Analysis of Immunity Transient Performance vs. Insertion Loss and BCI Limit Line

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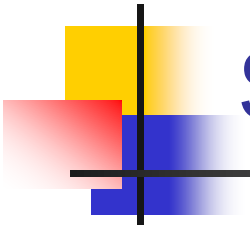


Supporters

Overview

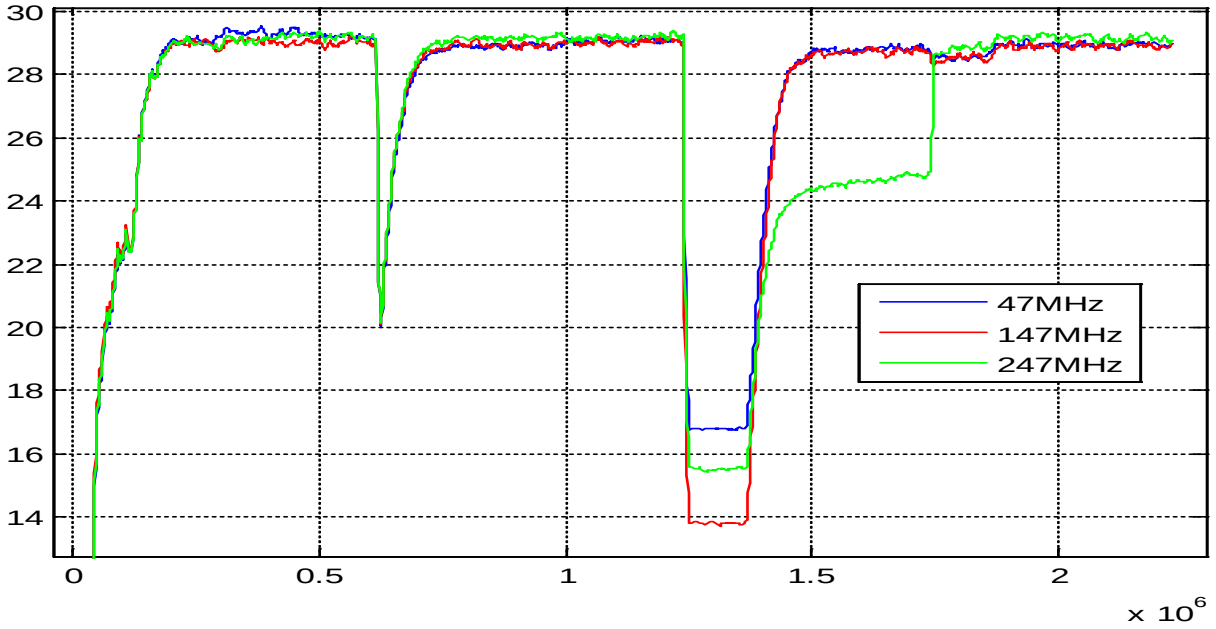
- Objective
- Interference Frequency vs. Transient SNR
- Interference Amplitude vs. Transient SNR
- Channel Insertion Loss vs. Transient SNR
- BCI Limit
- Conclusions
- Discussions

Objectives & Simulation Setup

- Analysis of the transient immunity performance to interference by simulations
- Channel model in the simulations are from Molex Channel Model: http://www.ieee802.org/3/bp/public/may13/Babenko_3bp_01_0513.pdf
- Interference tone in simulation: single FM tone,
  - A*cos(2*pi*fc*t+(dev/fm)*cos(2*pi*fm*t))
- Discussion on the channel insertion loss, interference frequency and amplitude impact on the transient SNR
- Discussion on BCI measurement and the worst case consideration

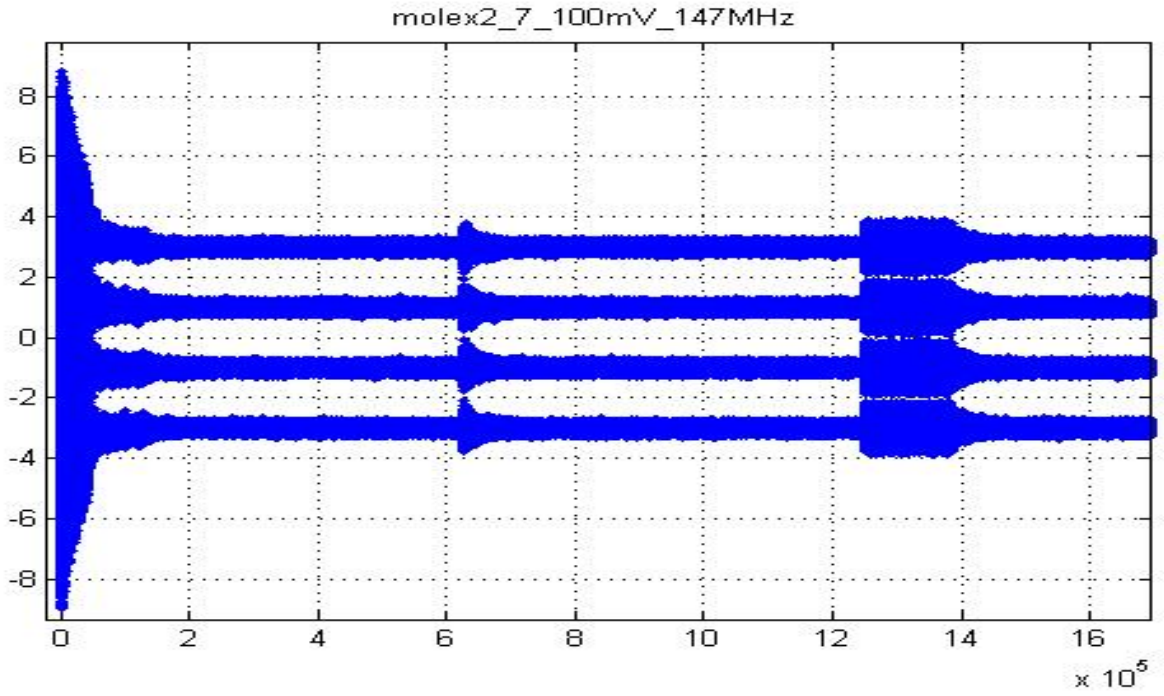
Interference Frequency vs. SNR Performance

- **1 Pair PAM4 @ 500Msps Sample Rate**
  - **SNR: 16.8dB @47MHz, 13.8dB @147MHz, 15.6dB @247MHz, 100mVpp Interference FM Tone**
  - **Molex Model Sample 2, -40°C**



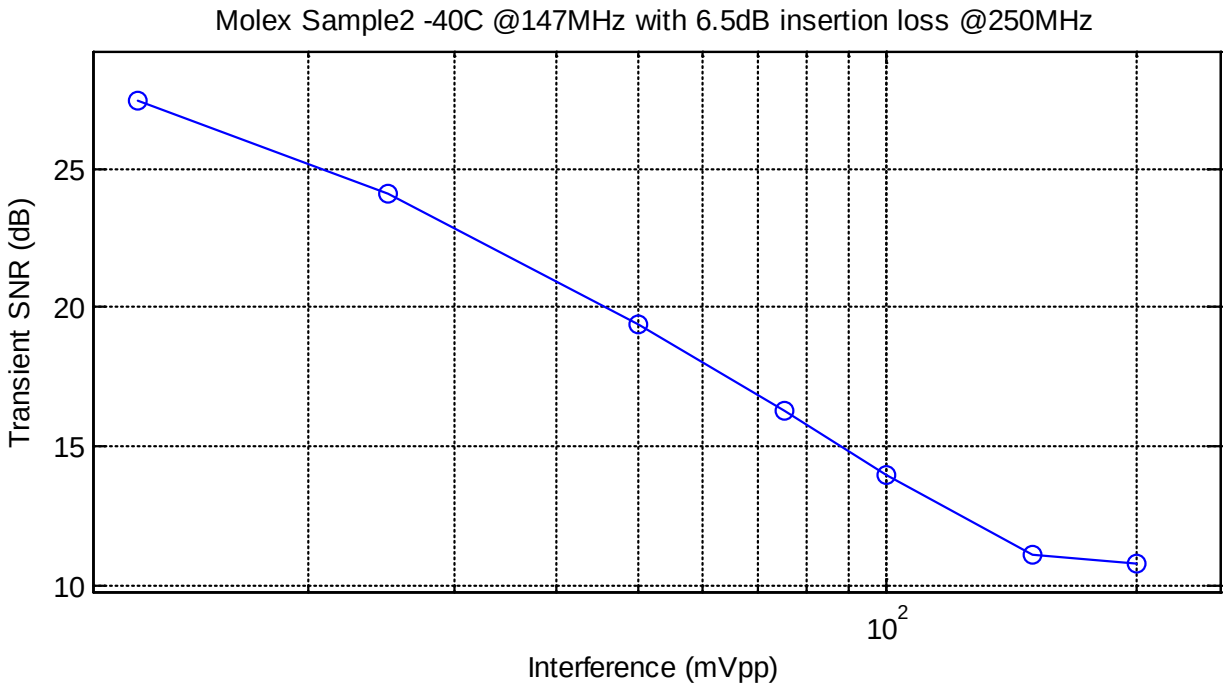
Slicer Input Waveforms

- Slicer input with 100mVpp, 147MHz interference



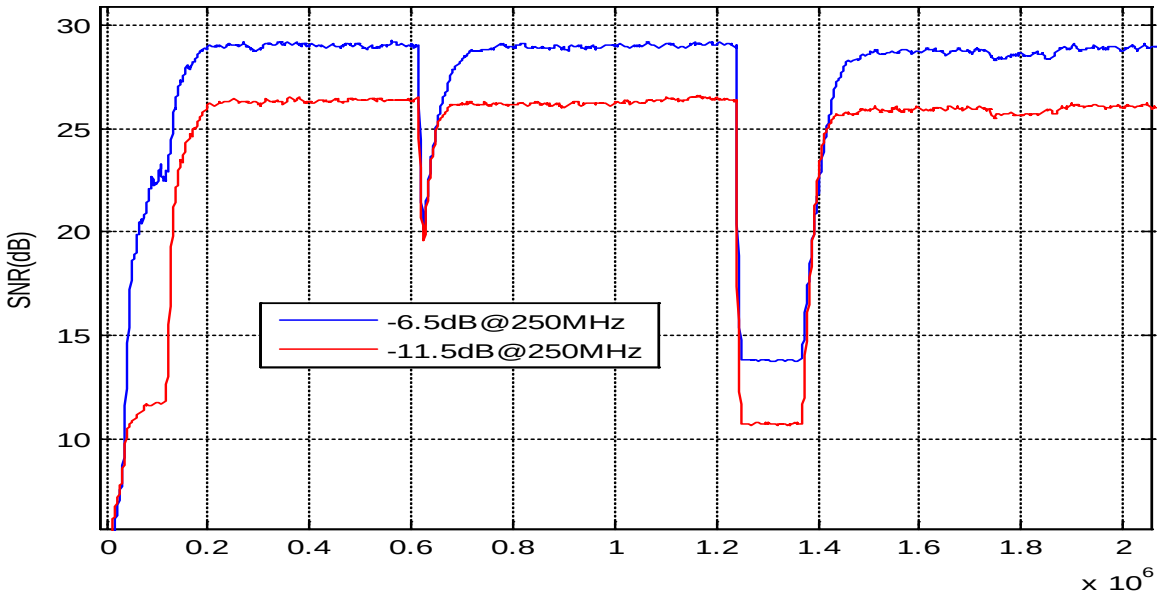
SNR Transient Response to the Interference with Different amplitudes

- Interference @ 147MHz with amplitude (mVpp): 12.5, 25, 50, 75, 100, 150 and 200



SNR Transient Response to the Different Channel Insertion Loss

- Simulation model is based on Molex Model: Sample2, 15m with 5 segments and 4 in-line connectors @ -40°C and 85°C with insertion loss of -6.5dB @ 250MHz and -11.5dB @250MHz, respectively.

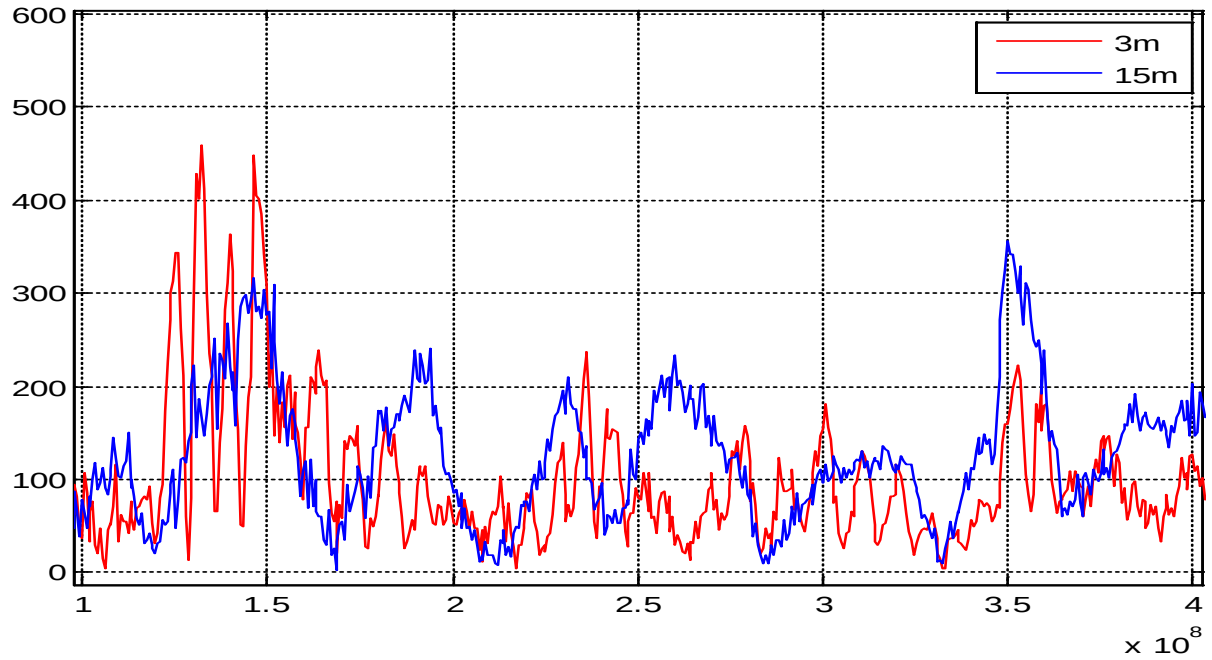


BCI Model Measurement

- EMC Ad Hoc Study Group recommended method, the setup:
  - 15m cable with 4 in-line connectors Setup shown right:

BCI Model Measurement

- The Peak to Peak Interference voltages with flat 200mA BCI limit line



Conclusion

- EMI Interference vs. Performance
  - Frequency:
    - Due to the insertion loss variation with different frequency, the same amplitude interference at different frequency get the different performance, the worst case here is at 147MHz.
  - Amplitude:
    - 100mVpp limit line is on the boundary, the safe value might be less than 60mVpp

Conclusion

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- Channel Insertion loss:
  - less than 6.5dB insertion loss @250MHz required for all the temperature range and cable length range
- SNR requirement: 23dB(10^-10) for PAM4
  - Enough SNR margin after the interference tone notched
  - The worst transient SNR case for 100mVpp is 13.8dB+5dB(assuming coding gain)=18.8dB, much less than 23dB, also, there is no design margin assigned

Conclusion

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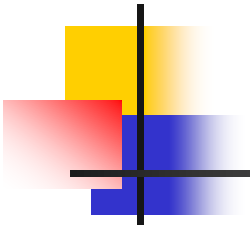
- BCI Model Limit Line
  - EMI Interference is strongly related to cable balance and connectors, when the cable assembly changed, BCI model would change
  - For the cases studied, 100mV Limit line is hard to achieve

Discussion

- Channel Model
  - 6.5dB @250MHz insertion loss or better, is that economically achievable?
- BCI model
  - Need to define worst case link segment (cable, connector)
  - Need to specify maximum length of untwisted cable at the connectors end
  - Suggest to test real cable with in-line connector included on EMC before EMC baseline determined



- Thank You!