A Modeling & Measurement Technique for RTPGE EMC Channel Analysis

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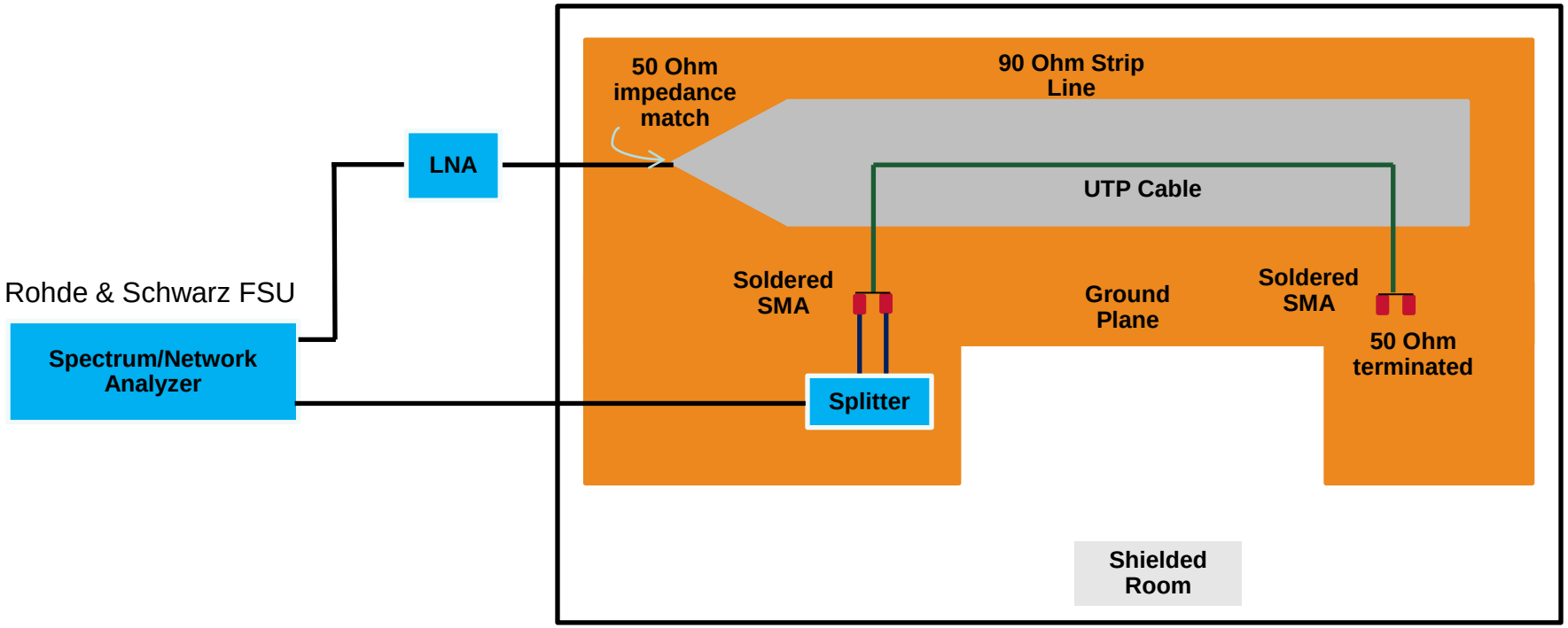
Outline

- Objectives
- EMC Channel Modeling Setup
- Correlation Results
- Channel Transfer Function Measurements
- Differential Transmit Mask Calculation
- Conclusions

Objectives

- Attain Emission Transfer Function for a Given Channel
- Compute & Estimate Peak Emission Spectrum
- Correlate Estimated Emission Spectrum to Direct Emission Measurement
- Develop a Emission Transfer Function Mask for Given RTPGE Channels
- Derive a Prototype Differential TX Mask

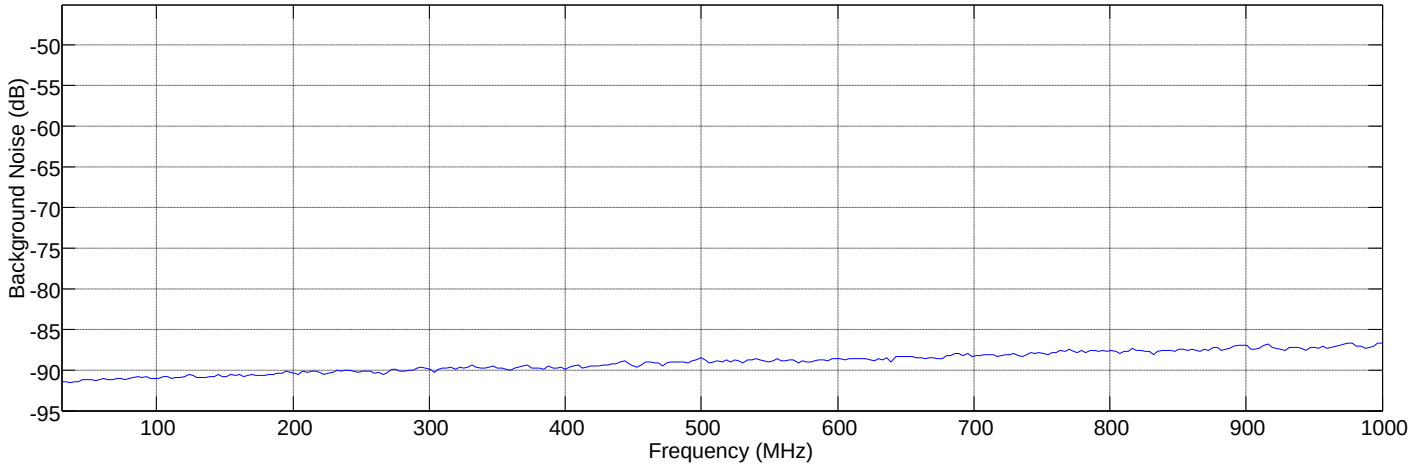
EMC Channel Modeling Setup



- 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.

Basic Assumptions

- All the components and test equipment must be properly decoupled from the channel under test.
- The background noise must be sufficiently below the target measurements.

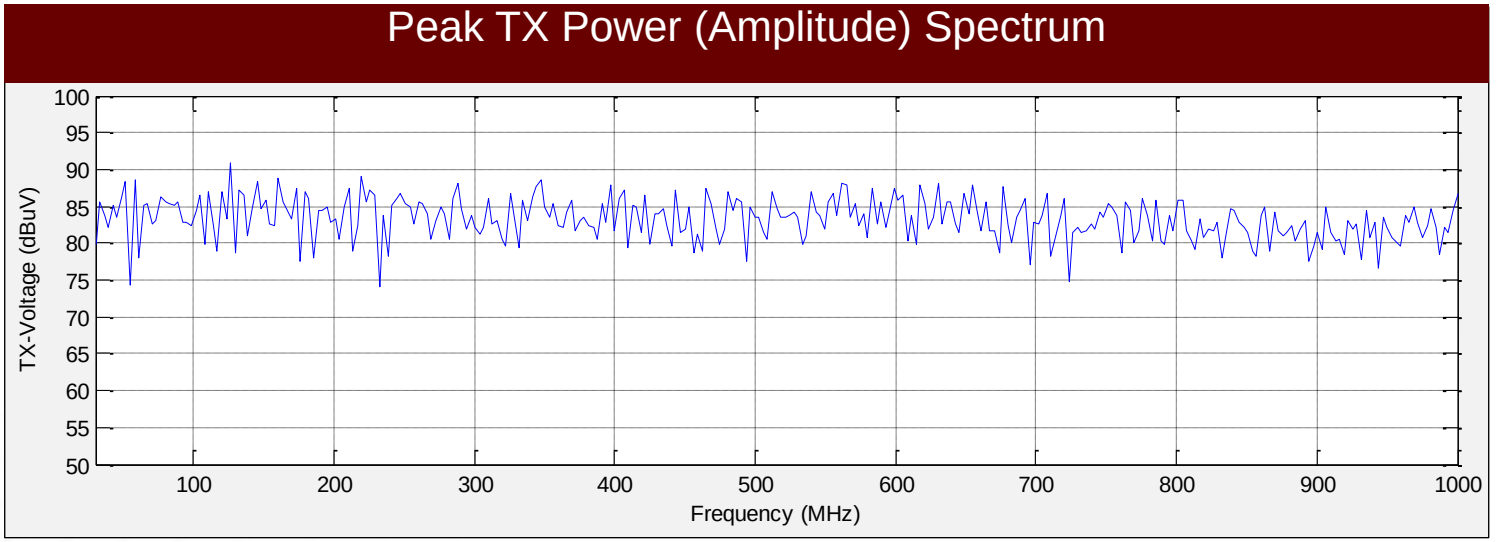


- The **peak emission spectrum** can be computed for a given/measured **TX peak power spectrum** and **emission transfer function** as the following:

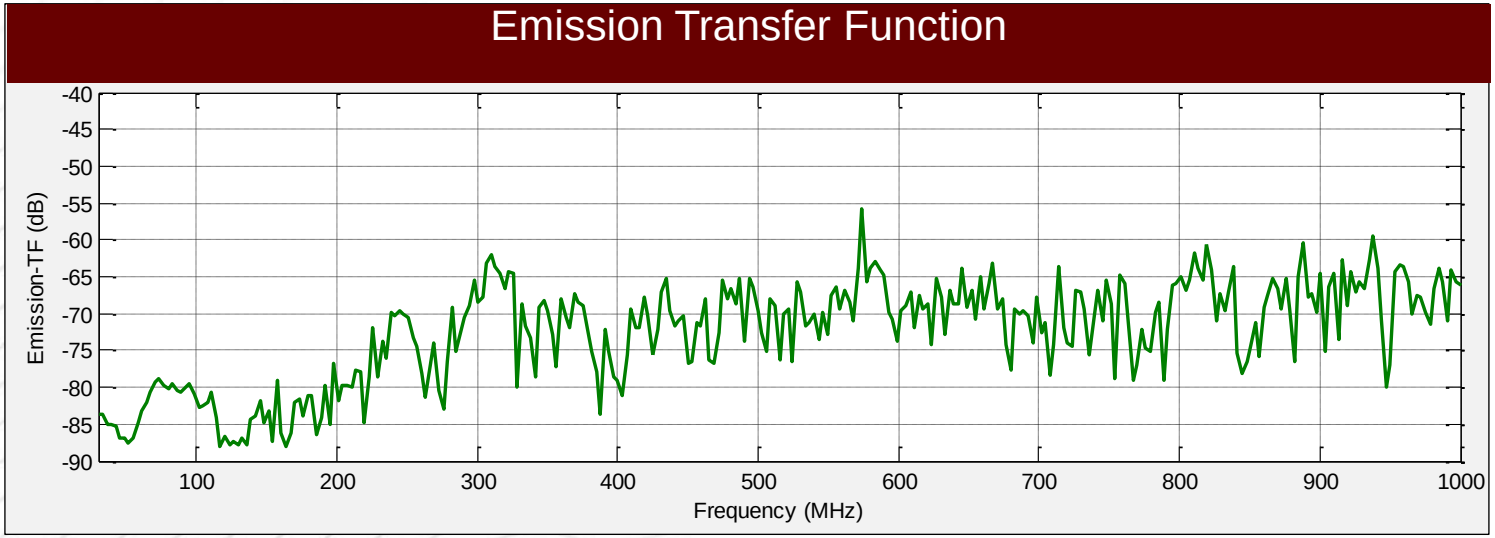
Emission (dBuV) = TX Power Spectrum (dBuV) + Emission Transfer Function (dB)

Peak Emission Estimation

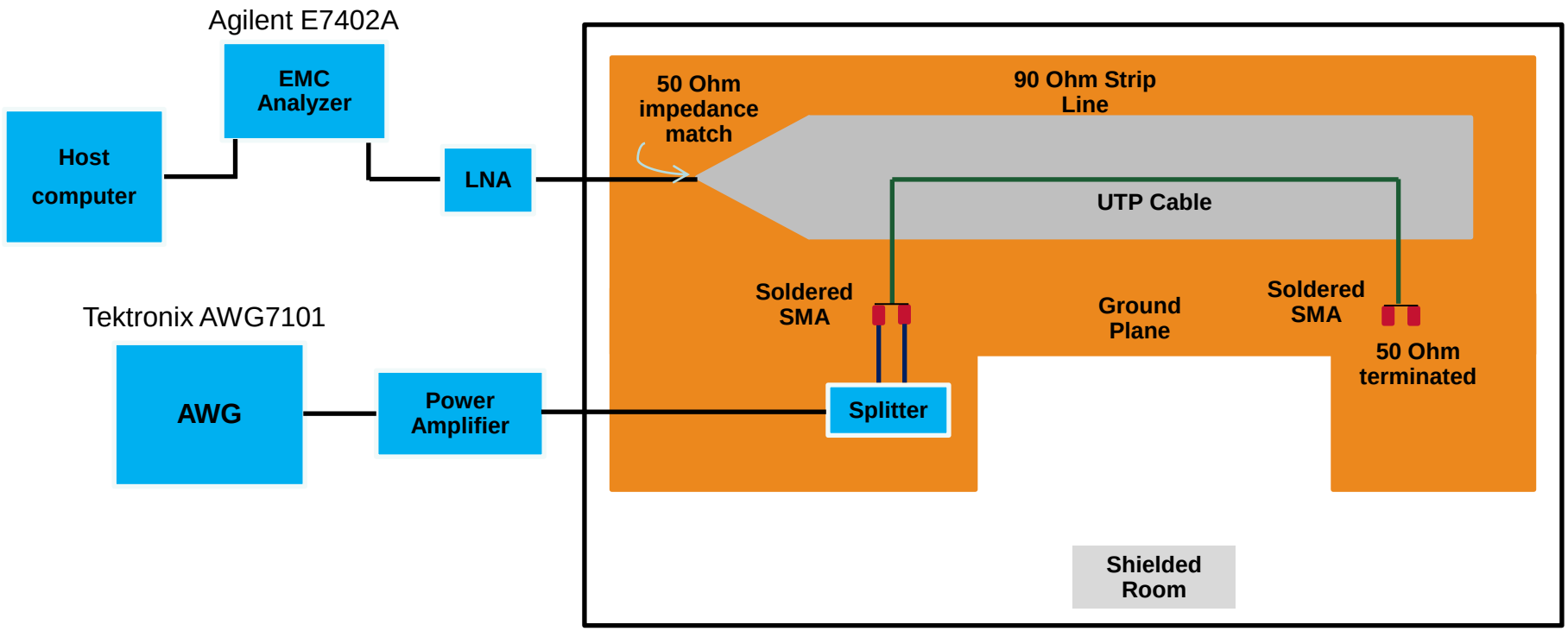
Broadband TX data, 2Vpp, (generated by AWG)



Emission Transfer Function Measured for a 2m UTP cable



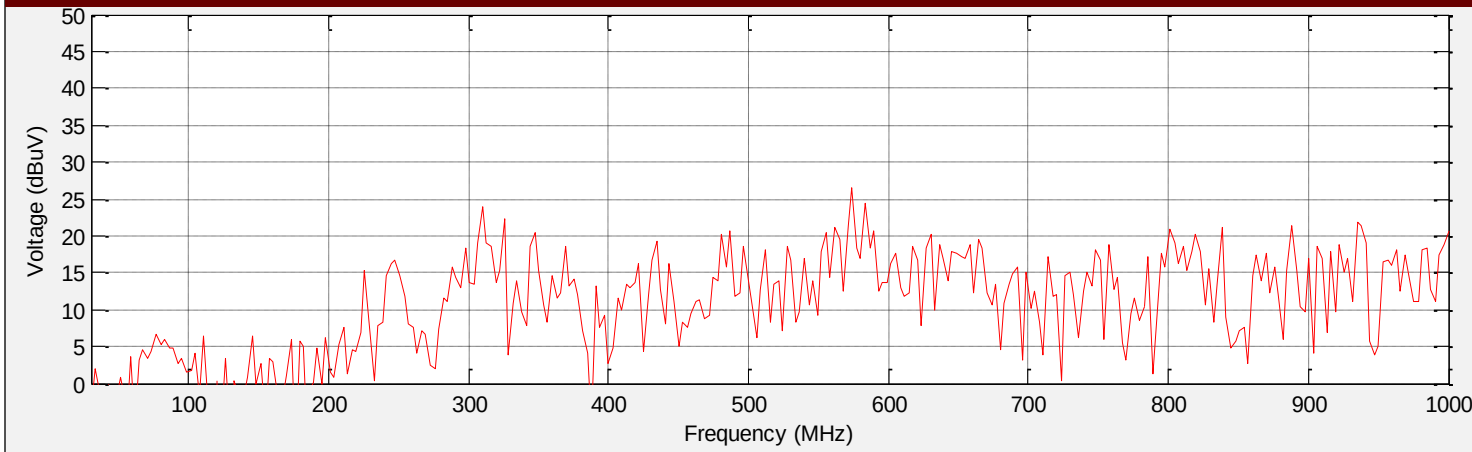
Direct Emission Measurement Setup



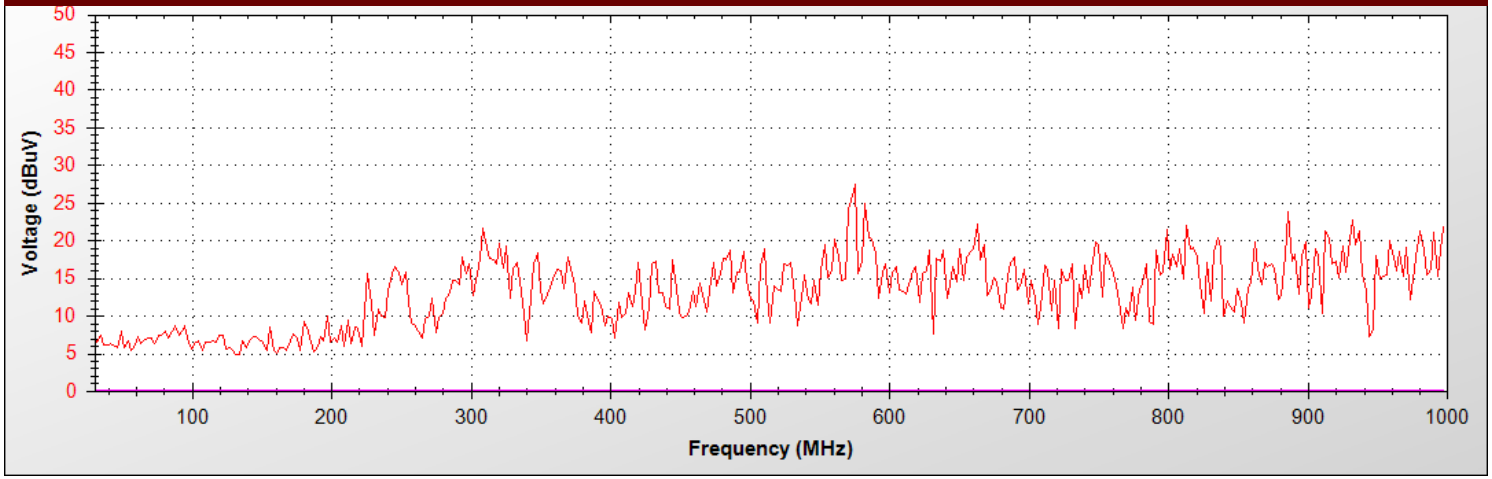
- AWG is used to generate various modulation schemes including a random broadband signal.
- Emission results are measured using EMC/Spectrum analyzer and recorded by the host computer.

Correlation Results

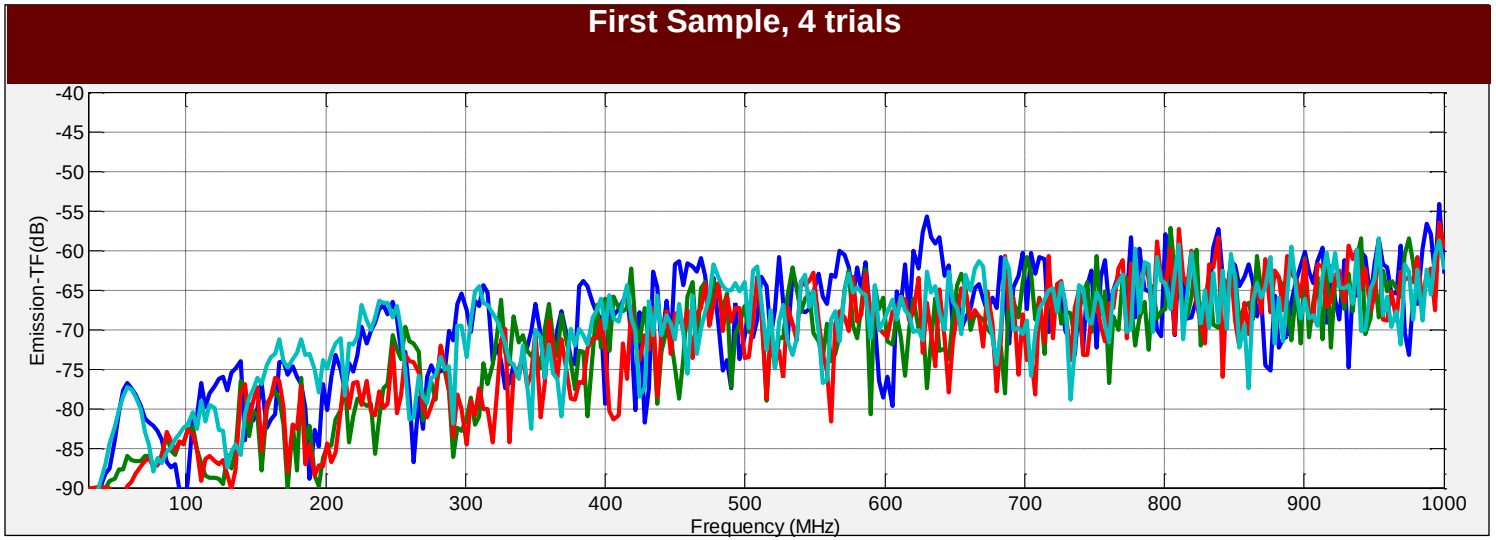
Peak Emission Estimation

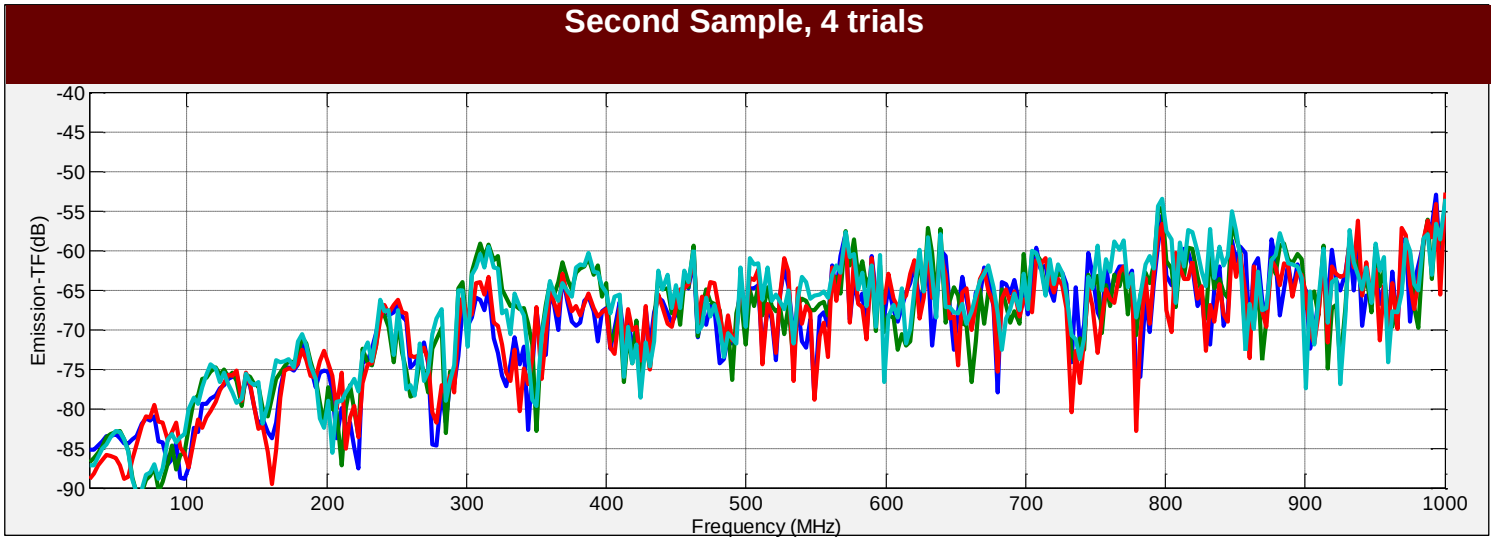


Direct Emission Measurement

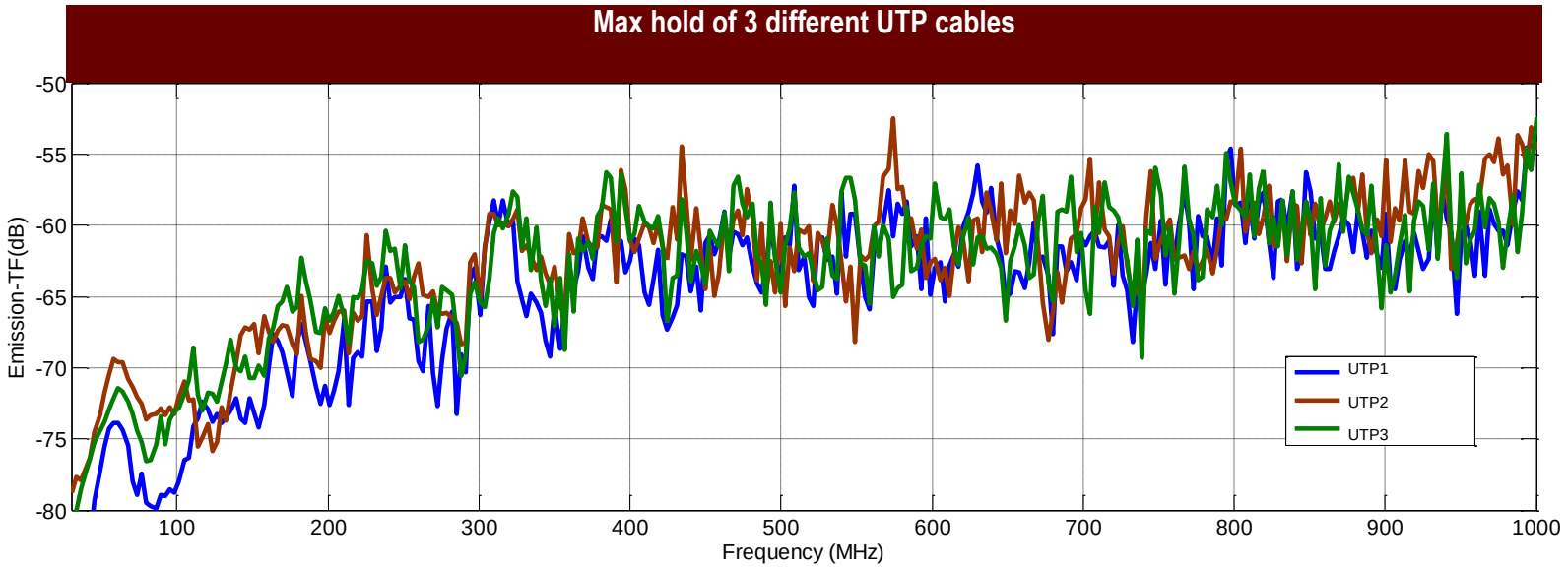


Emission Transfer Functions (same vendor)



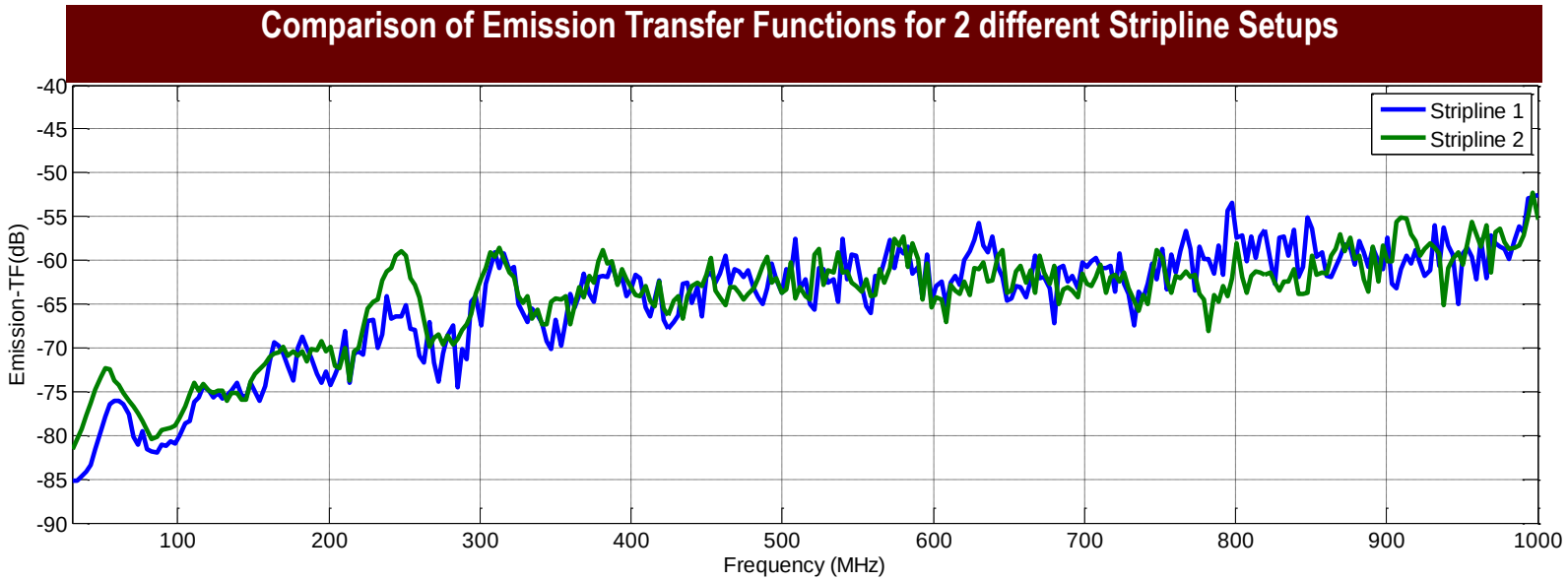


Emission Transfer Functions (different vendors)



- Each cable has 3 samples of 2m and laid out 4 times (12 captures)
- Each plot is from the maximum hold of 12 captures

How About Two Different Stripline Setups?



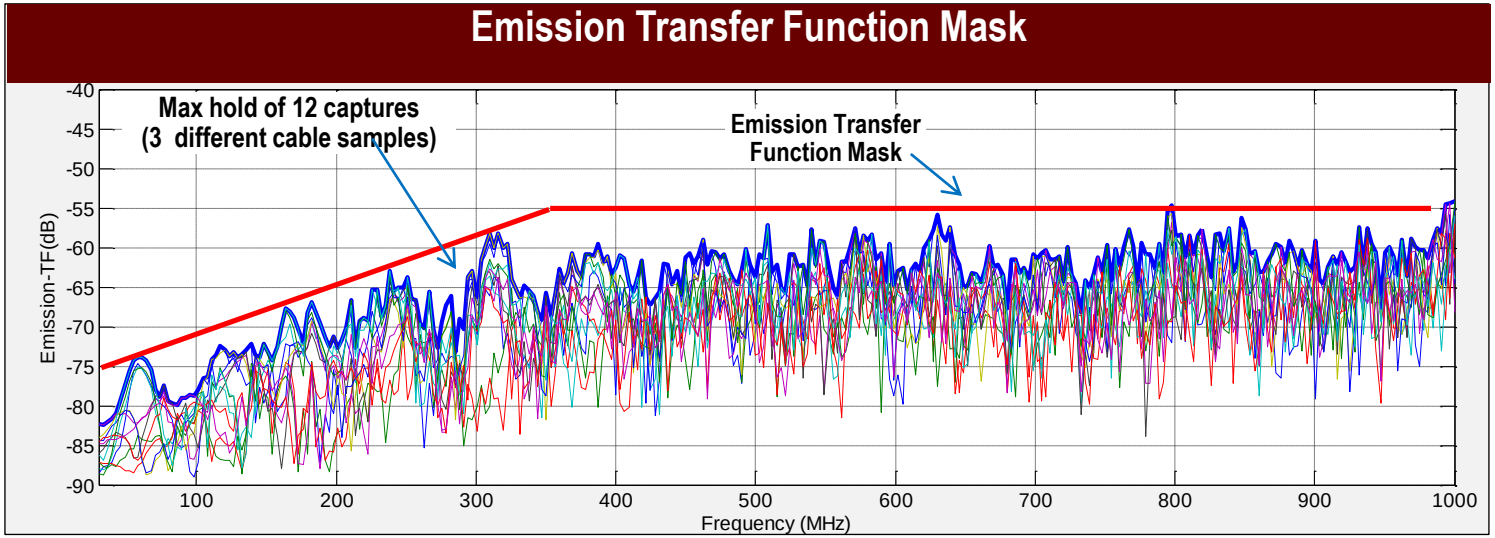
- 2 independent stripline setups were built compliant to CISPR25 and they have similar constructions.
- Same 2m UTP cable was tested in these different setups.

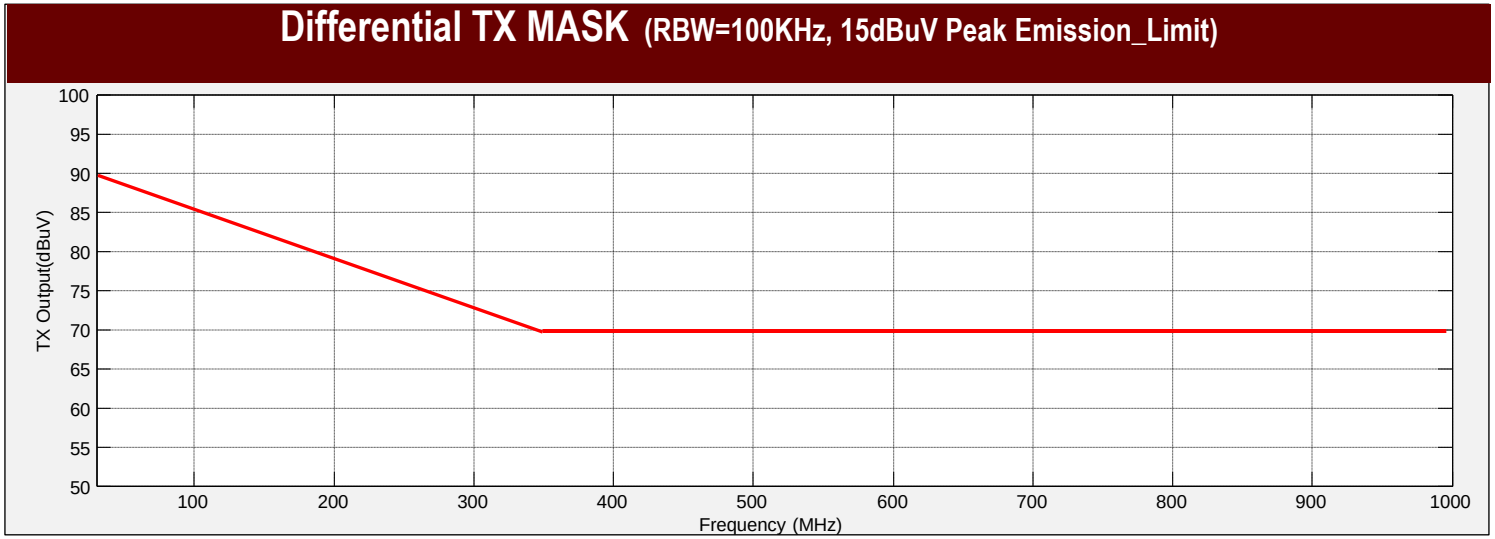
TX Mask Computation

- The emission transfer functions can be analyzed for various RTPGE channels and a statistical upper bound can be achieved for an emission transfer function mask.
- CISPR 25 provides emission limits for peak, quasi peak and average emissions.
- However, almost every OEM has its own limit for peak level emissions.
- In this presentation, based on a known OEM limit , a peak level of 15dBuV was chosen in the frequency range of up to 1GHz as emission limit.
- Therefore, a differential TX mask can be computed as the following:

TX MASK (dBuV) = Emission Limit (<=15dBuV) – Emission Transfer Function Mask (dB)

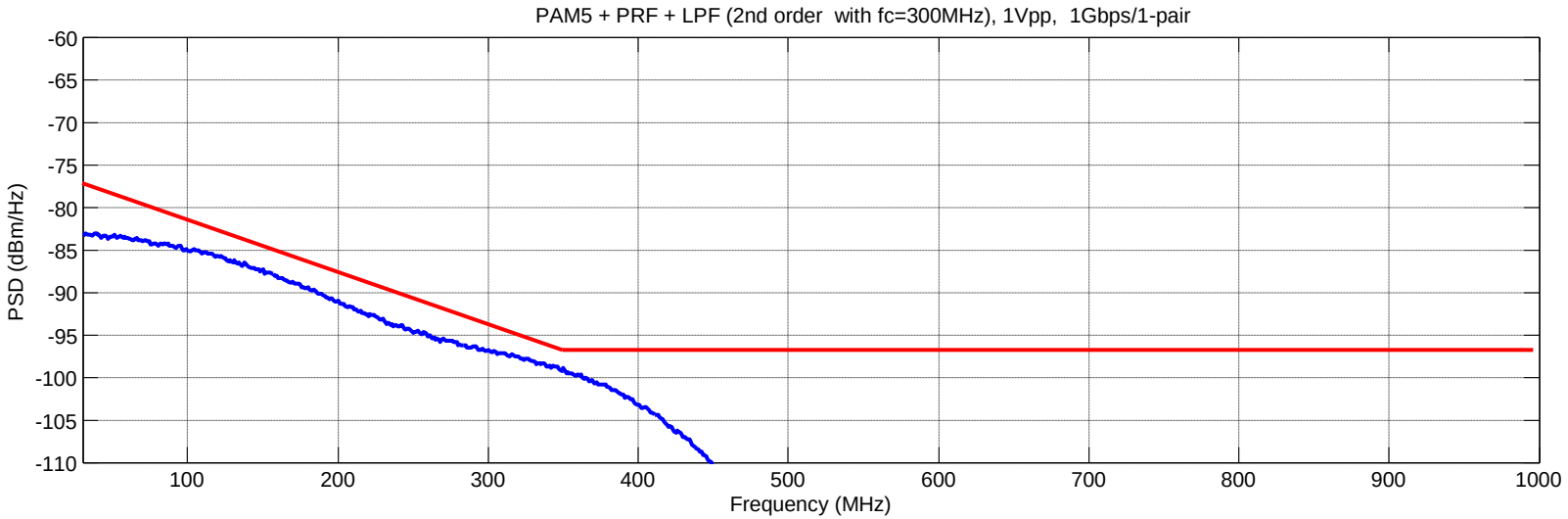
Differential TX Mask





Example: PAM5 modulation over 1-pair

- Using 1000BASE-T PAM5 (clocked 4x) over 1-pair, same PRF, 1Vpp (6dB power backoff) → 1Gbps/1-pair



Note: The unit dBUV is converted to dBm/Hz with RBW=100kHz

Conclusions

- A modeling and measurement technique is presented for RTPGE EMC channel analysis
- Given RTPGE channels, the emission transfer functions can be attained under a stripline test setup (compliant to CISPR 25 Ed.3)
- The emission transfer function depends on the channel (cable, connector and etc.). It is independent of particular modulation and detector type (peak, quasi peak or average) which allows a fair comparison of various modulation schemes using the same channel.
- We observed 5-10dB variations in the results for multiple cable cuts each being tested with multiple layouts. There was no variation for a fixed layout. Multiple captures yield to a emission transfer function mask for worst-case limit line
- A differential TX spectral mask is obtained based on emission transfer function mask and emission limit line. The most limiting emission level of 15dBuV was considered for this analysis.
- TX Mask suggests that 1Gbps solutions exist for UTP cables.
- Further analysis should be done with connectors and cables in order to complete this work.