SAS-2 S-Parameters of Cable Assemblies and Backplanes (08-187r0)

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Assertion

• The common mode return loss $S_{cc22}$ and differential to common mode return loss $S_{cd22}$ proposed in the SAS-2 letter ballot do appear to be attainable using existing SAS connector designs.

• In addition, common layout practices and techniques used to reduce electromagnetic emissions conflict with the proposed $S_{cc22}$ limits.
SAS-2 Letter Ballot Specifications

Scc22 and Scd22 Specifications

- dB vs GHz graph showing different types of specifications.

- The graph compares Scc22 and Scd22 with dB values ranging from -30 to 0 dB at various GHz frequencies.
Cable Assembly Data

miniSAS Scc22 Cable Assembly Measurements

- dB vs. GHz for different cable lengths and configurations.

- Key data points:
  - 0.5m_a
  - 0.5m_b
  - 0.5m_c
  - 2m_a
  - 2m_b
  - 2m_c
  - 6m_a
  - 6m_b
  - 6m_c
Cable Assembly Data Notes

- Samples consisting of three cable lengths from three different suppliers were measured.
- Fixturing was not de-embedded but the test board traces maintained a well controlled 25-ohm common mode impedance up to the miniSAS connector footprint.
- The miniSAS connector/cable interface has at least three unique coupled regions with each one yielding a unique common mode impedance ... PBC mounted connector, paddle card and bulk cable.
Common Mode Impedance Variations in Board Design

- Trace structure variation is a common layout practice
- Trace width and spacing are varied in order to access all points in connector and BGA pinfields
- Differential impedance is maintained while common mode impedance variations are tolerated
Trace Structure Simulations

• To better characterize the effects of such layout practices, three separate designs are simulated.
  • One inch uncoupled microstrip + one inch 100-ohm differential coupled microstrip with a single ended impedance of 54-ohms + 50-ohm termination for each leg
  • One inch uncoupled microstrip + one inch 100-ohm differential coupled microstrip with a single ended impedance of 70-ohms + 50-ohm termination for each leg
  • One inch uncoupled microstrip + one inch 100-ohm differential coupled microstrip with a single ended impedance of 80-ohms + 50-ohm termination for each leg

• The model is driven by a common mode source and then converted to $S_{CC22}$ format.
Trace Structure Simulations

Scc21 vs. Coupled Pair Impedance

GHz

dB

54-Ohms (SE)

70-Ohms (SE)

80-Ohms (SE)
Reflection Coefficient (∙) and $S_{22}$

- The reflection coefficient ($\Gamma$) is the ratio of the amplitudes of the reflected wave to the incident wave.
- It can be computed from the impedances of the incident media and termination.
- For the case of a common mode impedance of 40-ohms we obtain,

$$\rho = 0.23 \&$$

$$S_{CC22} = -12.7 \text{ dB}$$

$$\Gamma = \frac{V_{\text{reflected}}}{V_{\text{incident}}} = \frac{Z_t - Z_i}{Z_t + Z_i}$$

$$S_{22} = 20 \log(\rho)$$
Multiple Impedance Discontinuities

- Each change in common mode impedance will introduce a wave back to the compliance point. Multiple changes between 25 and 40 ohms will result in a return loss greater than -12.7 dB at specific frequency points.
Potential Scd22 Issues

• Imperfect twin-axial cable termination is very common. Any imbalance introduced during the assembly process can result in non-ideal mode conversion parameters (all $S_{CD}$ and $S_{DC}$ terms).
Cable Assembly Data

miniSAS Scd22 Cable Assembly Measurements

GHz

dB
Conclusions

• The $S_{CC22}$ data presented indicates letter ballot specification will be difficult to meet.

• However, the $S_{CD22}$ cable assembly data supports the letter ballot specification numbers.