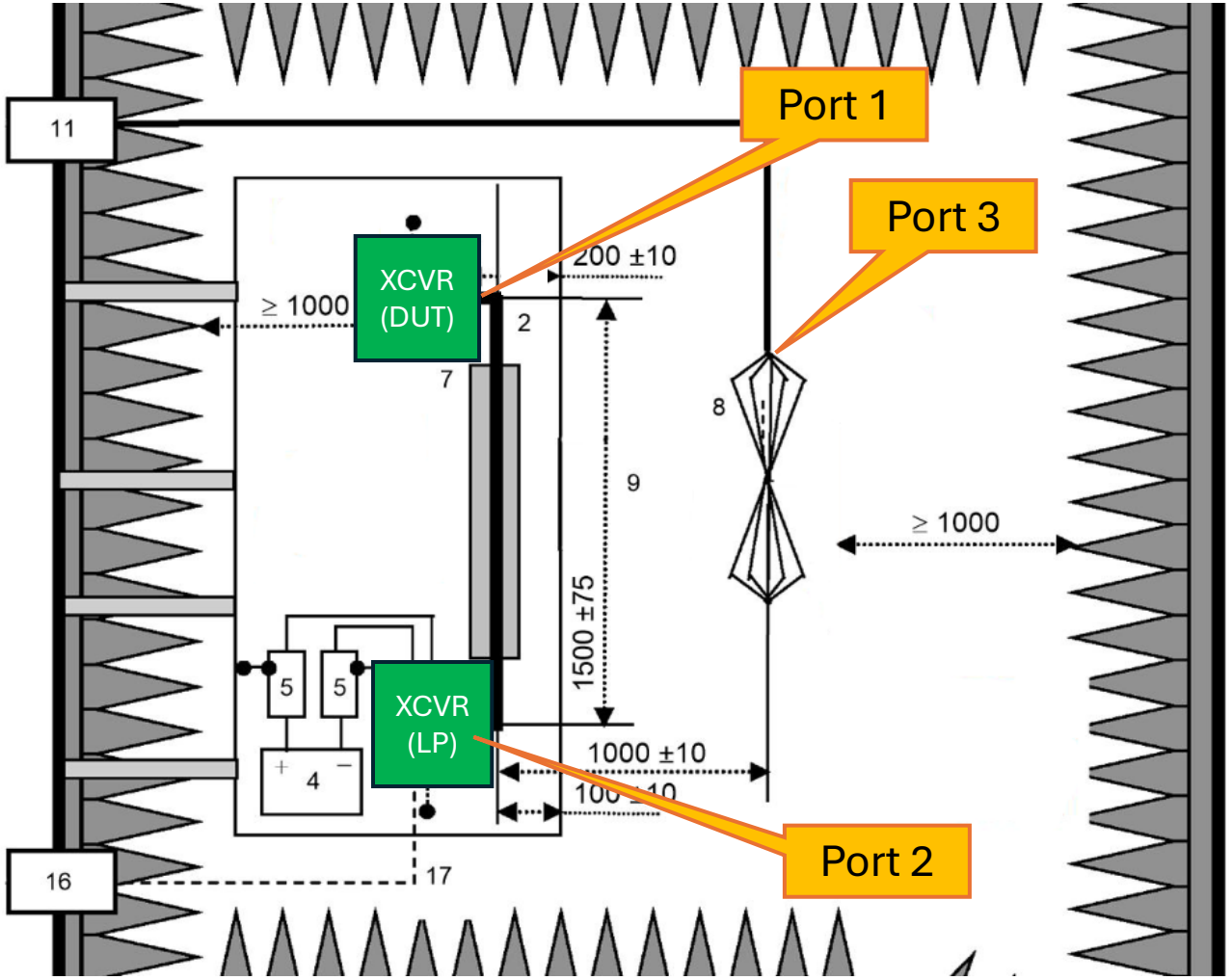
Introduction

- A method is introduced to analyze radiated emission (RE) from an asymmetric link based on the transmitters' PSD and the channel characteristics.
- The following cases with a coaxial channel are simulated and presented. Both cases use the PSD proposed in the presentation "*Transmit Power in ACT/GMSLE*" by Hossein and Jay in May 2025.
  - Case 1: The upper limit of the proposed ACT PSD mask, UPSD, is used to simulate the worse-case scenario.
  - Case 2: A mid-level PSD, represented by the "yellow line" in the original presentation is used to explore a more realistic scenario.
- The results are compared against stringent automotive RE EMC requirements

Radiated Emission Setup and Test Method

- Setup:
  - Standard **CISPR 25** RE setup
  - Coaxial cable type: RTK031
  - Cable length: 1.8 m
- Method:
  - A 3-Port S-Parameter is **measured** per CISPR 25 RE specification as the **transfer function** of the transmitter to the antenna.
  - Field strength is **calculated** based on the PSD and the measured transfer function.



Proposed PSD for Downstream

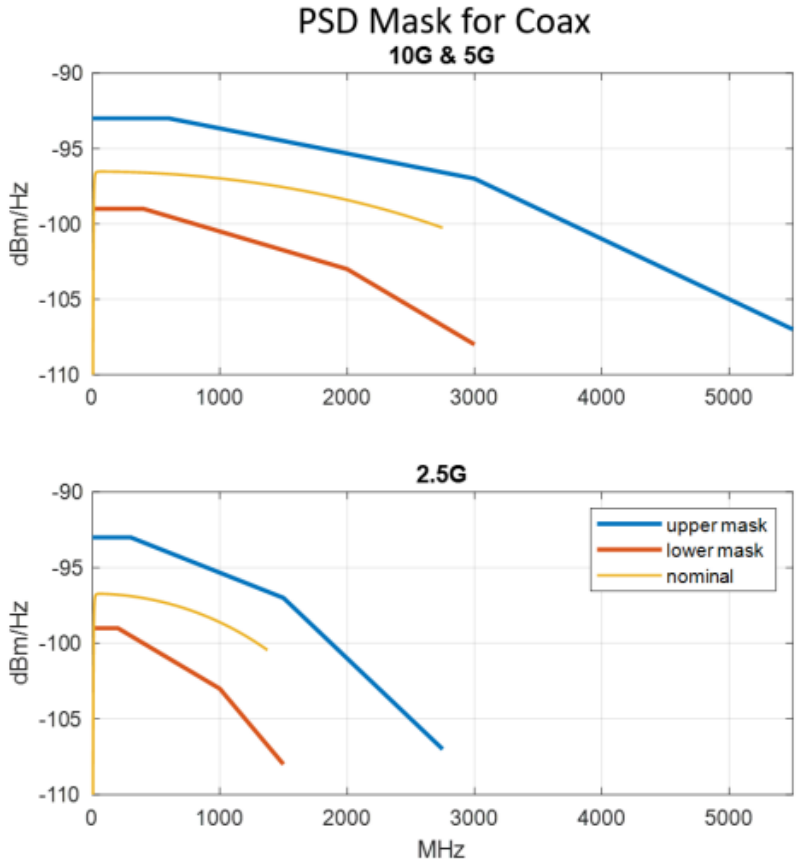
Hossein Sedarat - IEEE 802.3dm - ACT Transmit Power and PSD

PSD Mask - Downstream

$$UPSD(f) = \begin{cases} P_0 & 0 < f \le 600 \times S \\ P_0 + 1 - \frac{f}{600 \times S} & 600 \times S < f \le 3000 \times S \\ P_0 + 8 - \frac{f}{250 \times S} & 3000 \times S < f \le 5500 \times S \end{cases}$$

$$LPSD(f) = \begin{cases} P_0 - 6 & 5 < f \le 400 \times S \\ P_0 - 5 - \frac{f}{400 \times S} & 400 \times S < f \le 2000 \times S \\ P_0 - \frac{f}{200 \times S} & 2000 \times S < f \le 3000 \times S \end{cases}$$

- P_0 is -93 dBm/Hz for coax, and -90 dBm/Hz for STP
- S is 1 for 10G and 5G, and 0.5 for 2.5G
- f is frequency in MHz



Proposed PSD for Upstream

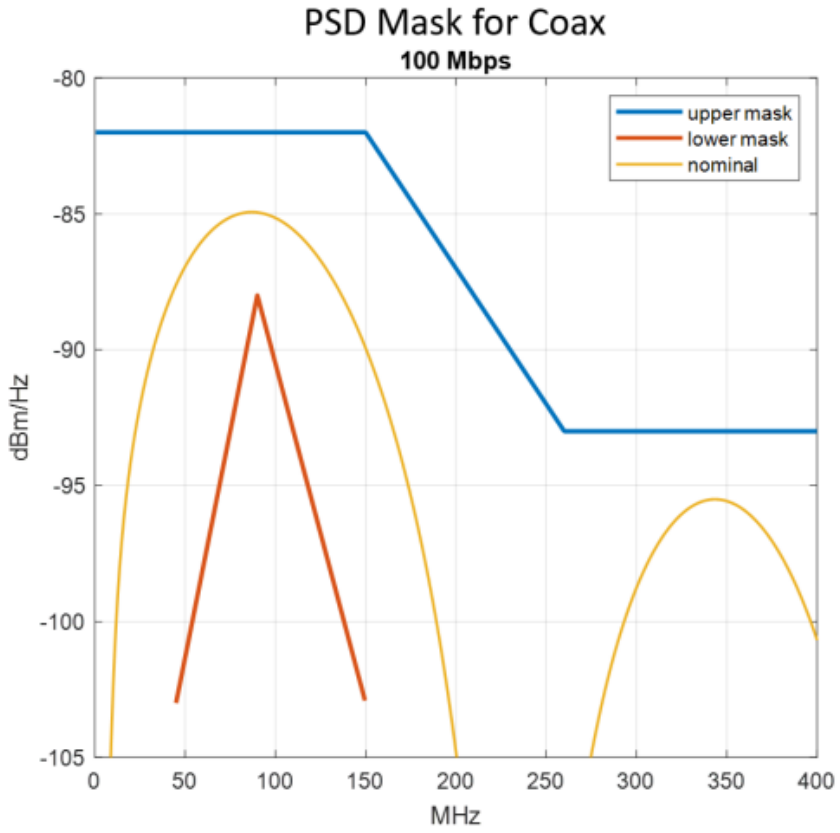
Hossein Sedarat - IEEE 802.3dm - ACT Transmit Power and PSD

PSD Mask - Upstream

$$UPSD(f) = \begin{cases} P_0 & 0 < f \leq 150 \\ P_0 + 15 - \frac{f}{10} & 150 < f \leq 260 \\ P_0 - 11 & 260 < f \leq 400 \end{cases}$$

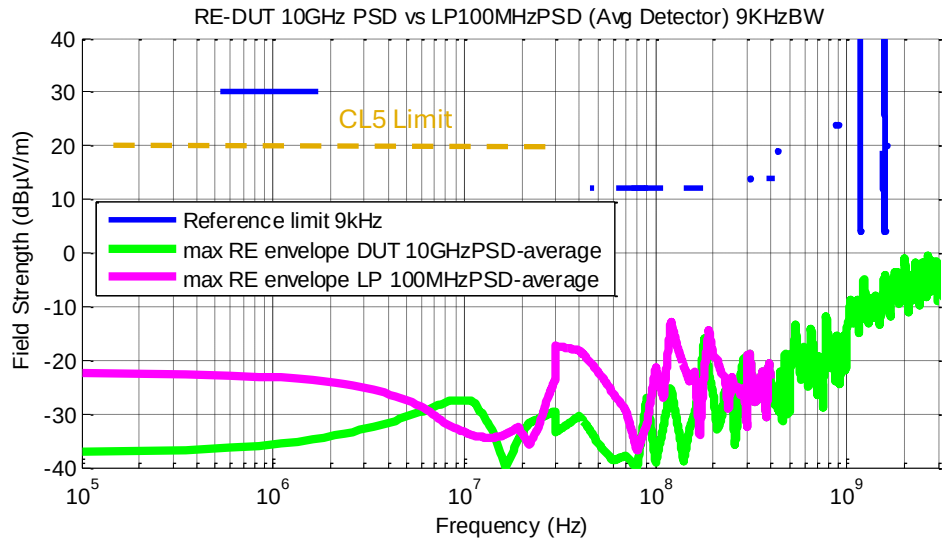
$$LPSD(f) = \begin{cases} P_0 - 6 - \left(\frac{90 - f}{3}\right) & 45 < f \leq 90 \\ P_0 - 6 - \left(\frac{f - 90}{4}\right) & 90 < f \leq 150 \end{cases}$$

- P_0 is -82 dBm/Hz for coax, and -79 dBm/Hz for STP
- f is frequency in MHz



Case 1, Radiated Emission Result - 9kHz BW

AV



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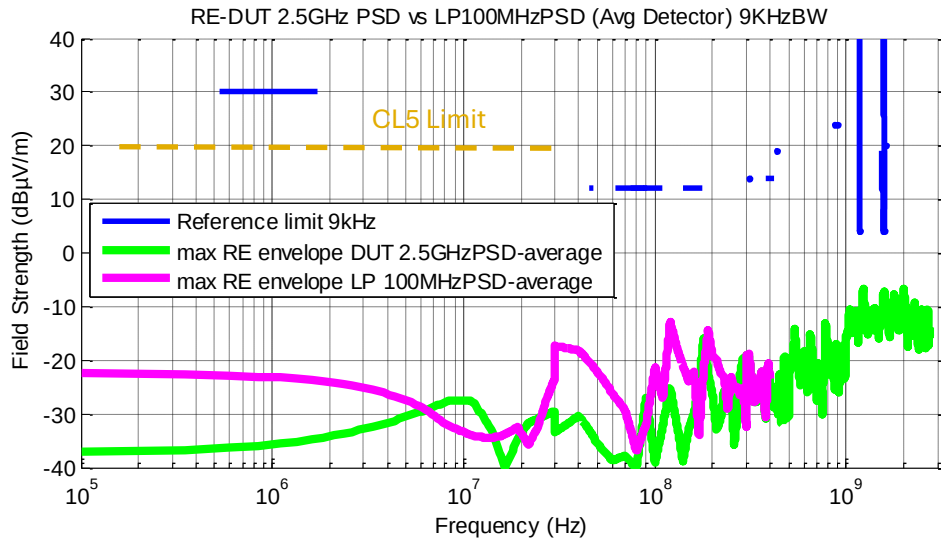

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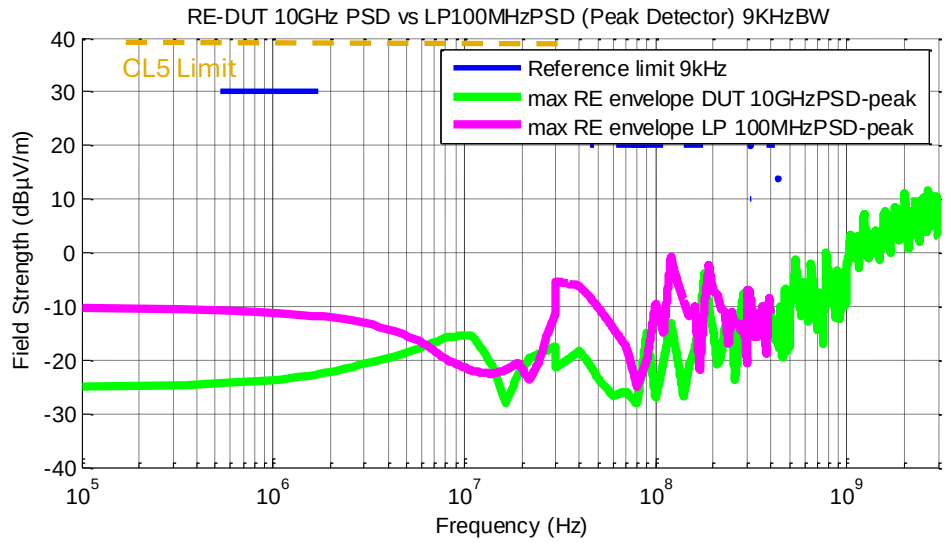

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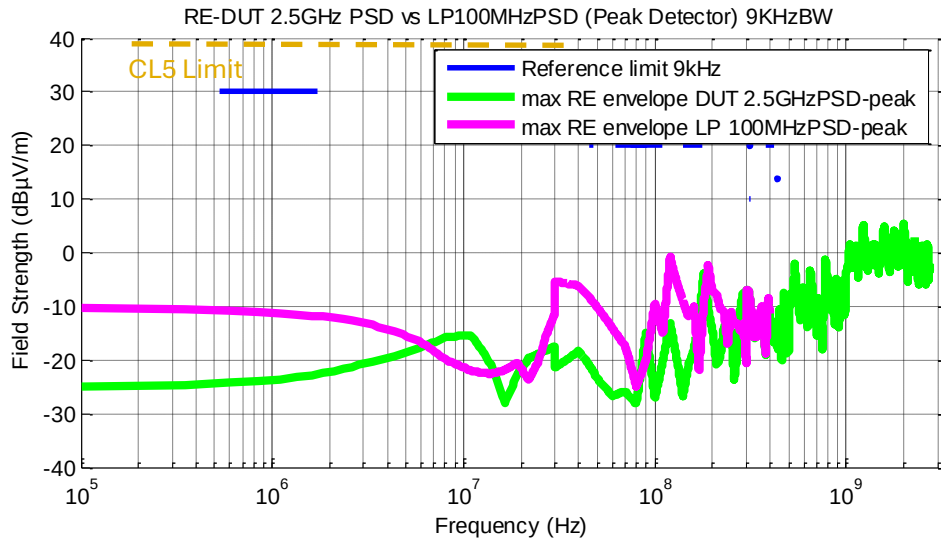
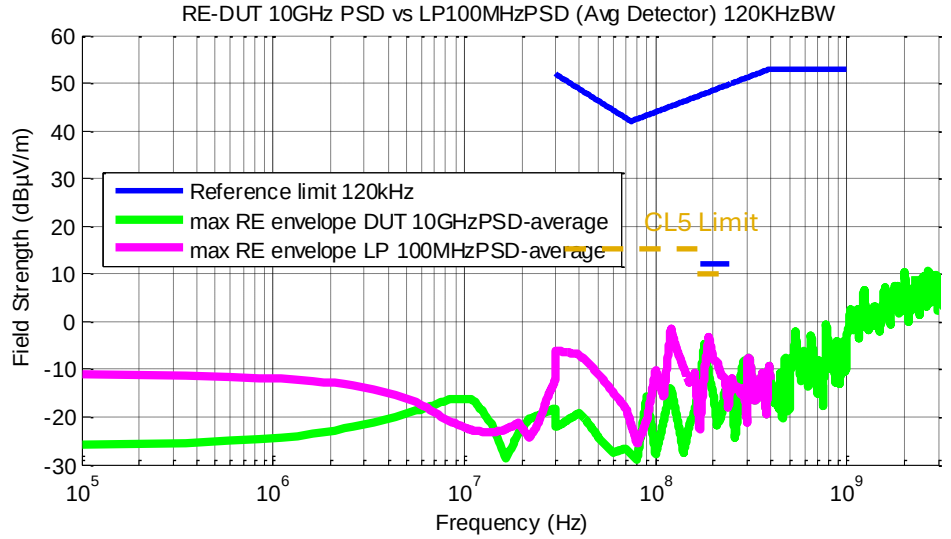


UPSD is used for analysis, Theoretically worst case, but may not be practical!

Case 1, Radiated Emission Result - 120kHz BW

AV



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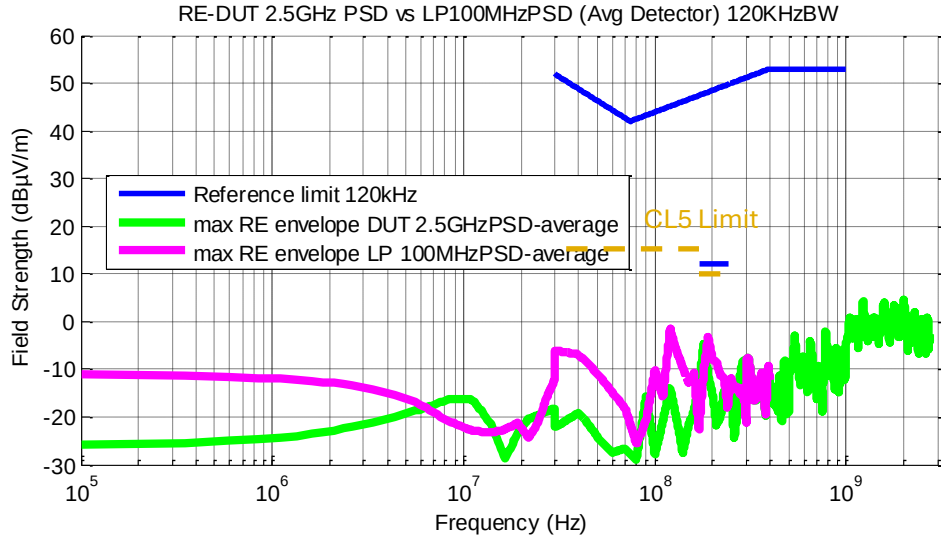

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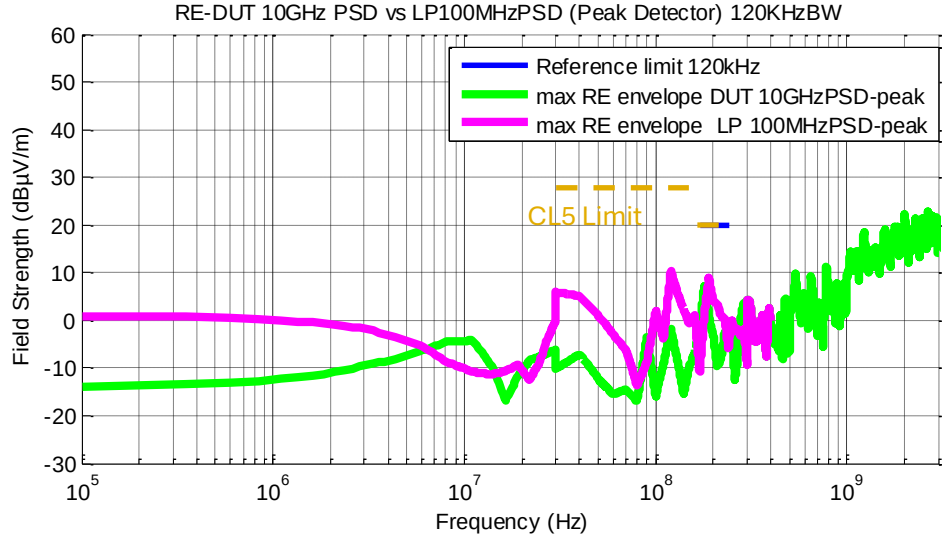

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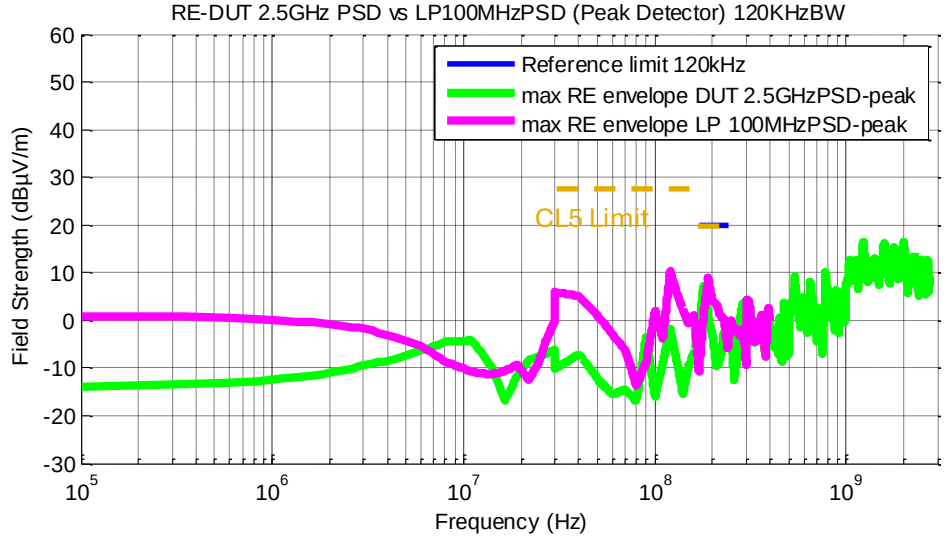
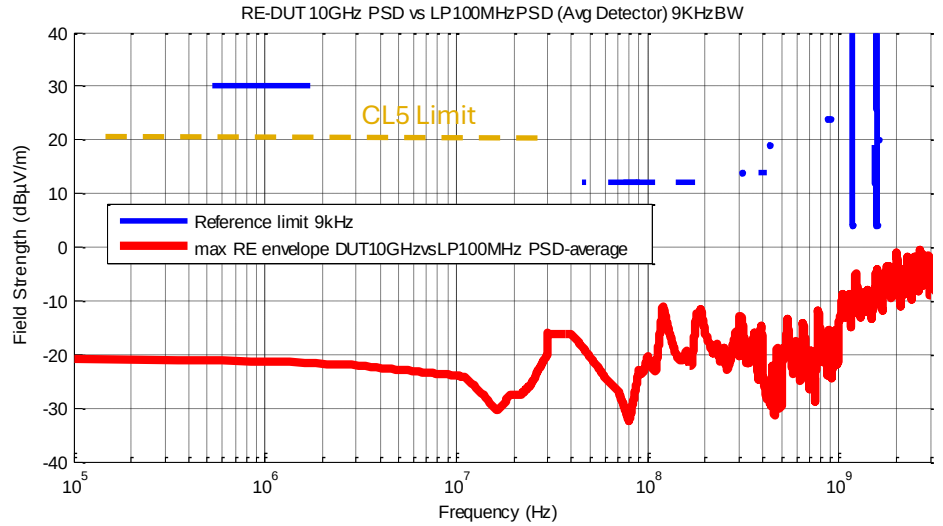


UPSD is used for analysis, Theoretically worst case, but may not be practical!

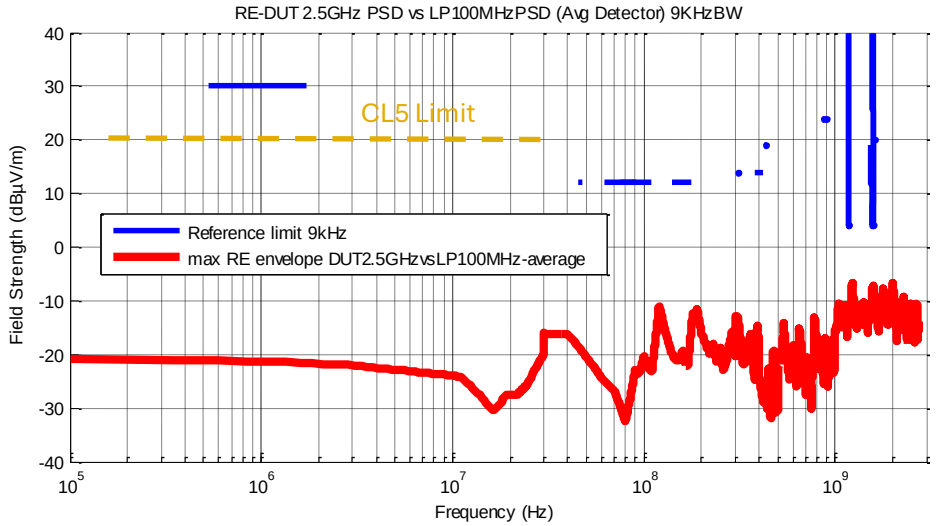
Case 1, Radiated Emission Result - 9kHz BW

Full-duplex mode

AV



AV



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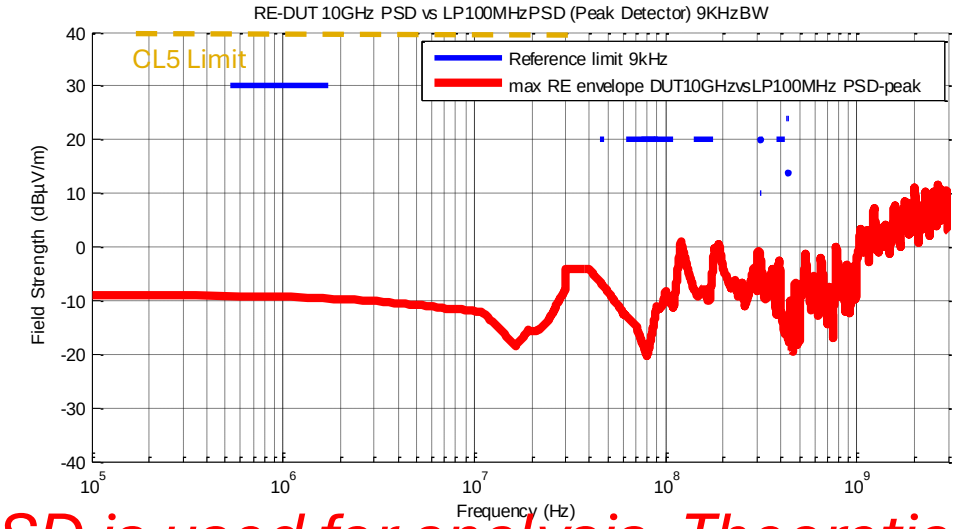

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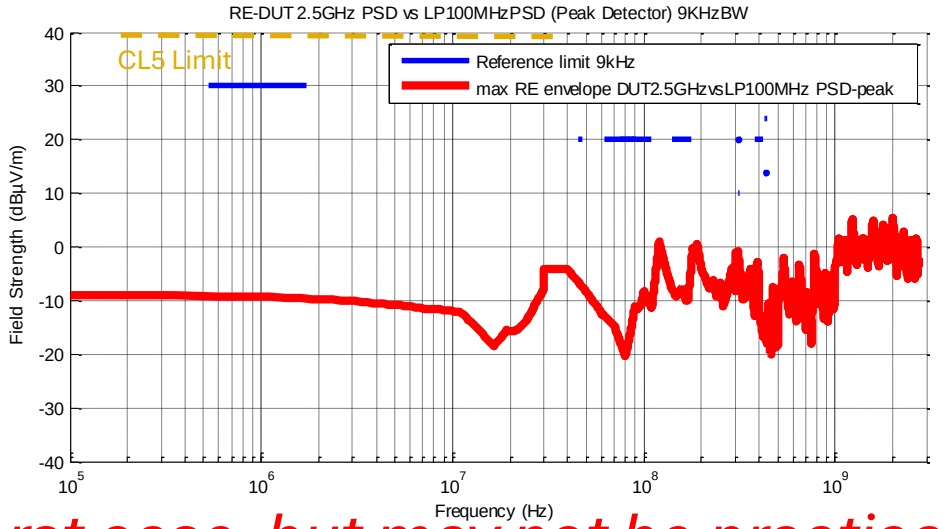
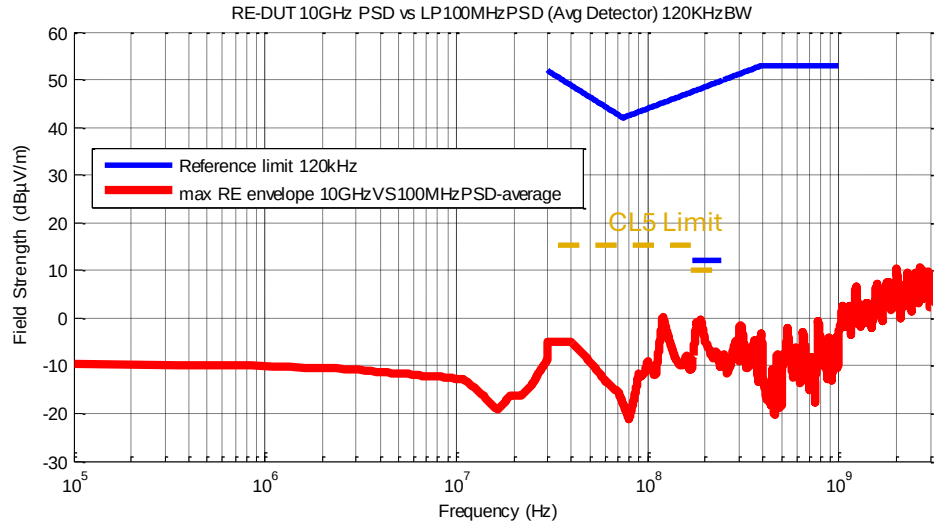


UPSD is used for analysis, Theoretically worst case, but may not be practical!

Case 1, Radiated Emission Result – 120kHz BW

Full-duplex mode

AV



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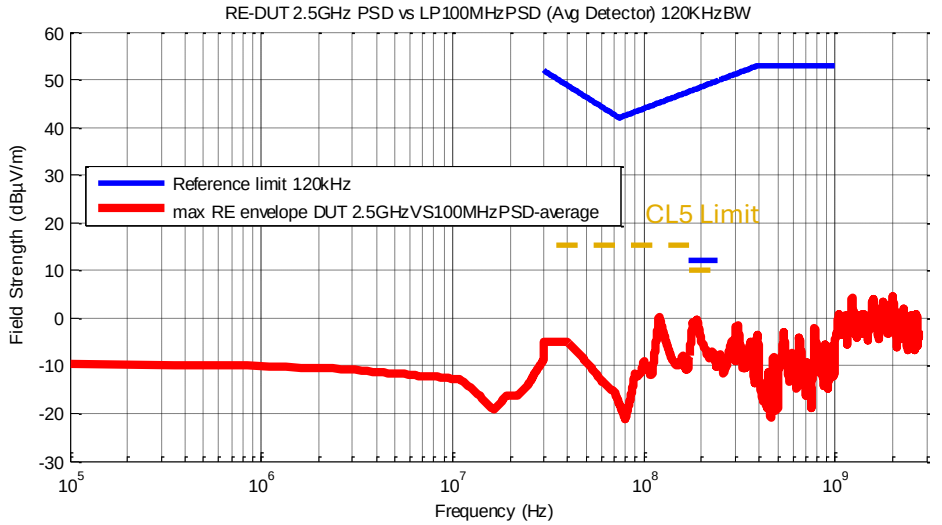

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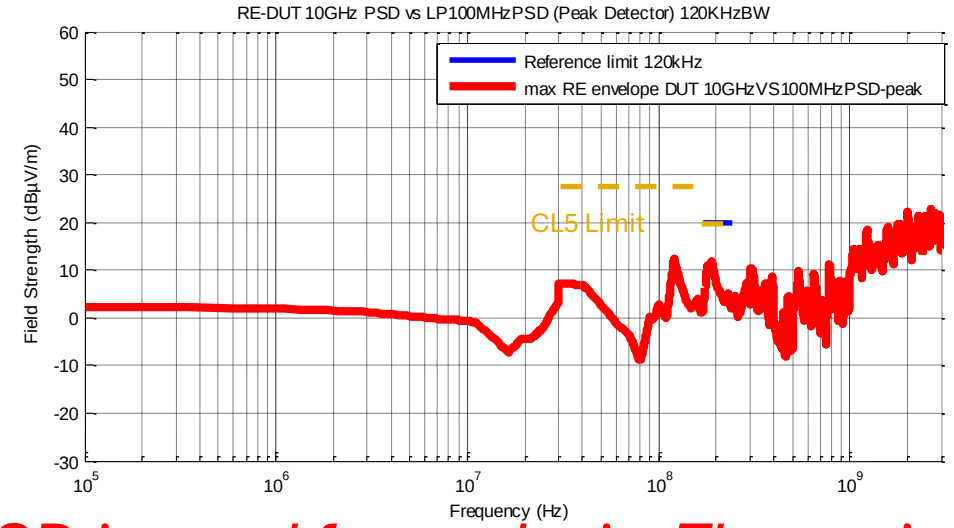

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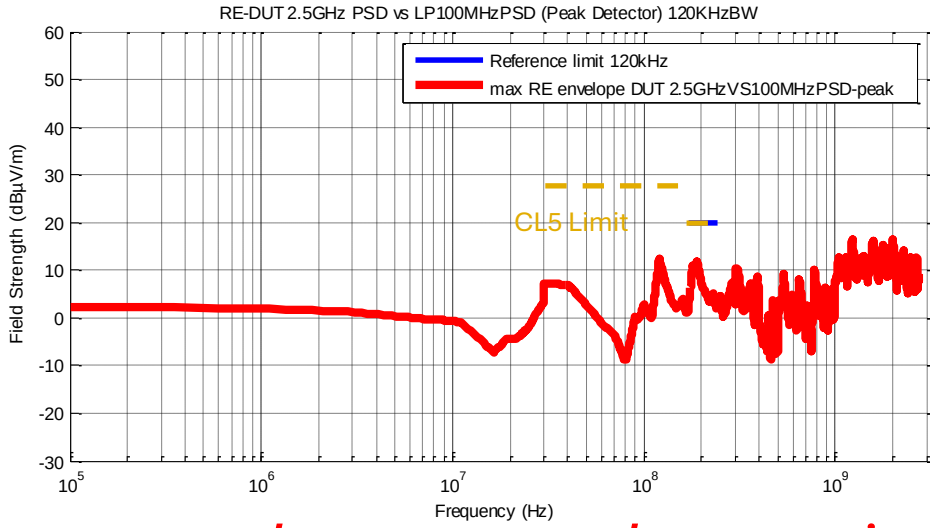
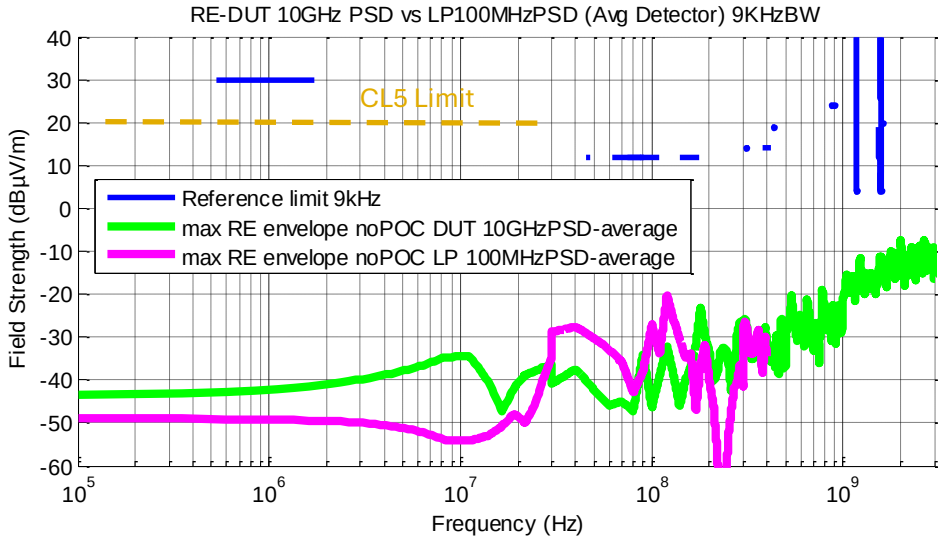


UPSD is used for analysis, Theoretically worst case, but may not be practical!

Case 2, Radiated Emission Result - 9kHz BW

Normal PSD, the yellow line in the PSD plot is used for analysis

AV



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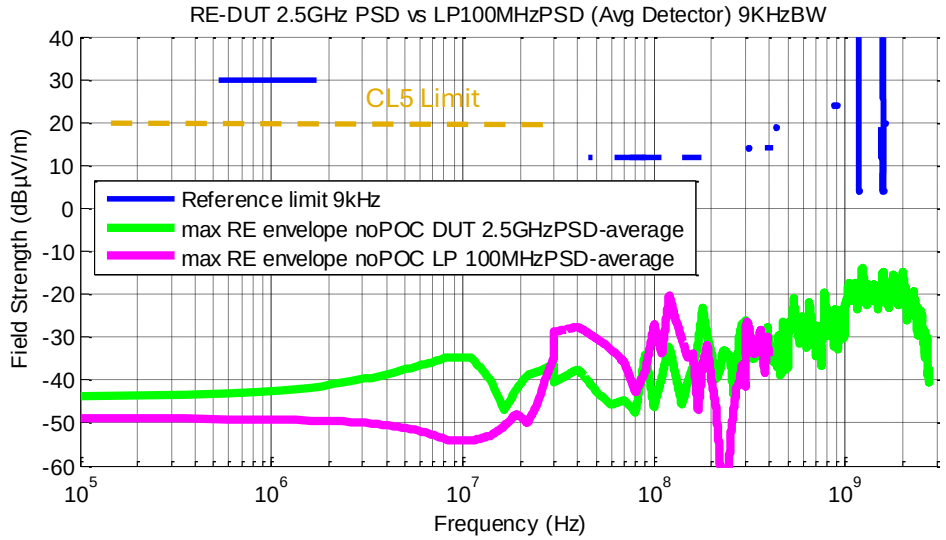

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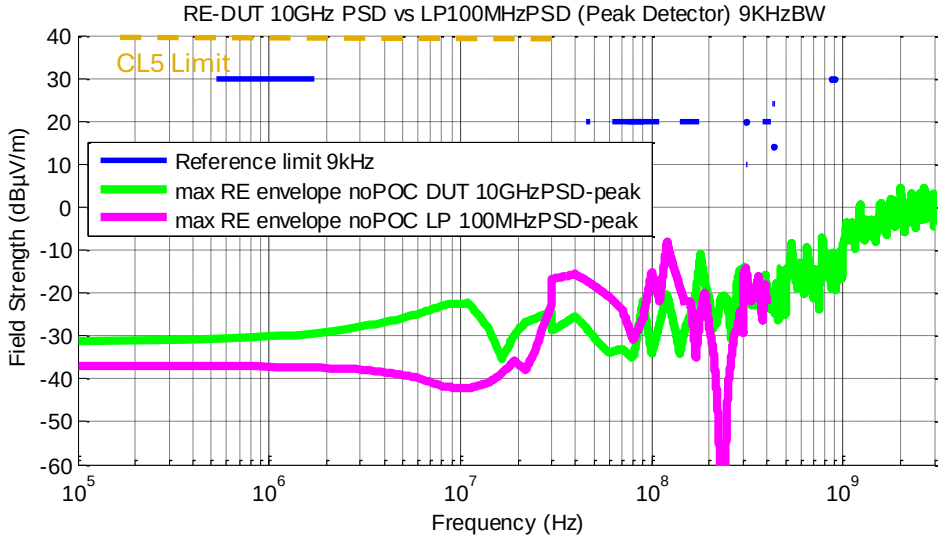

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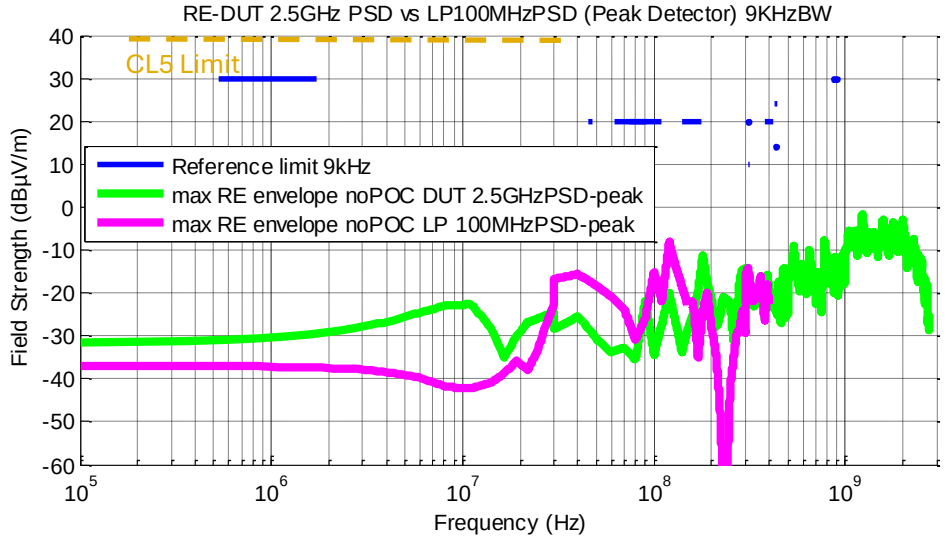
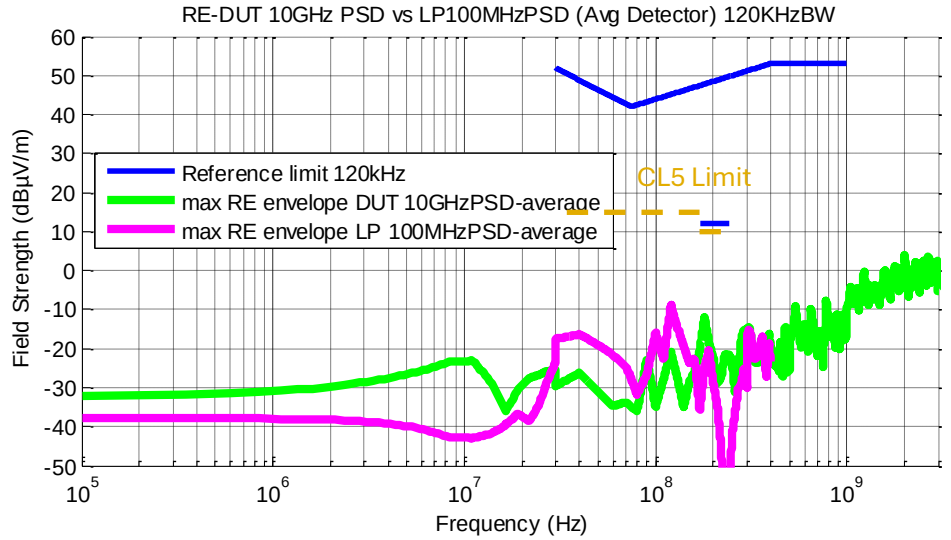


Case 2, Radiated Emission Result - 120kHz BW

Normal PSD, the yellow line in the PSD plot is used for analysis

AV



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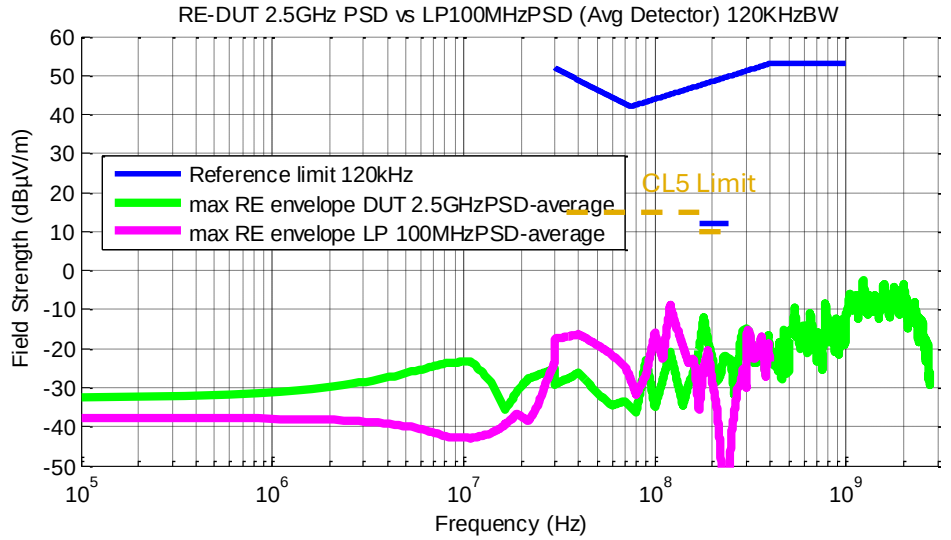

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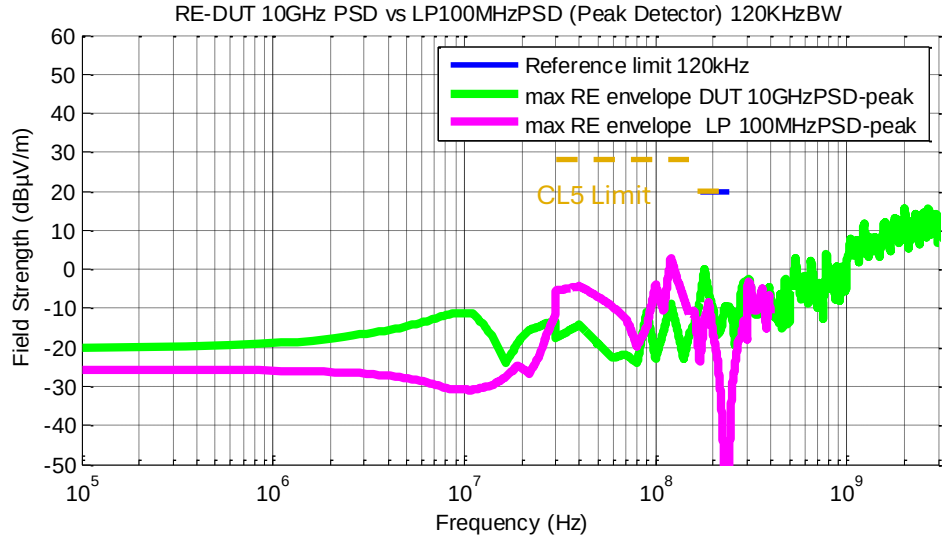

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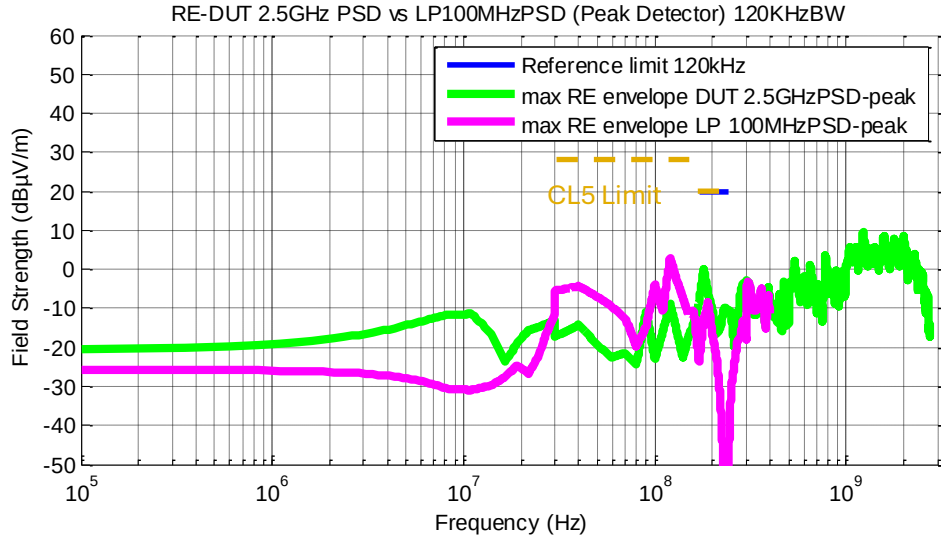
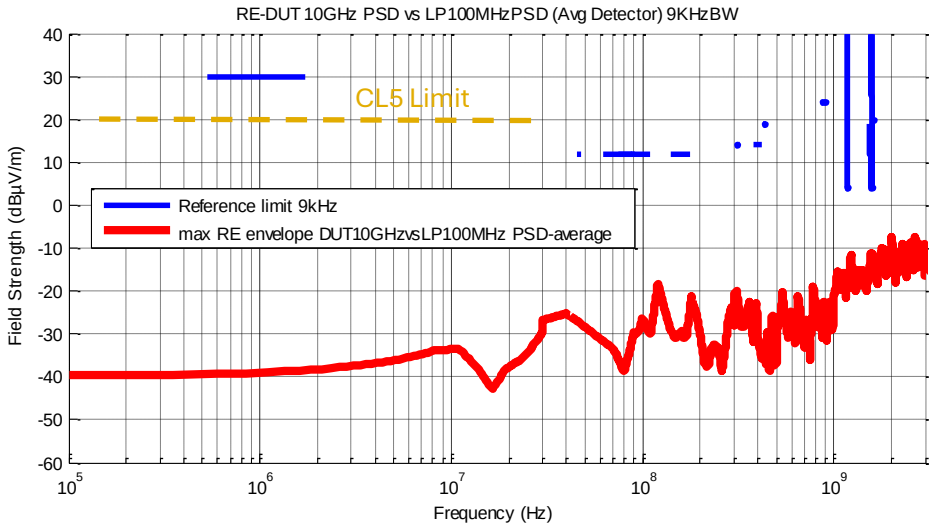


Case 2, Radiated Emission Result - 9kHz BW

Full-duplex, normal PSD, the yellow line in the PSD plot is used for analysis

AV



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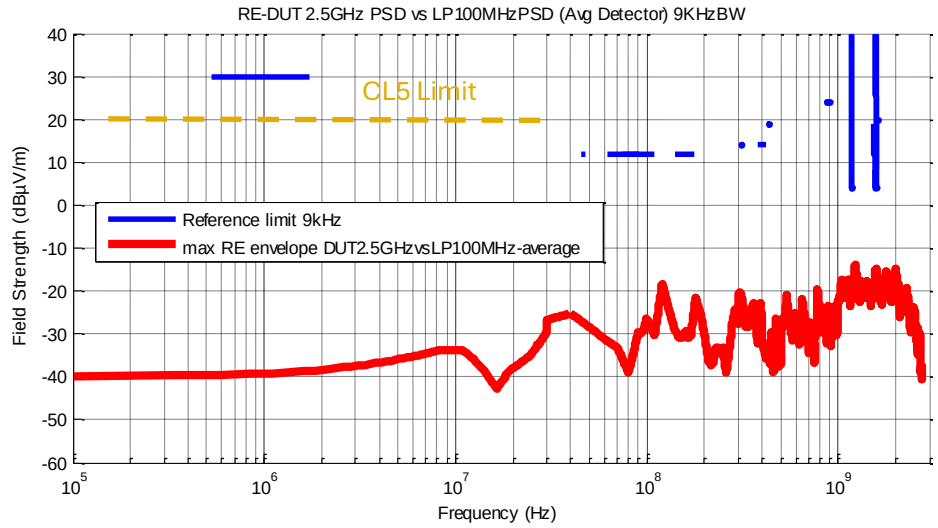

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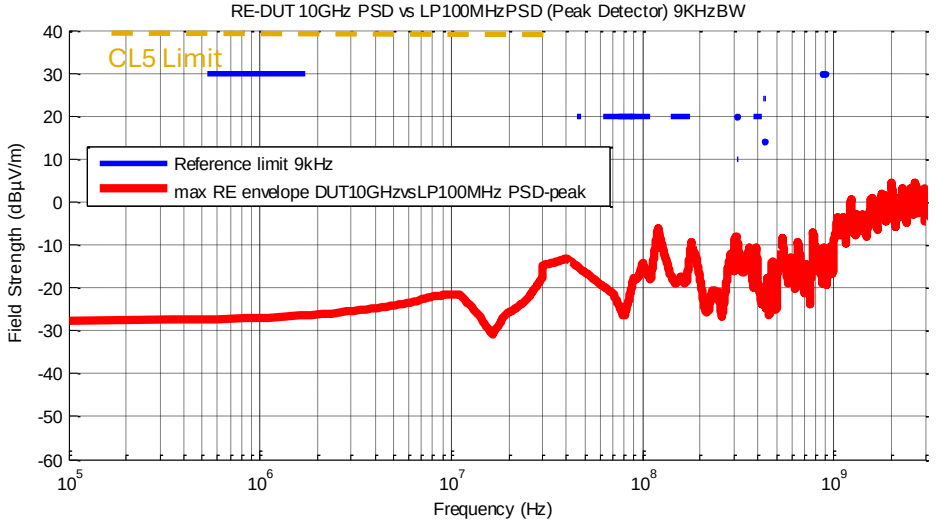

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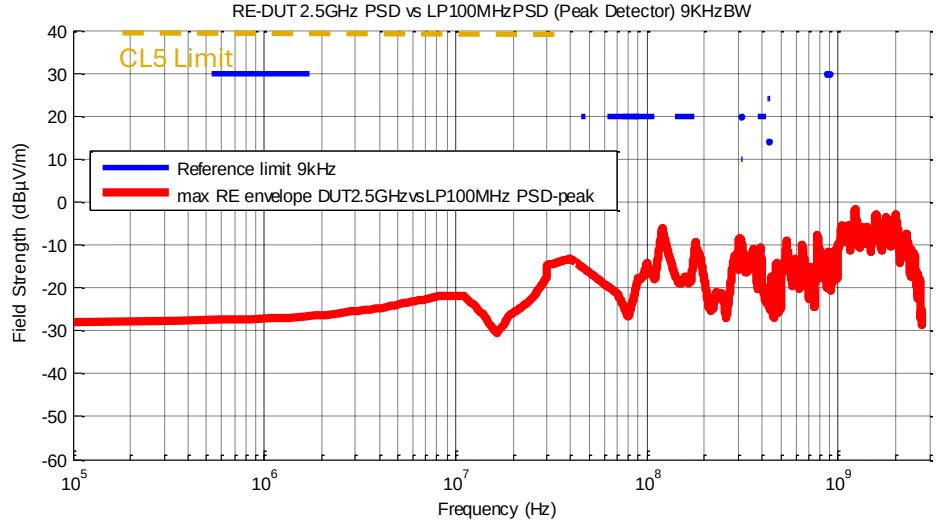
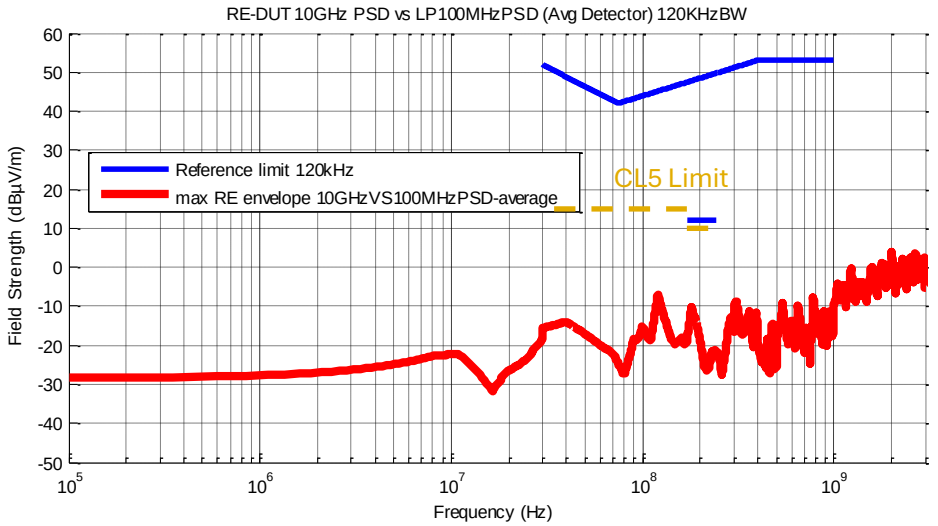


Case 2, Radiated Emission Result - 120kHz BW

Full-duplex, normal PSD, the yellow line in the PSD plot is used for analysis

AV



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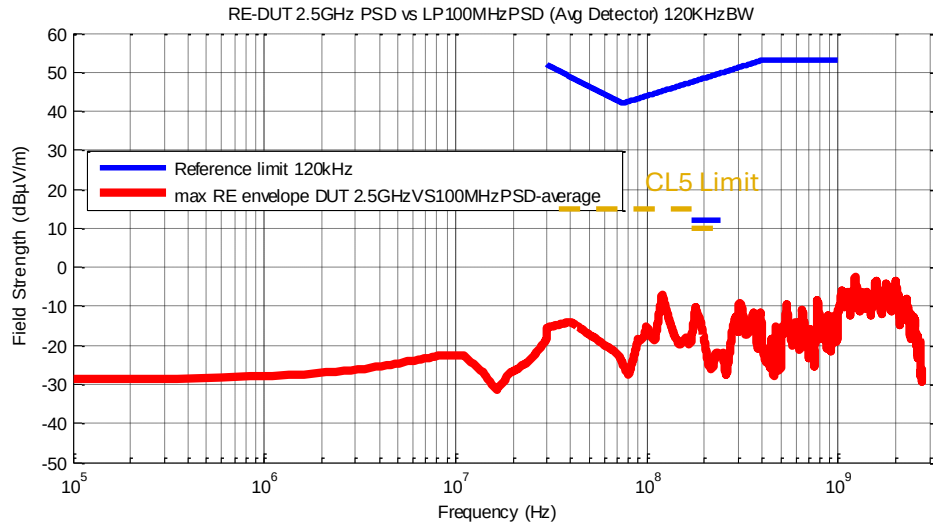

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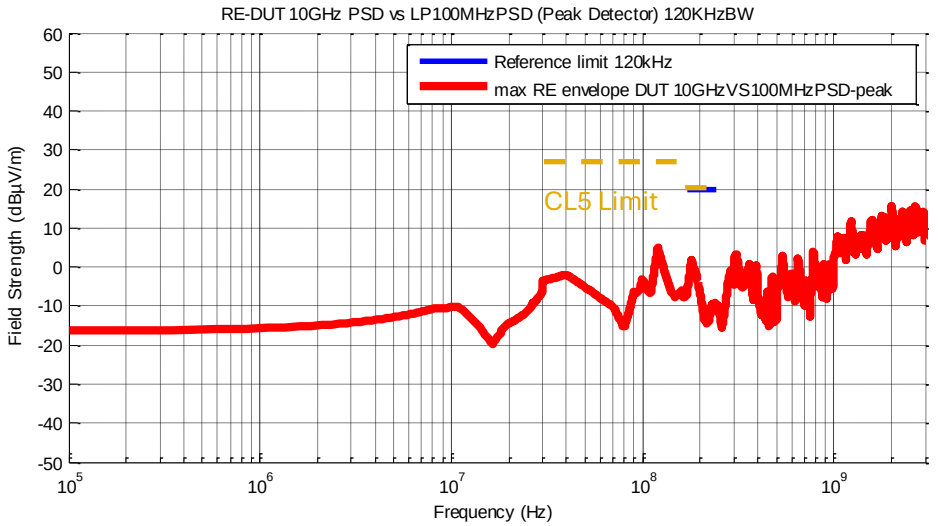

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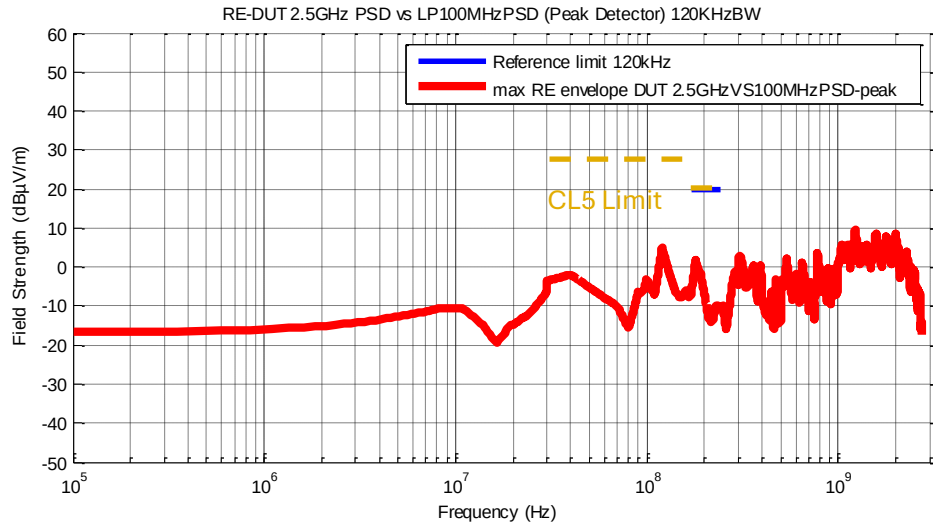

Conclusion

- The radiated emission from a coaxial channel based on proposed ACT PSD has sufficient margin to pass stringent automotive requirement.
- STP cable is expected to have a much better RE performance due to the common-mode rejection.

Thank You!