T10/07-007r2

Proposed 6G SAS Phy Specs for EMI Reduction

Mike Jenkins

LSI Logic

Proposed Modified or Additional Specifications to Control EMI

- Differential to Common Mode Conversion (SCD11 & SCD22)
  - Constrains CM voltage generated from differential signal
  - Similar to "Impedance Balance" in SATA spec
- TX Common Mode Voltage
  - Convert from single RMS or peak voltage to a limit across frequency spectrum

Proposed Format of Specs

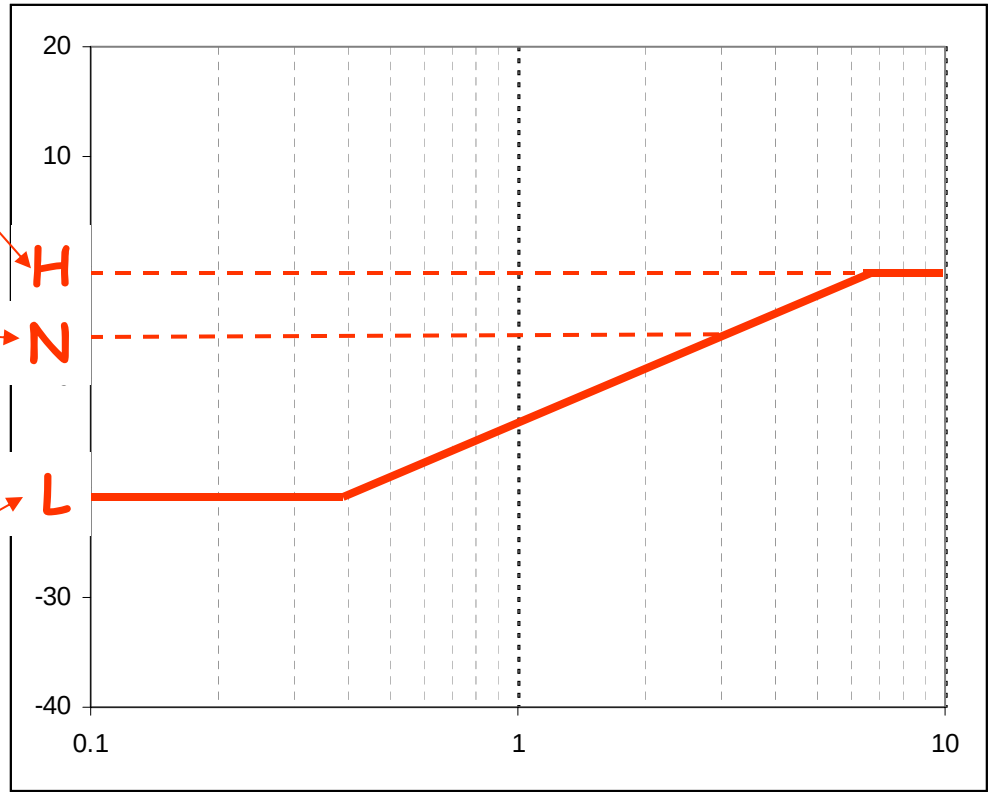
Measured Value < max [L, min [H, N + 13.3 log10(F/3GHz)]]

100 MHz < F < 6 GHz

H: Max value (high frequency asymptote)

N: Value at Nyquist frequency (3 GHz)

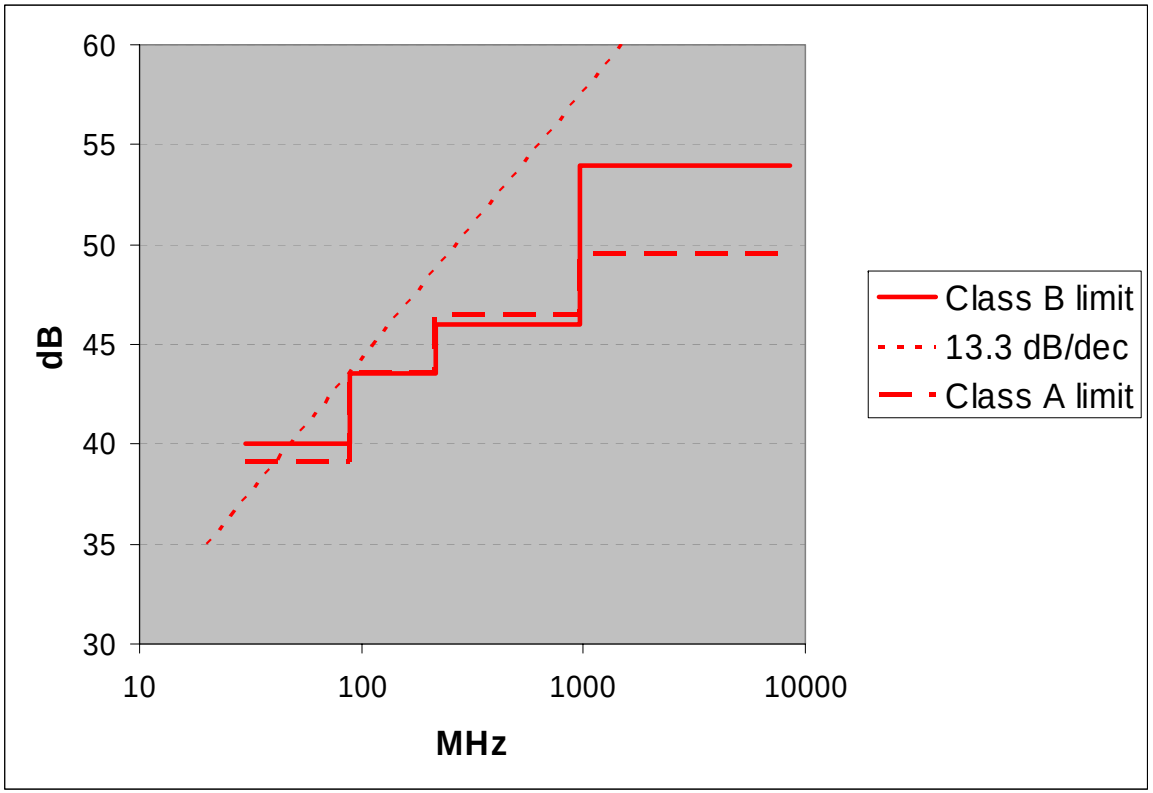
L: Min value (low frequency asymptote)



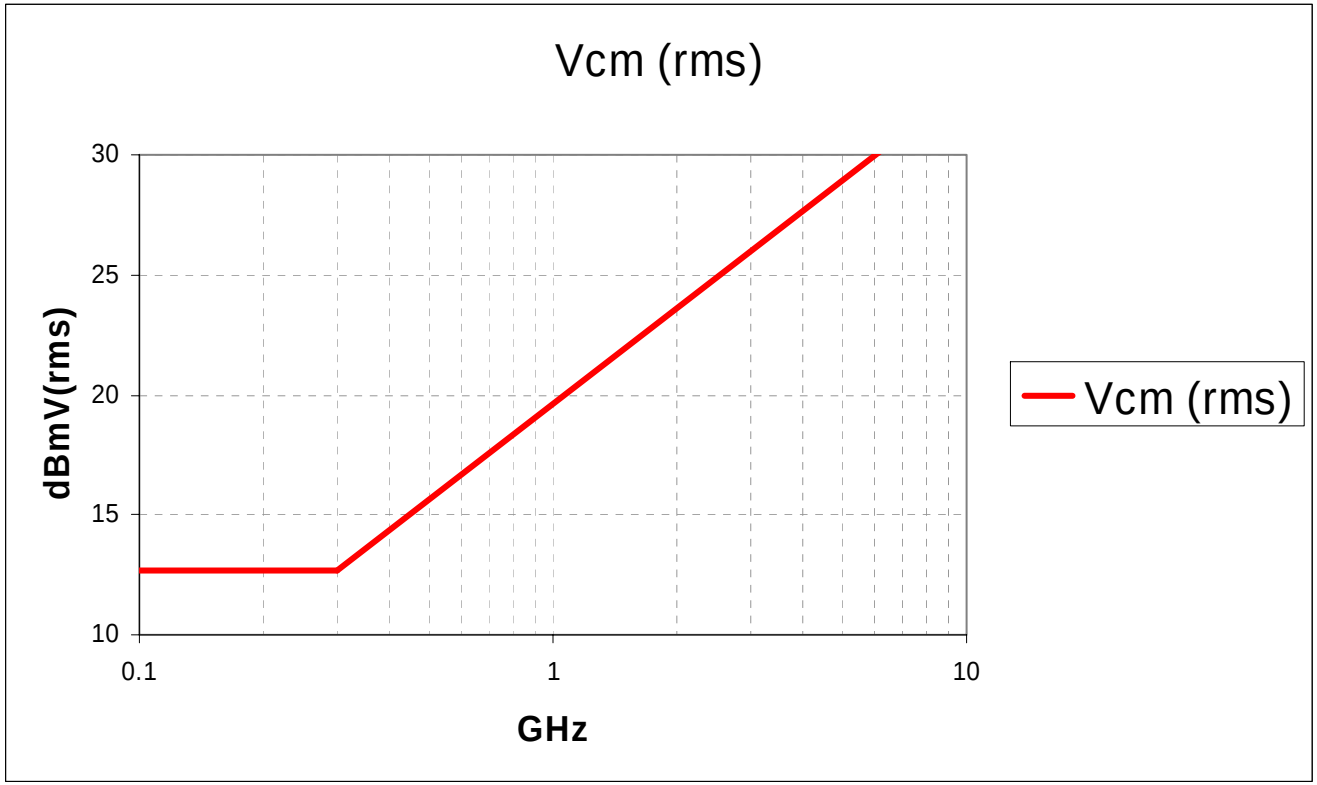
FCC Radiated Emissions Limits
(relative to 1uV/meter)

Mechanism for converting common mode noise into EMI is unknown, but EMI is assumed to be proportional to the noise that causes it.

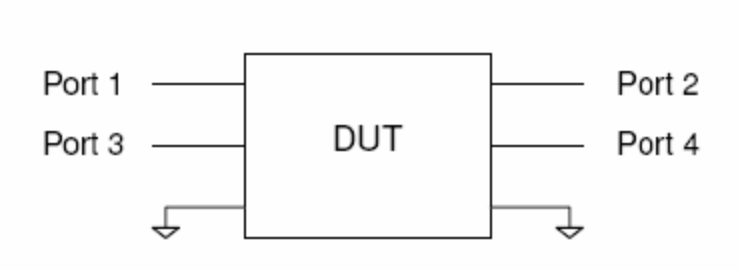
Hence, limit curve for each parameter (in dB) should reasonably track these Radiated Emission limits.



Proposed TX CM Voltage Limit
(L = 12.7 dBmV(rms), N = 26 dBmV(rms))



S-parameter Single-ended to Mixed Mode Conversion



Note: $S_{13} = S_{31}$ (reciprocal), so
SDC11 = **SCD11** = $(S_{11}-S_{33})/2$

SDD11 **SDC11**

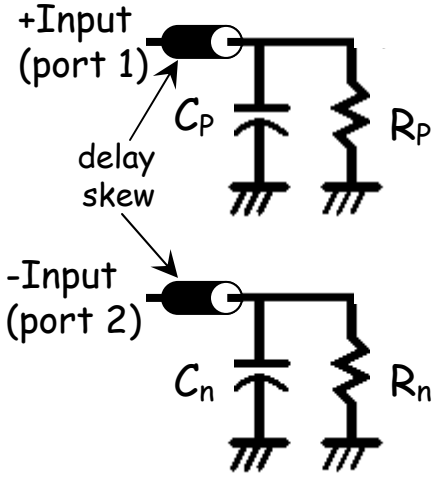
$$S_{mm} = \frac{1}{2}\begin{bmatrix} S_{11} - S_{13} - S_{31} + S_{33} & S_{12} - S_{14} - S_{32} + S_{34} & S_{11} + S_{13} - S_{31} - S_{33} & S_{12} + S_{14} - S_{32} - S_{34} \\ S_{21} - S_{23} - S_{41} + S_{43} & S_{22} - S_{24} - S_{42} + S_{44} & S_{21} + S_{23} - S_{41} - S_{43} & S_{22} + S_{24} - S_{42} - S_{44} \\ S_{11} - S_{13} + S_{31} - S_{33} & S_{12} - S_{14} + S_{32} - S_{34} & S_{11} + S_{13} + S_{31} + S_{33} & S_{12} + S_{14} + S_{32} + S_{34} \\ S_{21} - S_{23} + S_{41} - S_{43} & S_{22} - S_{24} + S_{42} - S_{44} & S_{21} + S_{23} + S_{41} + S_{43} & S_{22} + S_{24} + S_{42} + S_{44} \end{bmatrix}$$

SCD11 **SCC11**

For derivation of conversion to mixed mode parameters, see (for example):
http://www.simtech.a-star.edu.sg/Research/TechnicalReports/TR04JT03.pdf

Proposed SCD11, SCD22 Limit
(L = -26dB, N = -12.7dB)

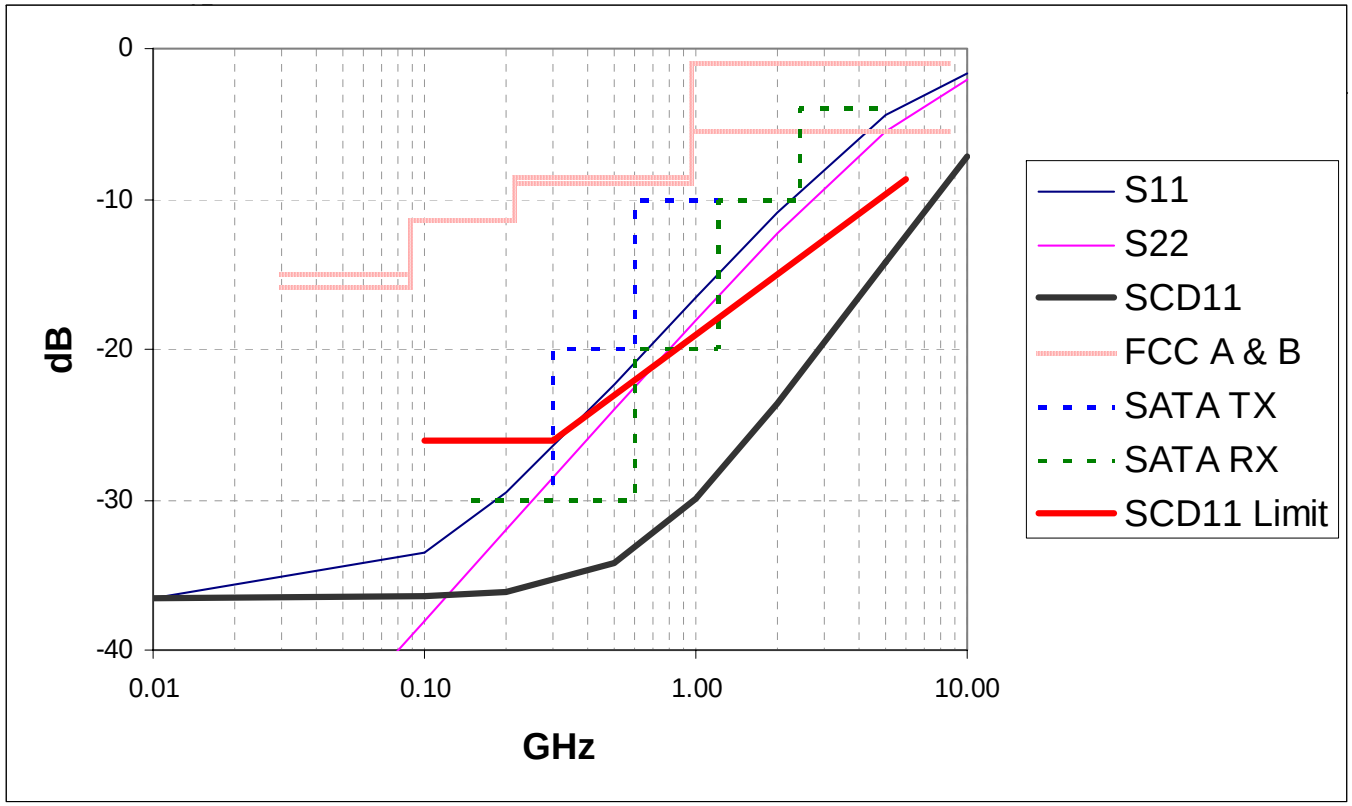
TOLp	0.03	Cp:	0.94 pF
TOLn	0	Cn:	0.8 pF
Zo(kΩ):	0.05	skew:	3 ps



$R_P = Zo \times (1+TOL_P)$

$R_n = Zo \times (1+TOL_n)$

Additional skew added to +Input



A Note about Impedance Scaling in Mixed Mode Conversion

For scattering parameters, the incident & reflected 'power waves' are defined as $V^+/\text{sqrt}(Z_{ref}+)$ and $V^-/\text{sqrt}(Z_{ref}-)$, respectively, where $Z_{ref}+$ is the reference impedance of the incident wave and $Z_{ref}-$ is the reference impedance of the reflected wave.

In mixed mode parameters, these impedances can be different. Hence, a ***differential*** input voltage of 1200mVpp encountering the proposed limit SCD11 of -12.7dB = 0.232 at the Nyquist frequency results in a reflected ***common mode*** voltage of:

V_{cm} = 1200mVpp x 0.232 **x sqrt[25Ω/100Ω]** = 139.2mVpp.

This limit compares reasonably with the proposed +26dBmV(rms) common mode TX voltage limit, equivalent to 20mV(rms) = 56.6mVpp.

ref: http://en.wikipedia.org/wiki/S-parameters