

# 10GBASE-T Transmit Parameters Proposal

**IEEE P803.2an Task Force  
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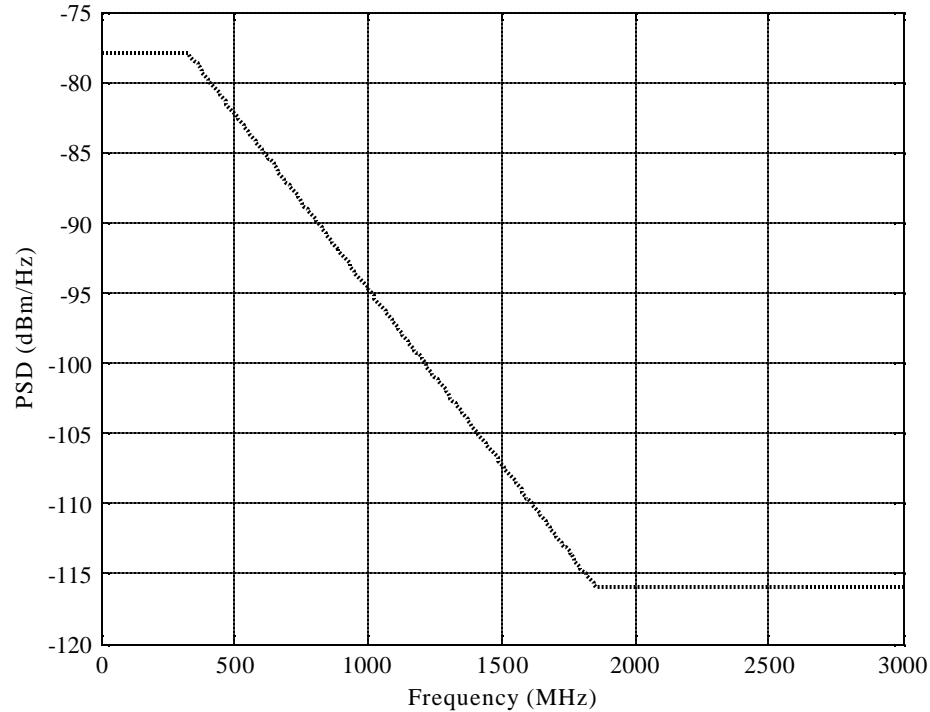
# Objectives

- **Compatible with FCC Class A and CISPR 22 Class A EMC Limits.**
  - PSD Mask provides an upper limit on the 10GBASE-T PSD.
  - TH Precoded PAM12 PSDs that comply with the proposed PSD Mask and Output Voltage/Power Specifications meet EMC limits.
  - Vendor discretionary power backoff or spectral shaping can provide additional EMC margin.
- **Compatible with 2 Vpp to 2.5 Vpp Output Voltage Range Based on PARs of 1.7 to 2.2.**
  - Upper limit of  $-78$  dBm/Hz from 1 MHz to 300 MHz

# Objectives

- **Compatible with Low-Complexity Transmit Filters.**
  - Transmit shaping is compliant with input return loss specifications.
  - Transmit shaping produces minimal PAR enhancement.
  - PSD Mask accommodates reasonable filter tolerances of  $\pm 10\%$  to  $\pm 20\%$ .
- **Compatible with Required SNR Operating Point for PAM-12**
  - $-116$  dBm/Hz PSD Mask floor above 1850 MHz

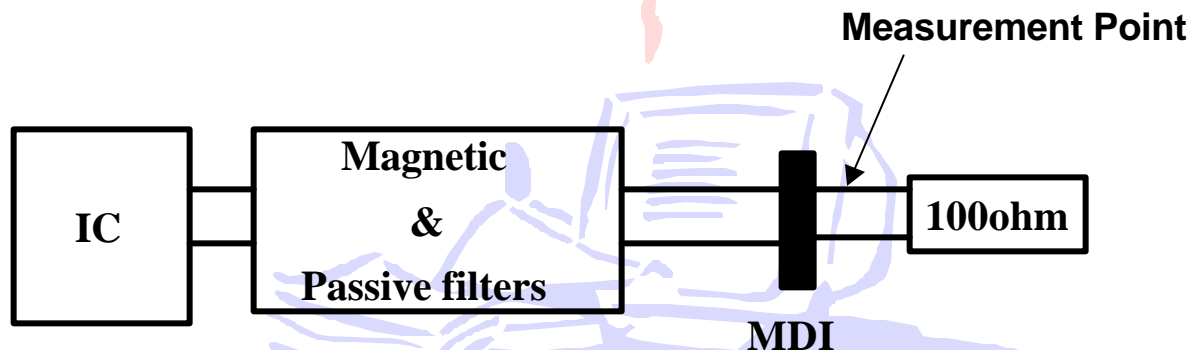
# Transmit PSD Mask Definition



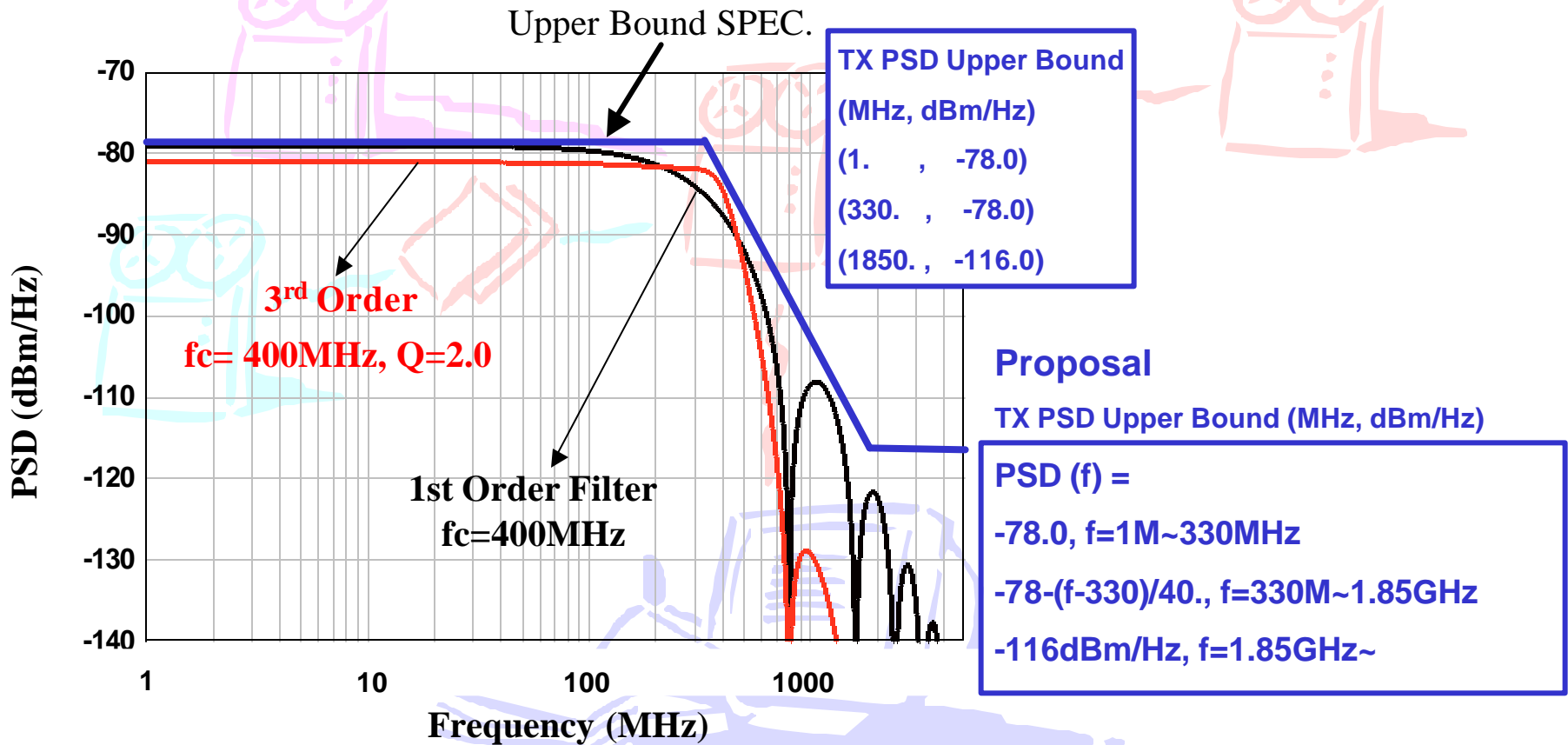
$$\text{PSD Mask}(f_{\text{MHz}}) = \left\{ \begin{array}{ll} -78 \text{ dBm/Hz}, & 1 \leq f \leq 330 \\ -78 - \left( \frac{f - 330}{40} \right) \text{ dBm/Hz}, & 330 < f \leq 1850 \\ -116 \text{ dBm/Hz}, & 1850 < f \leq 3000 \end{array} \right\}$$

# Other Major Transmit Parameters

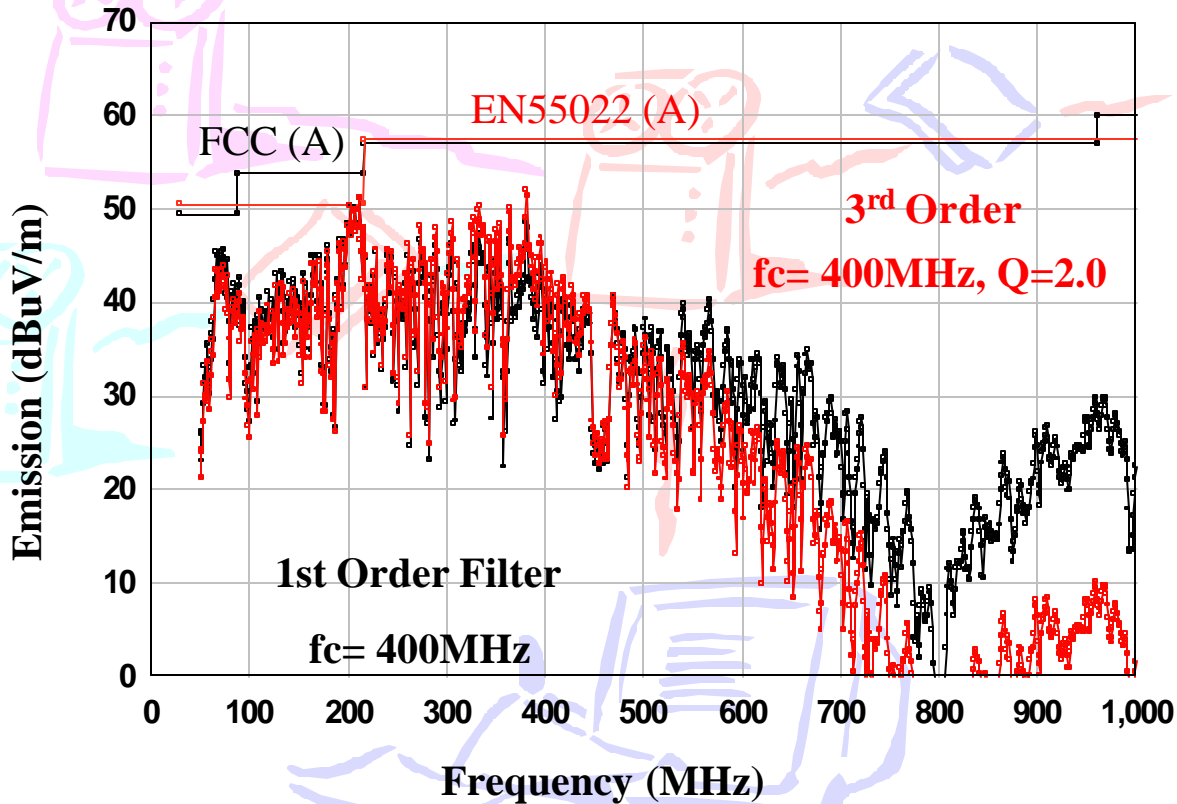
- **Average Transmit Power: 4.0 dBm to 5.5dBm.**  
(Excluding power backoff)
- **SNR: Equal or Greater than 36 dB.**
- **Time Domain Amplitude Template is Not Necessary.**



# Mask-Limited (Upper Bound) Tx PSDs

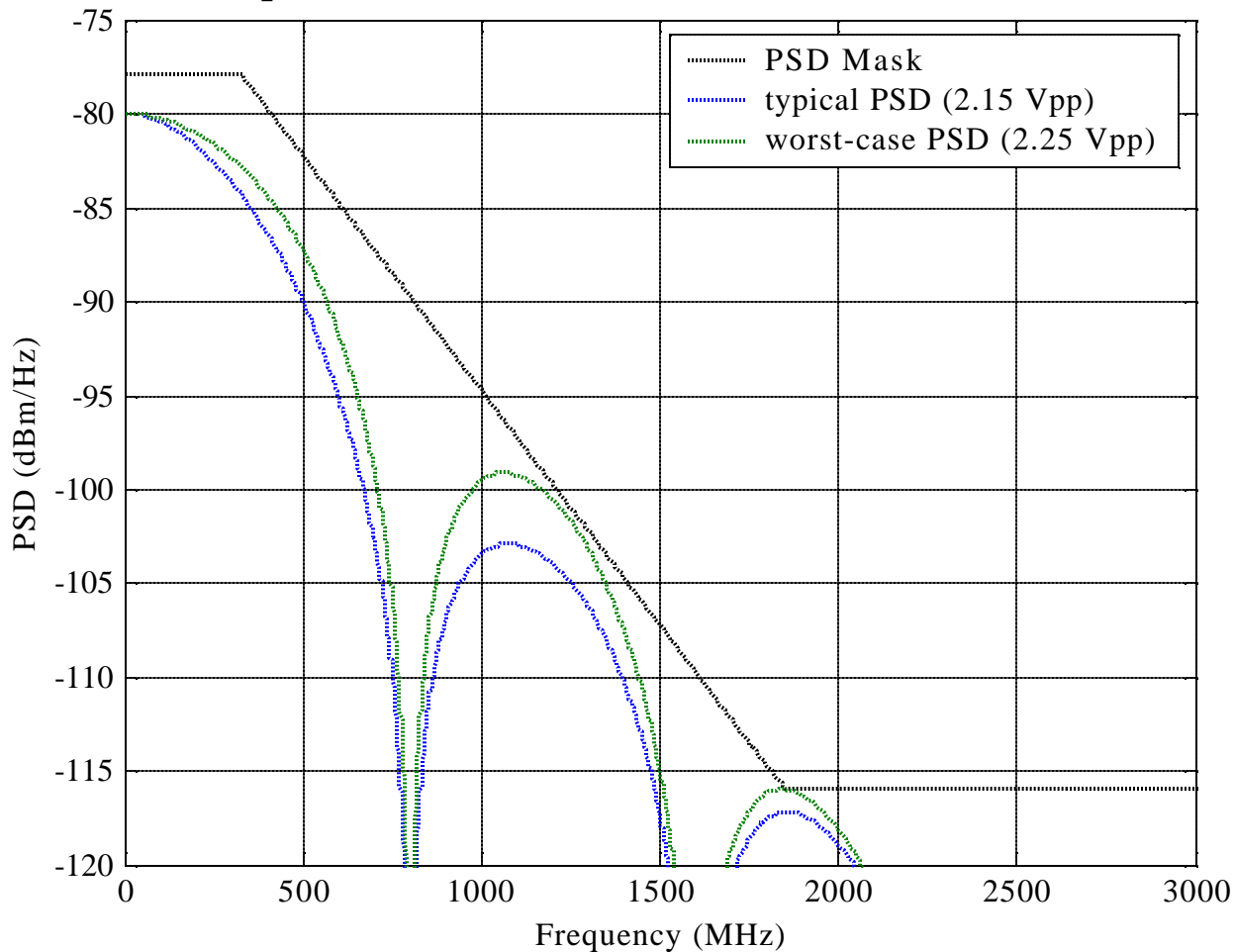


# EMI for Mask-Limited Transmit PSDs



# More Mask-Limited Transmit PSDs

Proposed 10GBASE-T PSD Mask versus Tx PSDs



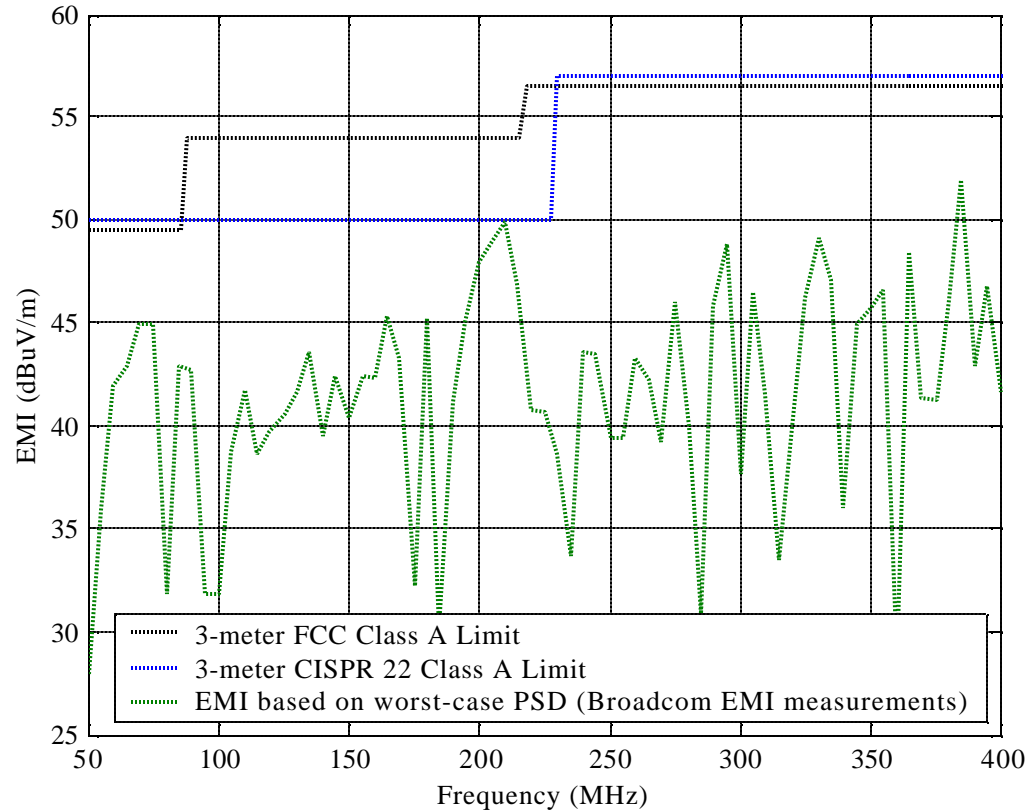


# Calculated PSD-Based EMI

- **EMI Measurements are Made with a Suitable Reference Transmit Waveform.**
  - Bandlimited Noise
  - Multi-Level PAM Signal
- **Reference Transmit Waveform is Calibrated Out of EMI Measurement to Produce Emission Gain Response.**
  - Frequency-dependent conversion factor from dBm/Hz to dBmV/m.
- **Emission Gain Response is Applied to PSD to Produce Calculated PSD-Based EMI.**
  - PSD is THP PAM12 spectrum compliant with PSD Mask.

# EMI for Mask-Limited Transmit PSD

Emissions Limits versus PSD-Based EMI

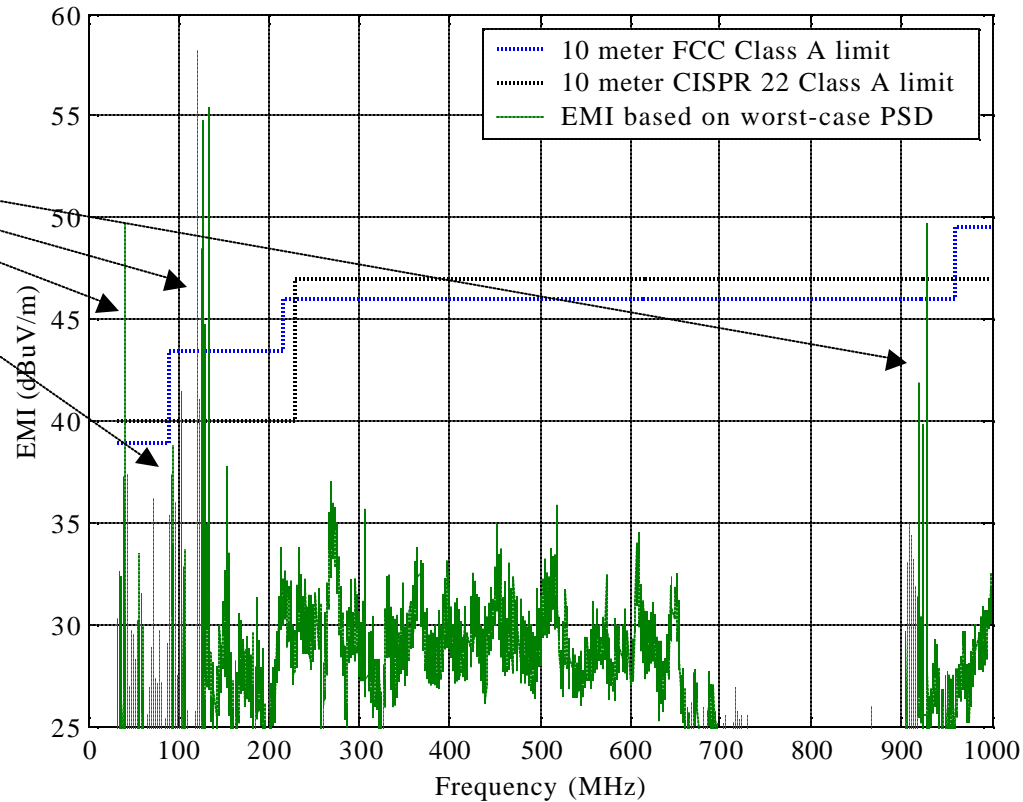


- **EMI Measurement on CAT6 Cable with Patch Panel**
  - Reference: 10GBASE-T PAM Scheme: Proposed Overall Architecture, Multi-Vendor Proposal (powell\_1\_0704)
- **Calculated EMI based on worst-case PSD**
- **10-meter FCC limit and 30-meter CISPR limit scaled to 3 meters**

# EMI for Mask-Limited Transmit PSD

Emissions Limits versus PSD-Based EMI

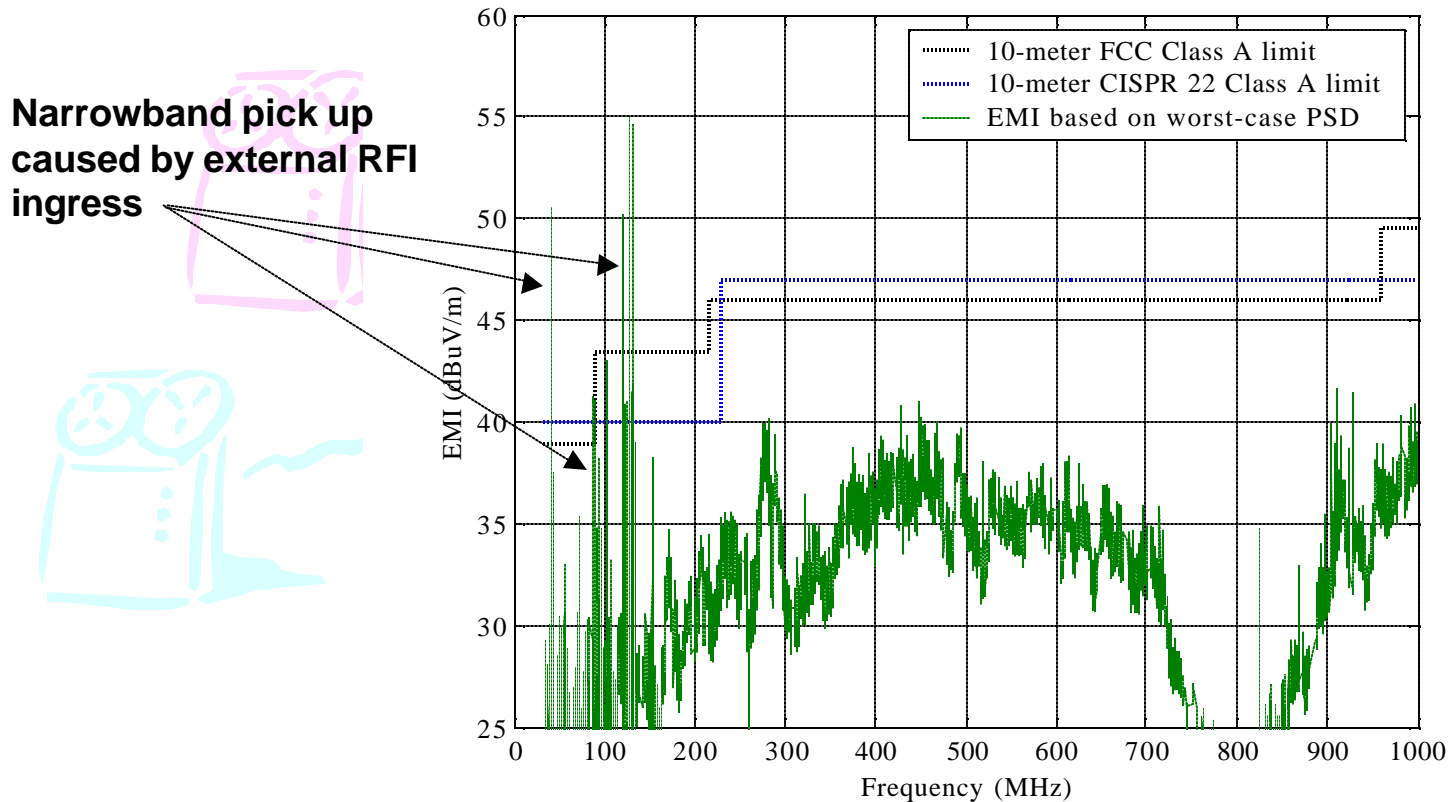
Narrowband pick up caused by external RFI ingress



- **EMI Measured on CAT5e Cable with CAT5e Keystone (patch panel) Jacks**
  - Previously unpublished Solarflare measurement (refined line interface and termination since earlier measurements -- cohen\_1\_0903)
- **Calculated EMI based on worst-case PSD**
- **30-meter CISPR limit scaled to 10 meters**

# EMI for Mask-Limited Transmit PSD

Emission Limits versus PSD-Based EMI



- **EMI Measurement on CAT5e Cable with CAT6 Keystone (patch panel) Jacks**
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## Conclusion

- **Proposed 10GBASE-T PSD Mask Complies with EMC Limits without Requiring Complex Transmit Shaping Filters.**
  - FCC Class A
  - CISPR 22 Class A
- **PSD Mask Serves as Upper Limit on TH Precoded PAM12 PSD.**
  - Additional EMI margin can be realized through passband shaping filters or power backoff
- **Average Transmit Power Range: 4.0 dBm to 5.5 dBm.**
- **PSD Mask is Compatible with Output Voltage and Return Loss Specifications.**