



10GBASE-T Tx PSD Mask Proposal

**IEEE P803.2an Task Force
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Objectives

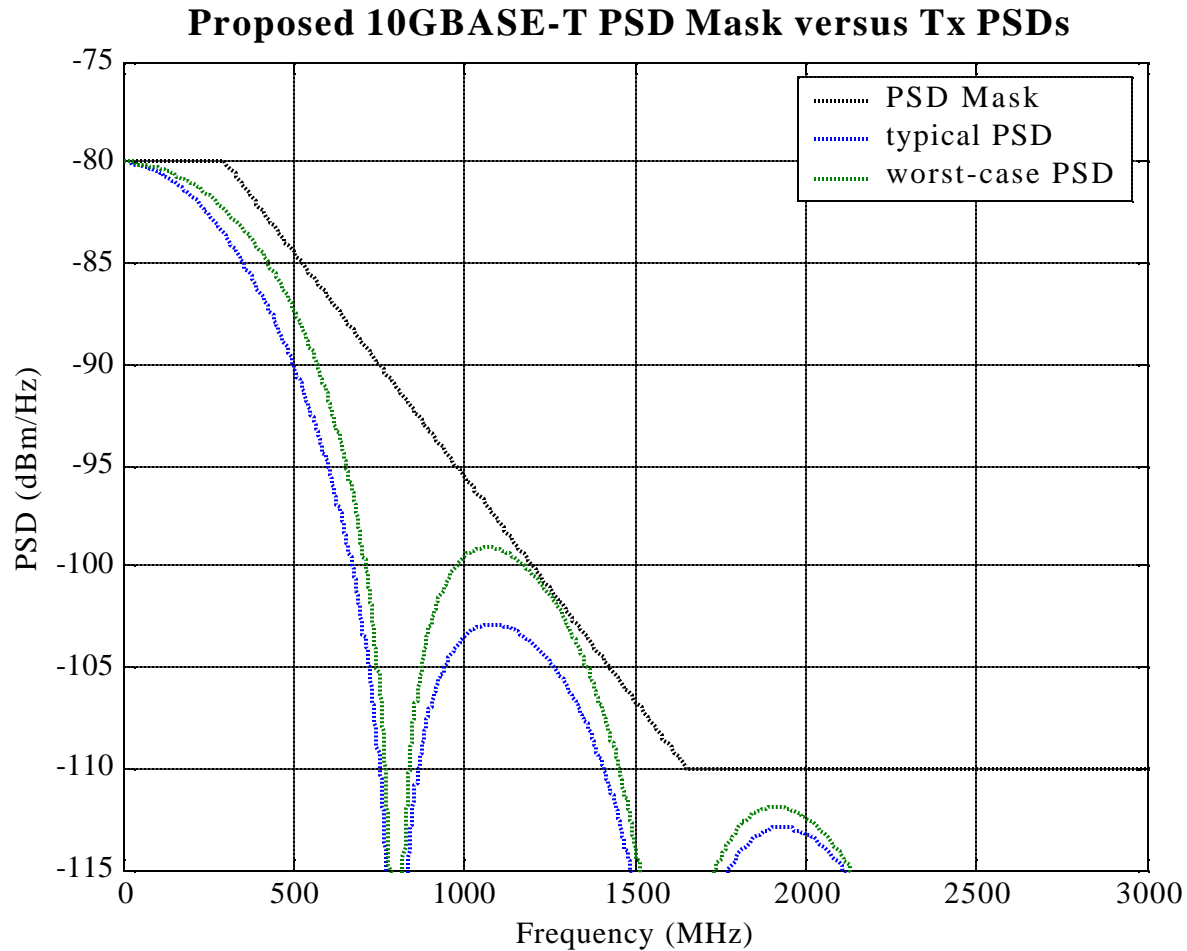
- **Compatible with FCC Class A and CISPR 22 Class A EMC Limits.**
 - PSD Mask provides an upper limit on the 10GBASE-T PSD.
 - TH Precoded PAM12 PSDs that comply with the proposed PSD Mask meet EMC limits.
 - Vendor discretionary power backoff or spectral shaping can provide additional EMC margin.
- **Compatible with 2 Vpp to 2.5 Vpp Output Voltage Range Based on PARs of 1.7 to 2.2.**
 - Upper limit of -80 dBm/Hz from 0 MHz to 300 MHz

Objectives

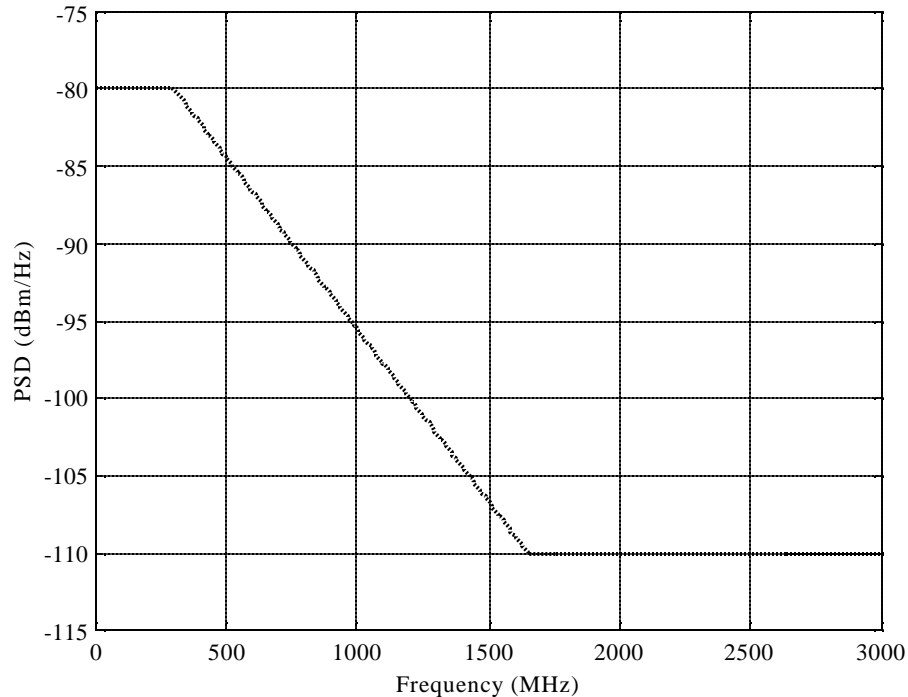
- **Compatible with Low-Complexity Transmit Filters.**
 - Transmit shaping is compliant with input return loss specifications.
 - Transmit shaping produces minimal PAR enhancement.
 - PSD Mask accommodates reasonable filter tolerances of $\pm 10\%$ to $\pm 20\%$.



Proposed 10GBASE-T PSD Mask



Tx PSD Mask Definition



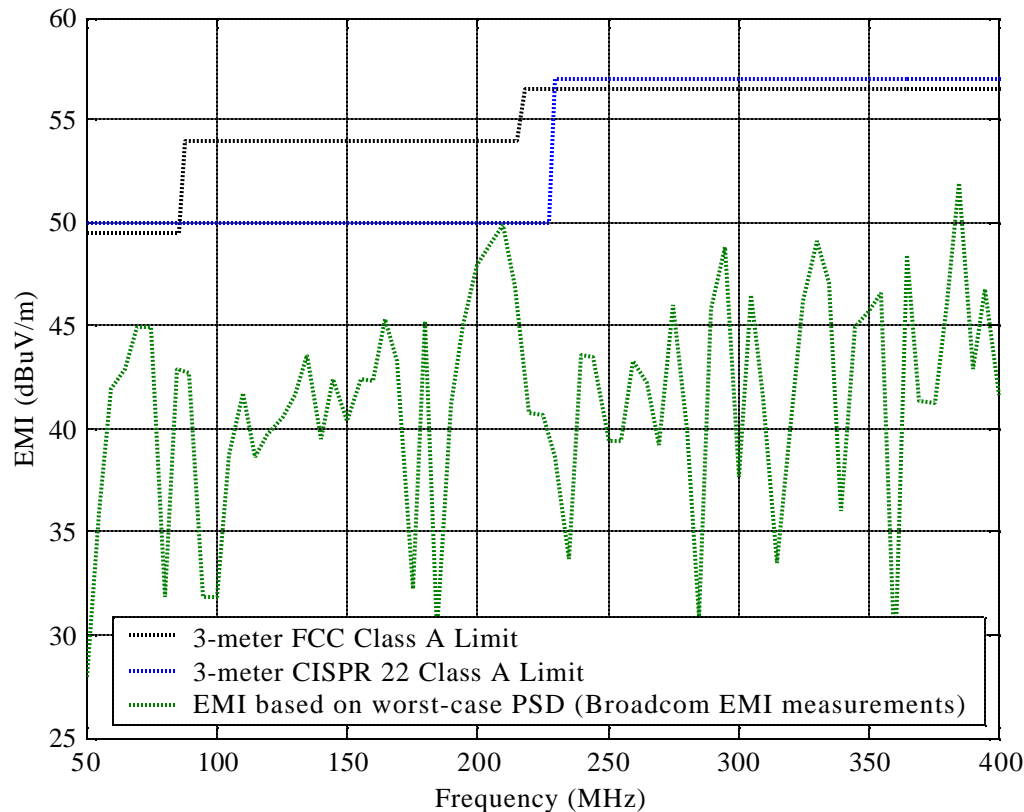
$$PSD\ Mask(f) = \left\{ \begin{array}{ll} -80\ dBm/Hz, & 1\ MHz \leq f \leq 300\ MHz \\ -80 - \left(\frac{f - 300}{45} \right) dBm/Hz, & 300\ MHz < f \leq 1650\ MHz \\ -110\ dBm/Hz, & 1650\ MHz < f \leq 3000\ MHz \end{array} \right\}$$

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.

PSD-Based EMI versus EMC Limits

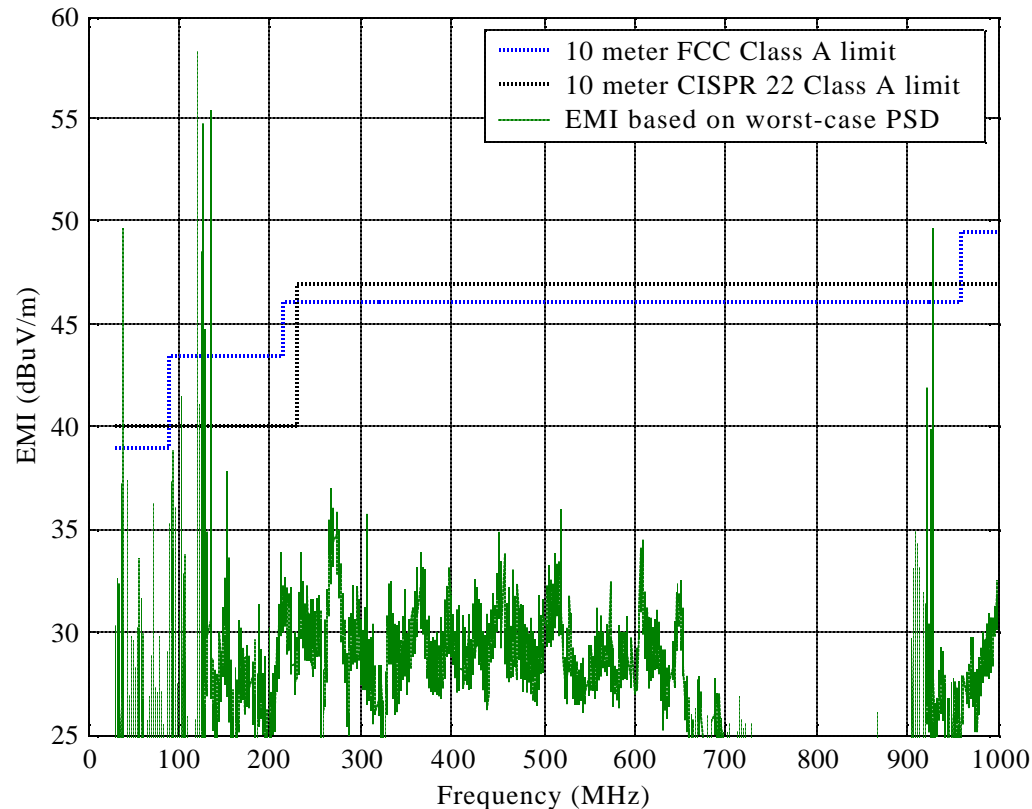
Emissions Limits versus PSD-Based EMI



- **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**

PSD-Based EMI versus EMC Limits

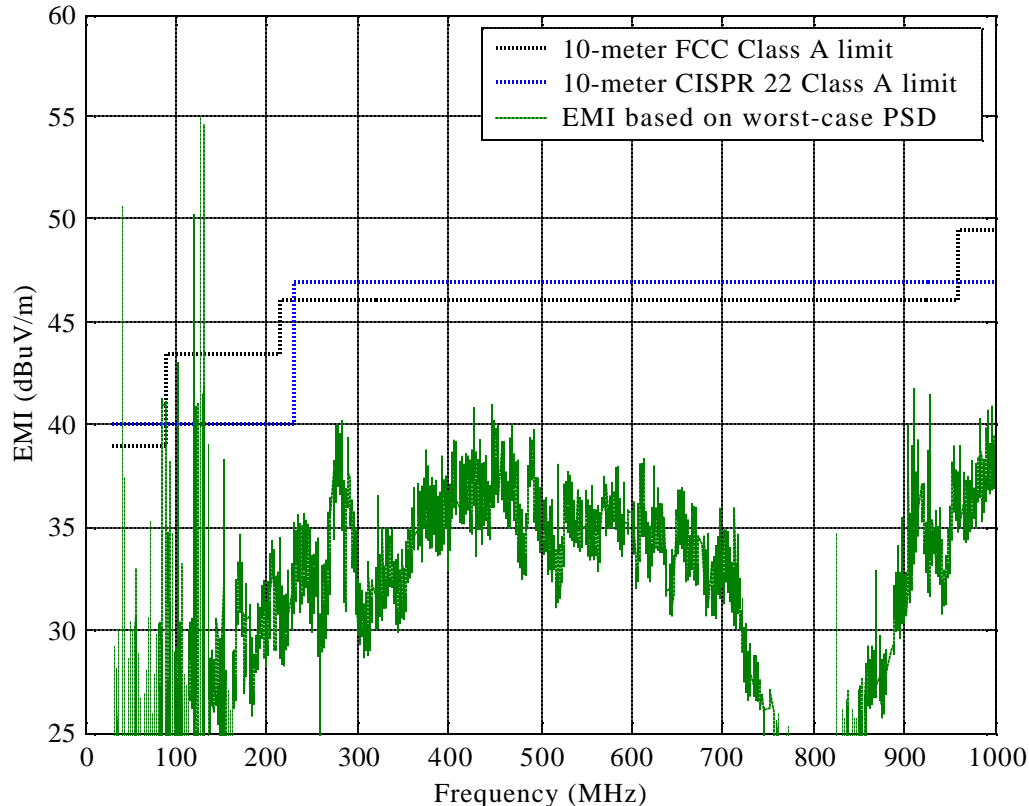
Emissions Limits versus PSD-Based EMI



- **EMI Measured on CAT5e Cable with CAT5e Keystone (patch panel) Jacks**
 - Previously unpublished Solarflare measurement
 - Ignore narrowband emissions (most likely caused by air traffic control ingress)
- **Calculated EMI based on worst-case PSD**
- **30-meter CISPR limit scaled to 10 meters**

PSD-Based EMI versus EMC Limits

Emission Limits versus PSD-Based EMI



- **EMI Measurement on CAT5e Cable with CAT6 Keystone (patch panel) Jacks**
 - Previously unpublished Solarflare measurement
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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
- **PSD Mask is Compatible with Output Voltage and Return Loss Specifications**