

# On Tx Emission Requirements

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# Prior Contributions

- 802.3ch

- [http://www.ieee802.org/3/NGAUTO/public/may17/DiBiaso\\_3NGAUTO\\_01\\_0517.pdf](http://www.ieee802.org/3/NGAUTO/public/may17/DiBiaso_3NGAUTO_01_0517.pdf)
- [http://www.ieee802.org/3/ch/public/nov17/Pandey\\_3ch\\_01\\_1117.pdf](http://www.ieee802.org/3/ch/public/nov17/Pandey_3ch_01_1117.pdf)
- [http://www.ieee802.org/3/ch/public/jan18/Pandey\\_3ch\\_01\\_0118.pdf](http://www.ieee802.org/3/ch/public/jan18/Pandey_3ch_01_0118.pdf)
  - For STP, “Emission = TX-PSD Mask (dBuV) + Coupling Attenuation (dB)”
- [http://www.ieee802.org/3/ch/public/may18/mueller\\_3ch\\_02a\\_0518.pdf](http://www.ieee802.org/3/ch/public/may18/mueller_3ch_02a_0518.pdf)
- [http://www.ieee802.org/3/ch/public/adhoc/180516\\_STP\\_cable\\_r1.pdf](http://www.ieee802.org/3/ch/public/adhoc/180516_STP_cable_r1.pdf)
- [http://www.ieee802.org/3/ch/public/adhoc/mueller\\_3ch\\_channel\\_04\\_0518.pdf](http://www.ieee802.org/3/ch/public/adhoc/mueller_3ch_channel_04_0518.pdf)

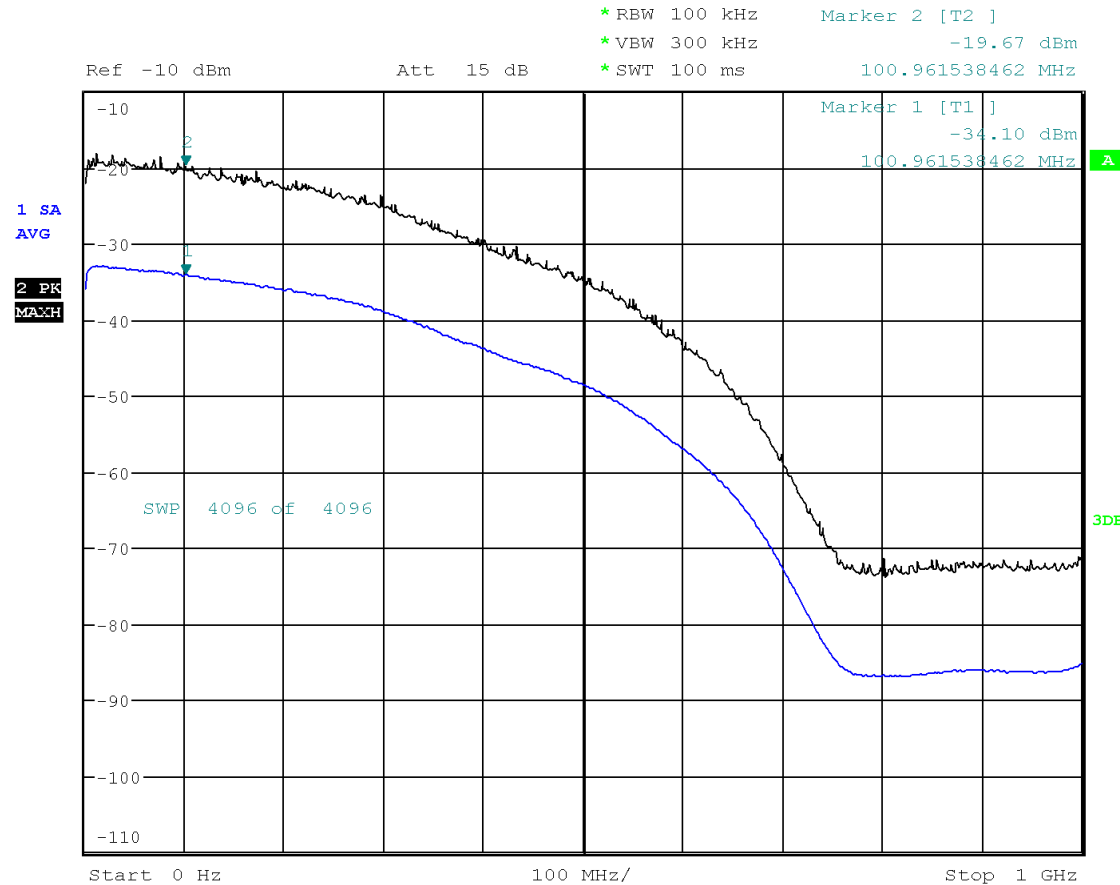
- 802.3bp

- [http://www.ieee802.org/3/bp/public/jan13/tazebay\\_3bp\\_01a\\_0113.pdf](http://www.ieee802.org/3/bp/public/jan13/tazebay_3bp_01a_0113.pdf)
- [http://www.ieee802.org/3/bp/public/may13/kish\\_3bp\\_01\\_0513.pdf](http://www.ieee802.org/3/bp/public/may13/kish_3bp_01_0513.pdf)
- [http://www.ieee802.org/3/bp/public/nov13/dai\\_3bp\\_01\\_1113.pdf](http://www.ieee802.org/3/bp/public/nov13/dai_3bp_01_1113.pdf)
- [http://www.ieee802.org/3/bp/public/jul14/chini\\_3bp\\_01\\_0714.pdf](http://www.ieee802.org/3/bp/public/jul14/chini_3bp_01_0714.pdf)
- [http://www.ieee802.org/3/bp/public/sep14/chini\\_3bp\\_01a\\_0914.pdf](http://www.ieee802.org/3/bp/public/sep14/chini_3bp_01a_0914.pdf)

# mGig Auto PHY Tx Emission Requirements

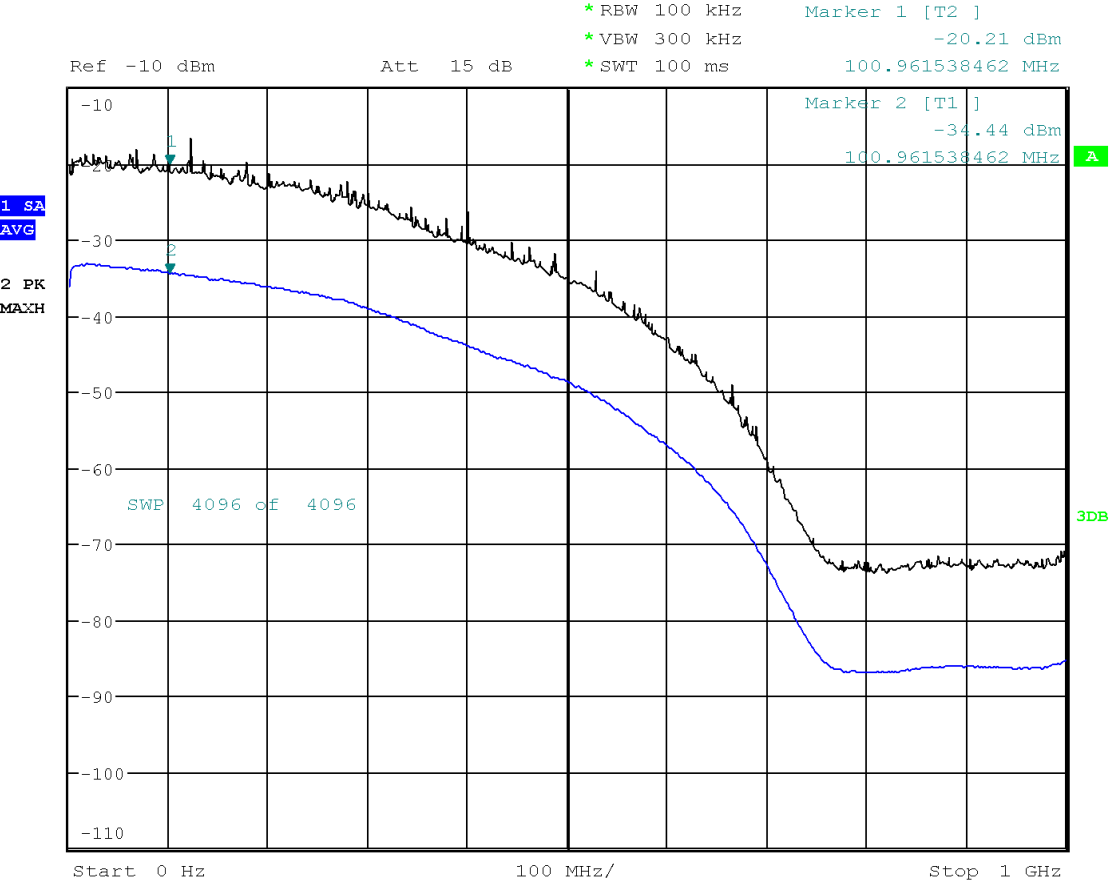
- 802.3ch defines coupling attenuation
  - $Coupling\ Attenuation(f) \geq \left\{ \begin{array}{ll} 70 & 30 \leq f \leq 750\ MHz \\ 50 - 20 \cdot \log_{10}\left(\frac{f}{7500}\right) & 750 \leq f \leq 5500\ MHz \end{array} \right\}$  dB
- Emission = TX-PSD Mask (dBUV) + Coupling Attenuation (dB)
  - [http://www.ieee802.org/3/ch/public/jan18/Pandey\\_3ch\\_01\\_0118.pdf](http://www.ieee802.org/3/ch/public/jan18/Pandey_3ch_01_0118.pdf)
- Does the limit stay at -142 dBm/Hz? Frequency Range?
  - For 1000BASE-T1: -142dBm/Hz up to 1GHz
- Based on “Peak” or RMS PSD measurements?
  - **With random data, the “PEAK” emission is not well defined. It is random and tends to increase along with duration of measurement.**
  - [http://www.ieee802.org/3/bp/public/nov13/dai\\_3bp\\_01\\_1113.pdf](http://www.ieee802.org/3/bp/public/nov13/dai_3bp_01_1113.pdf) considered whether the emission measurements should be based on RMS PSD.

# Measured Peak vs. RMS Tx PSD: 10GBASE-T Test Mode 5



- Self-synchronizing scrambler deg=58, DSQ128, LDPC
- PEAK-to-RMS  $\approx$  14.5dB after about 7 minutes

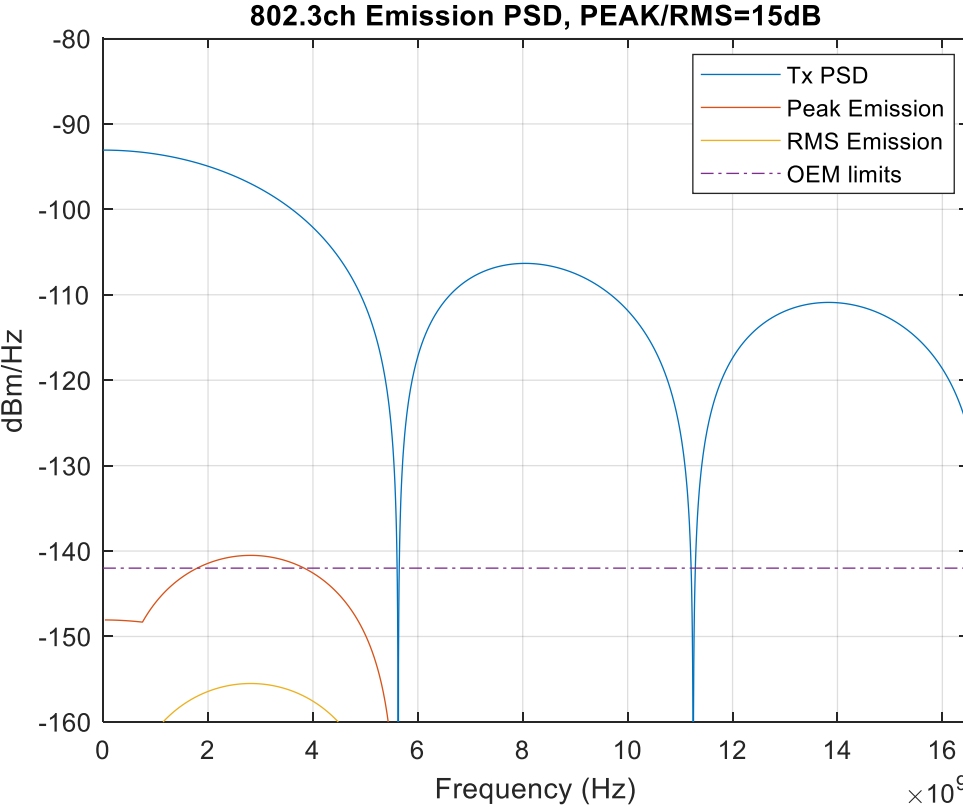
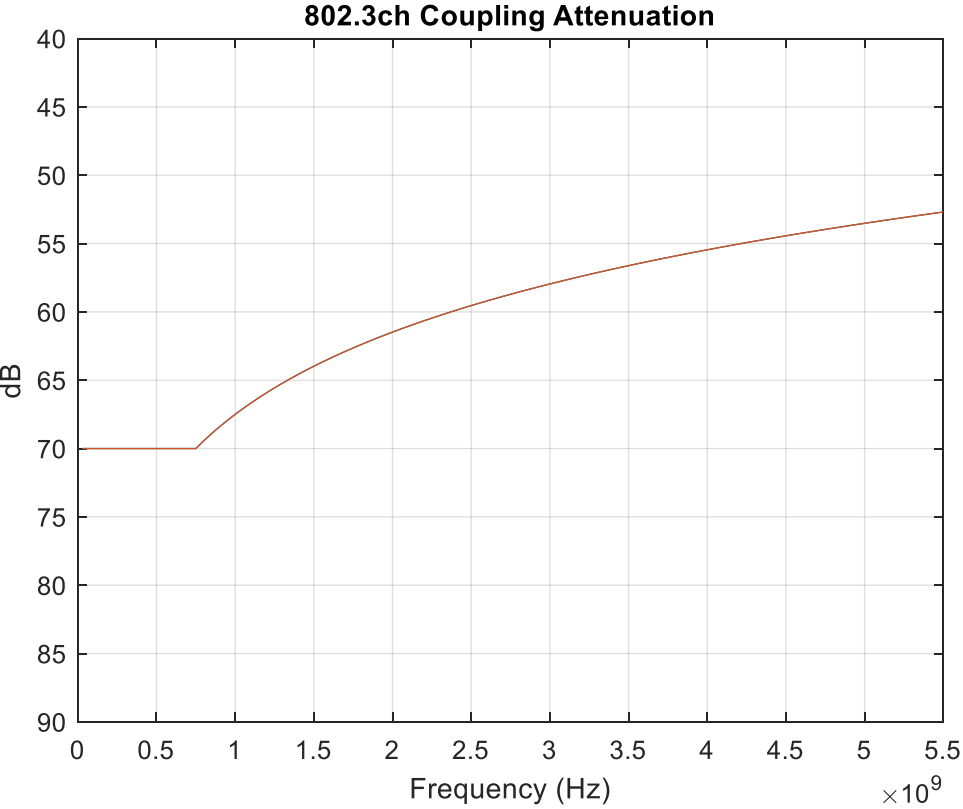
# Measured Peak vs. RMS Tx PSD: 10GBASE-T Test Mode 1



- Side-stream scrambler deg=33, PAM2
- PEAK-to-RMS  $\approx$  14.2dB after about 7 minutes

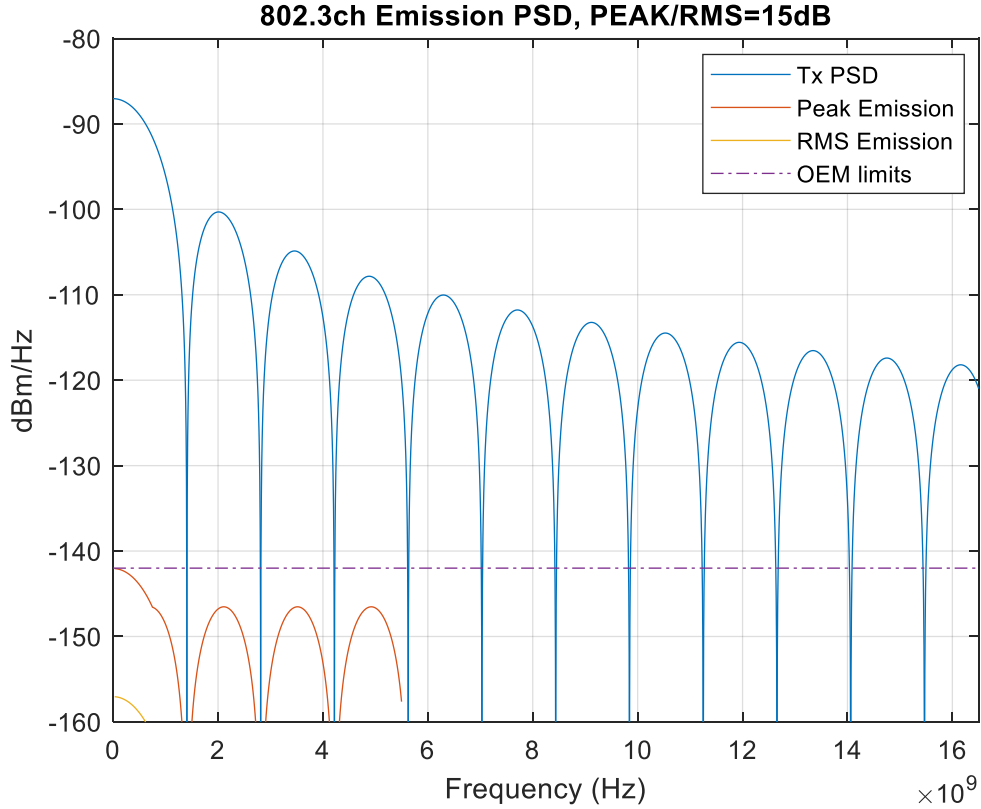
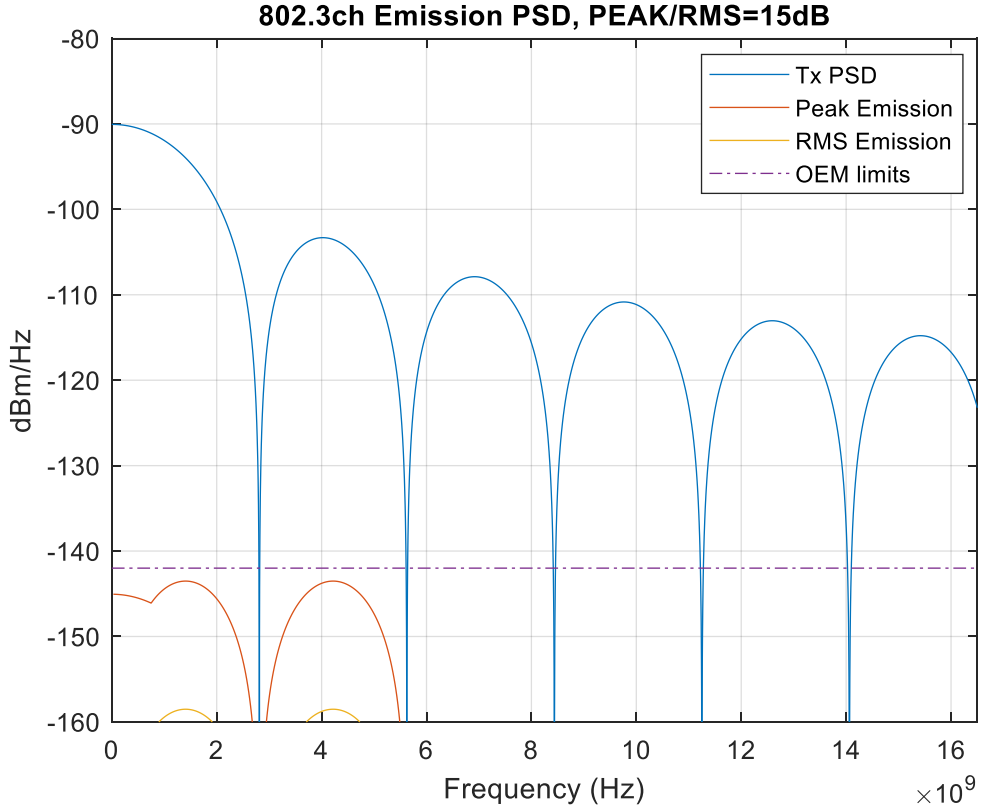


# Calculated 10GBASE-T1 Tx Emissions



- Assume 15dB PEAK-to-RMS ratio in TxPSD levels
- 2dB limit line violation near 3GHz

# Calculated 5G and 2.5GBASE-T1 Tx Emissions

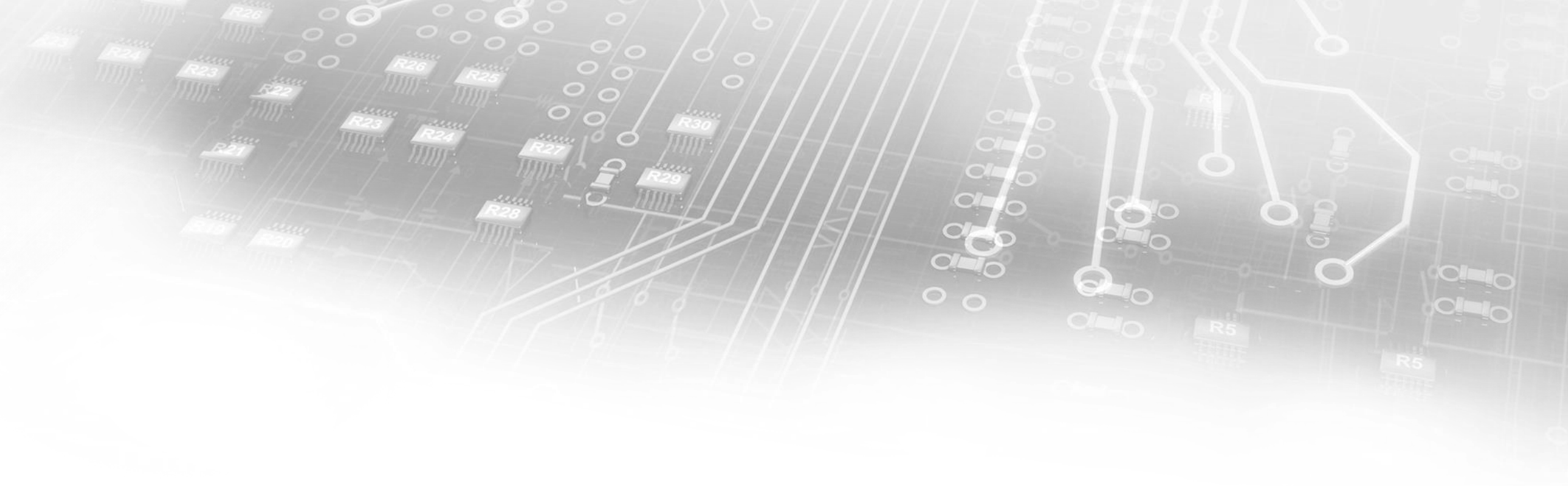


- For 2.5GBASE-T1, 0dB margin at low frequency

# Conclusions

- From Suján's contribution:
  - Emission = TX-PSD Mask (dBUV) + Coupling Attenuation (dB)
    - [http://www.ieee802.org/3/ch/public/jan18/Pandey\\_3ch\\_01\\_0118.pdf](http://www.ieee802.org/3/ch/public/jan18/Pandey_3ch_01_0118.pdf)
- Assume 15dB Peak-to-RMS Tx PSD ratio
- Assume the emission limit line stays at -142dBm/Hz across frequency range
- Apply coupling attenuation spec. as defined in Equation 149-9
- **Results**
  - **10GBASE-T1 peak emission exceeds the limit line by 2dB**
  - **2.5GBASE-T1 peak emission shows 0dB margin at low frequency**





# BACKUP SLIDES

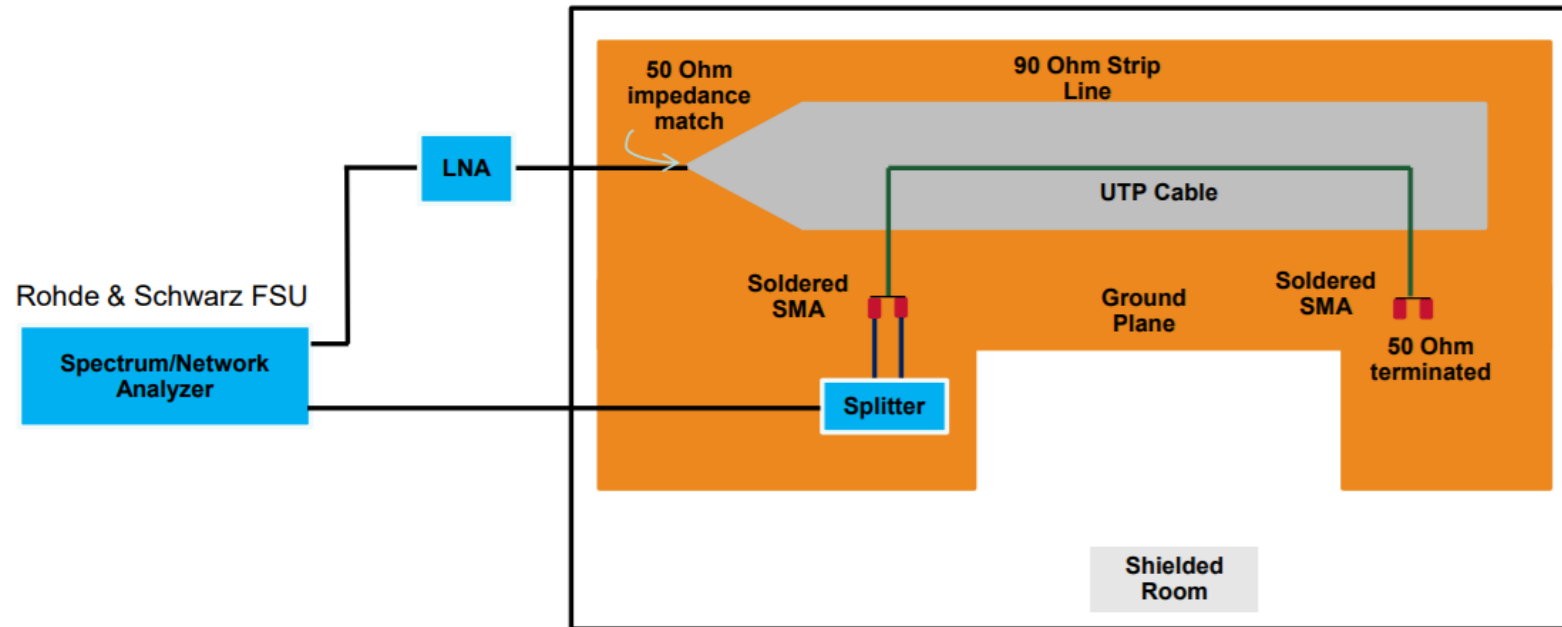
## 802.3bp Tx Emissions



# 802.3bp Emission Requirements

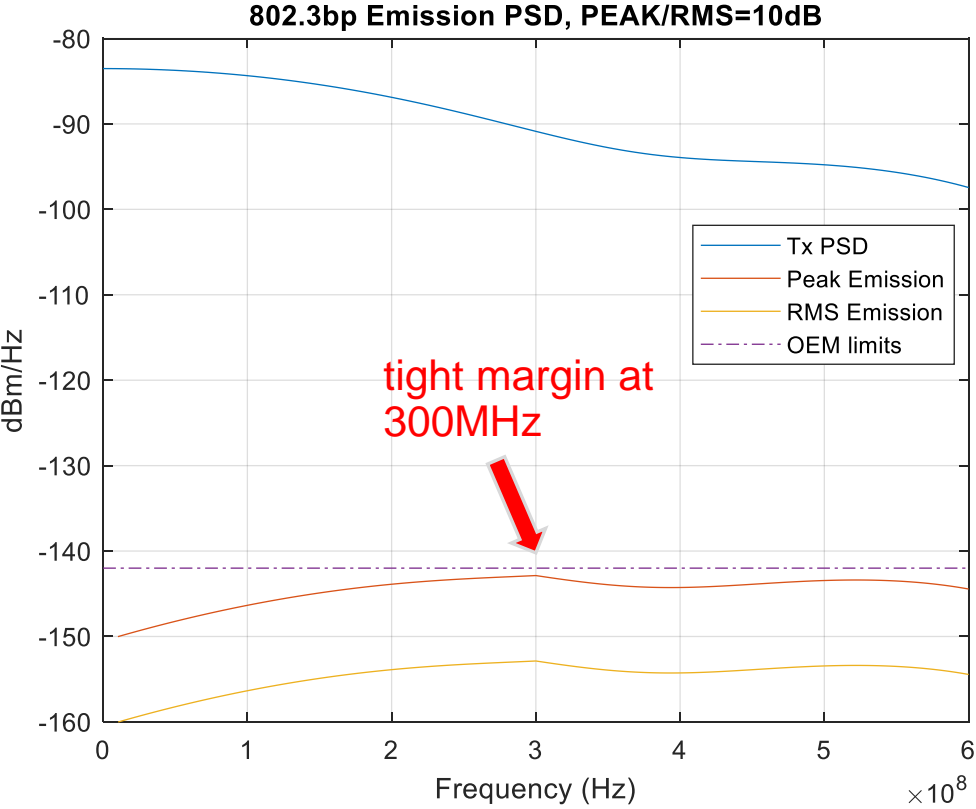
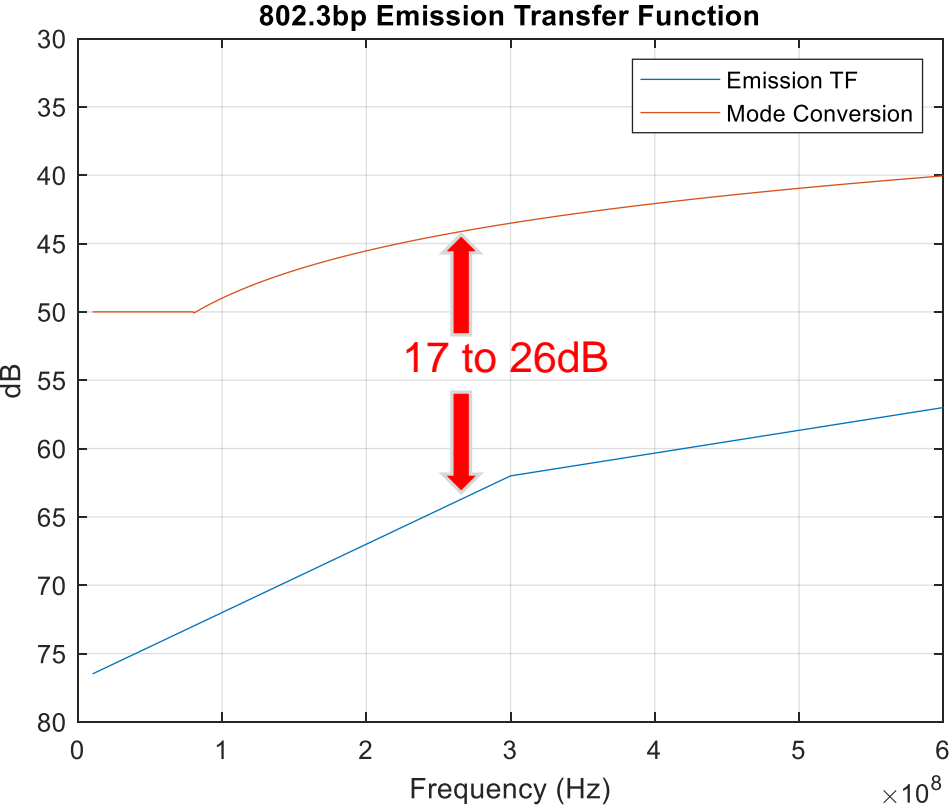
- OEM limit
  - Peak emission limit = 15dBuV in the frequency range of up to 1GHz
  - With 100kHz RBW, and 50 ohm → 15dBuV - 157 = **-142 dBm/Hz**
- Test configuration see next page
  - Based on strip line measurements with 2m UTP
  - Emission (dBm/Hz) = TX Power Spectrum (dBm/Hz) - Emission Transfer Function (dB)
- Emission Transfer Function
  - $ETF(f) \geq \left\{ \begin{array}{ll} 77 - \frac{f}{20} & 10 \leq f \leq 300 \\ 67 - \frac{f}{60} & 300 \leq f \leq 600 \\ 57 & 600 \leq f \leq 1000 \end{array} \right\}$  dB, f in MHz
- 97.6.1.4 Differential to common mode conversion
  - $ConversionLoss(f) \geq \left\{ \begin{array}{ll} 50 & 10 \leq f \leq 80 \\ 72 - 11.52 * \log_{10} f & 80 < f \leq 600 \end{array} \right\}$  dB, f in MHz
  - Applies to LCL, TCL, LCTL, and TCTL

# EMC Channel Modeling Setup



- The emission is determined by the mode conversion transfer function of the channel under test.
- 2m UTP cables were tested under the stripline.
- See CISPR 25 Ed. 3 2007/2008, Annex G for stripline construction.

# 802.3bp Emission



- Degree 15 data mode scrambler polynomials were selected to reduce TxPSD PEAK-to-RMS ratio