SAS-2 S-Parameters of Cable Assemblies and Backplanes (08-187r1)

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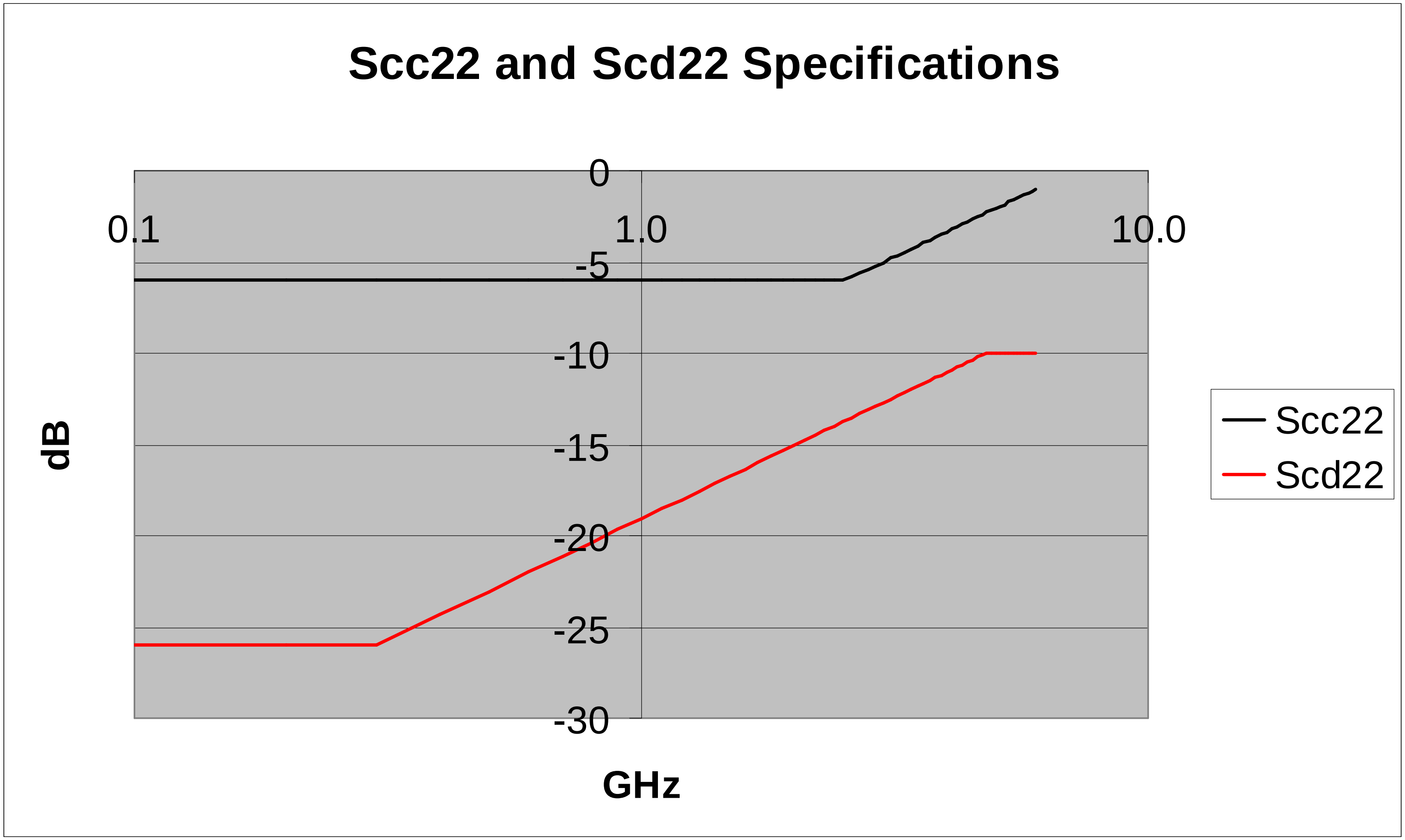
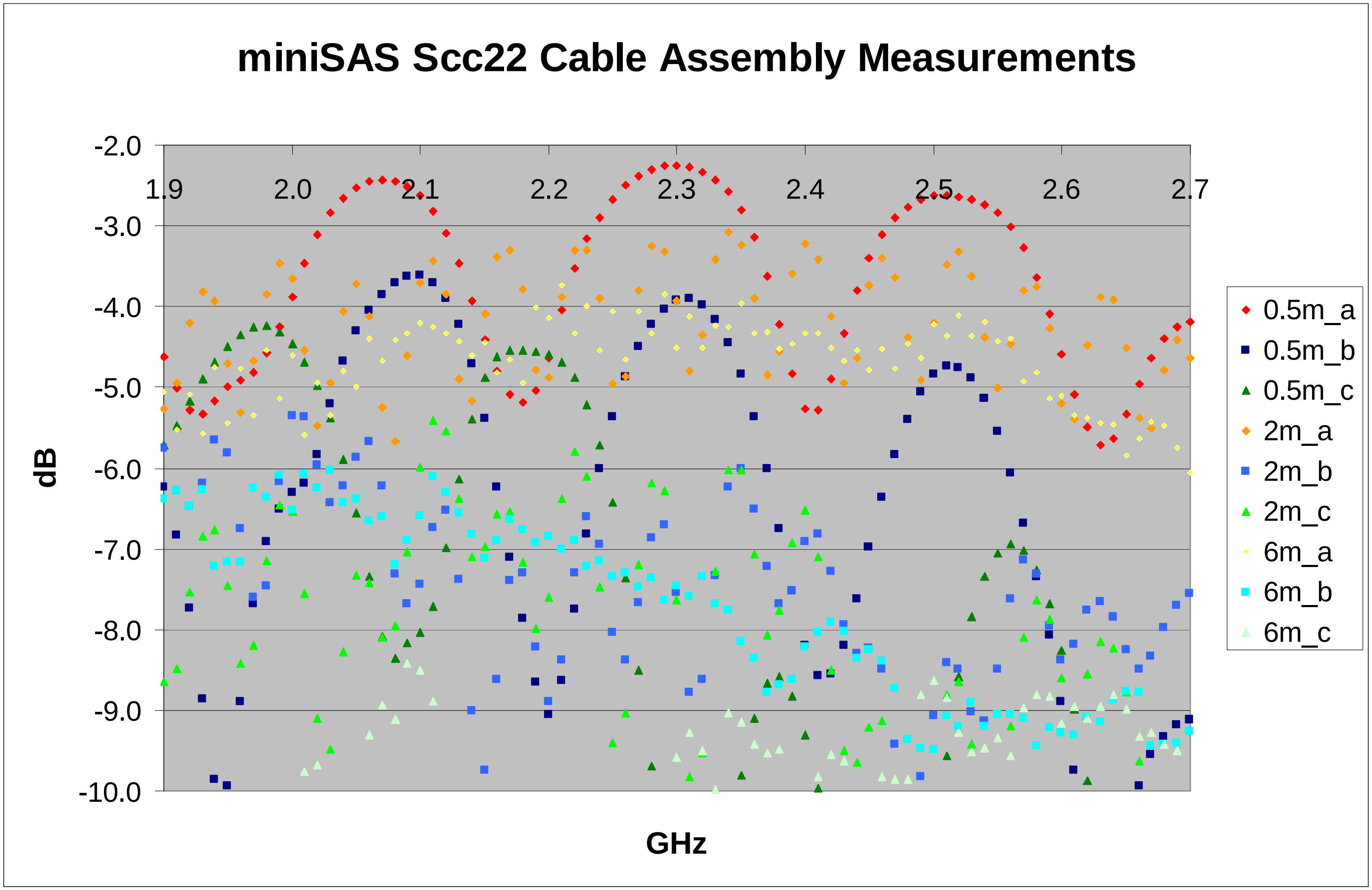
Assertion

- 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



Cable Assembly Data

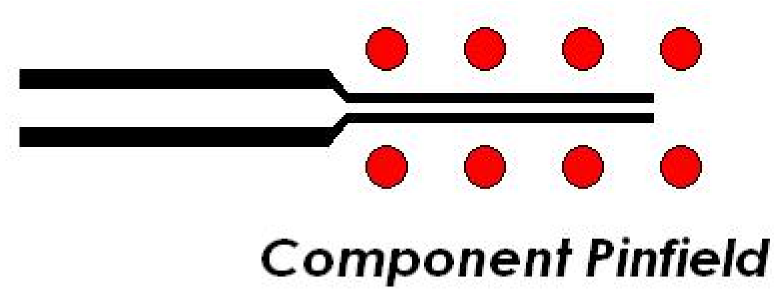


Cable Assembly Data Notes

- 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

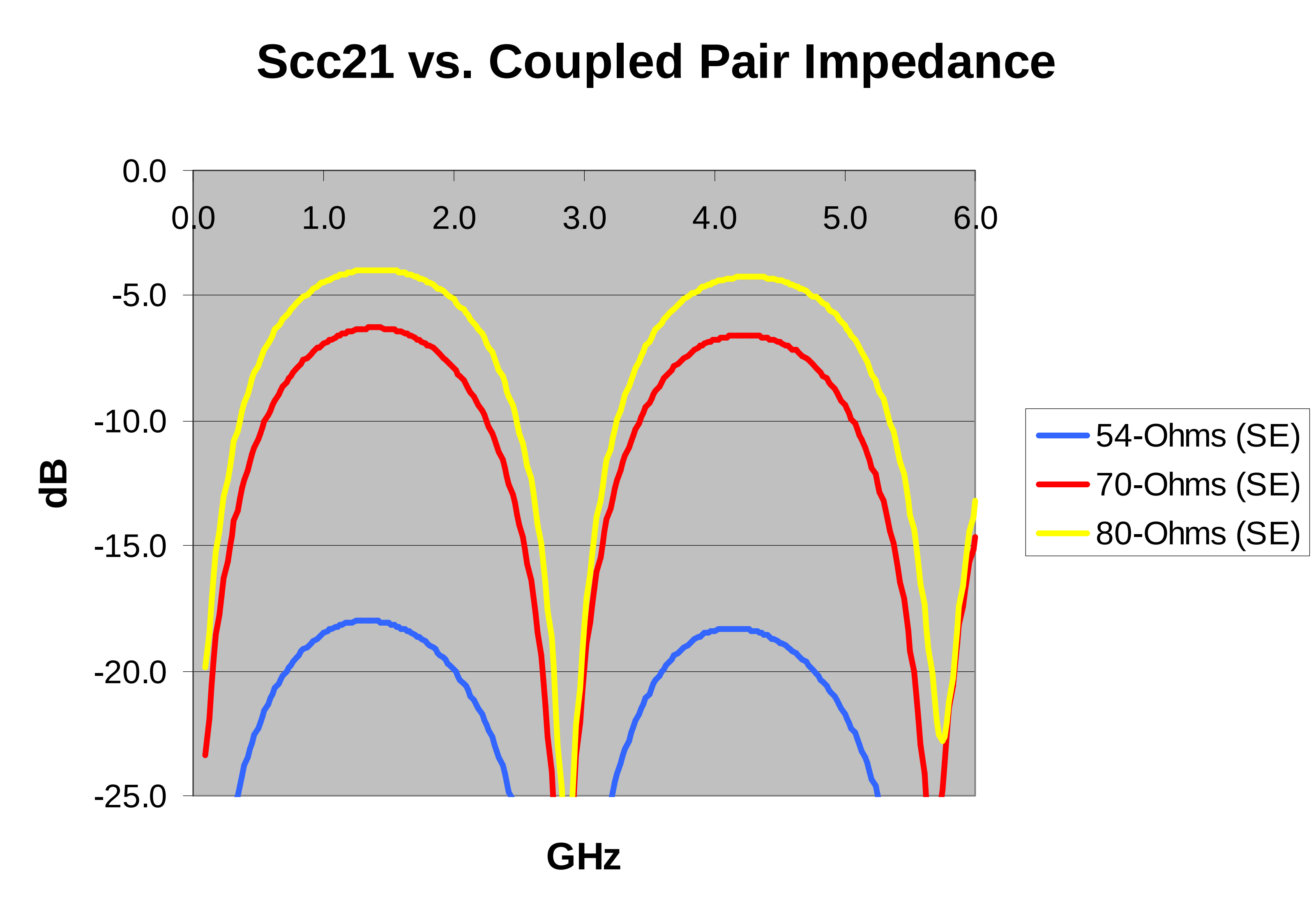
- Trace structure variation is a common layout practice
- Trace with and spacing are varied in order to access all points in connector and BGA pinfields
- Differential impedance is maintained while common mode impedance variations are tolerated



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



Reflection Coefficient (•) and S_{22}

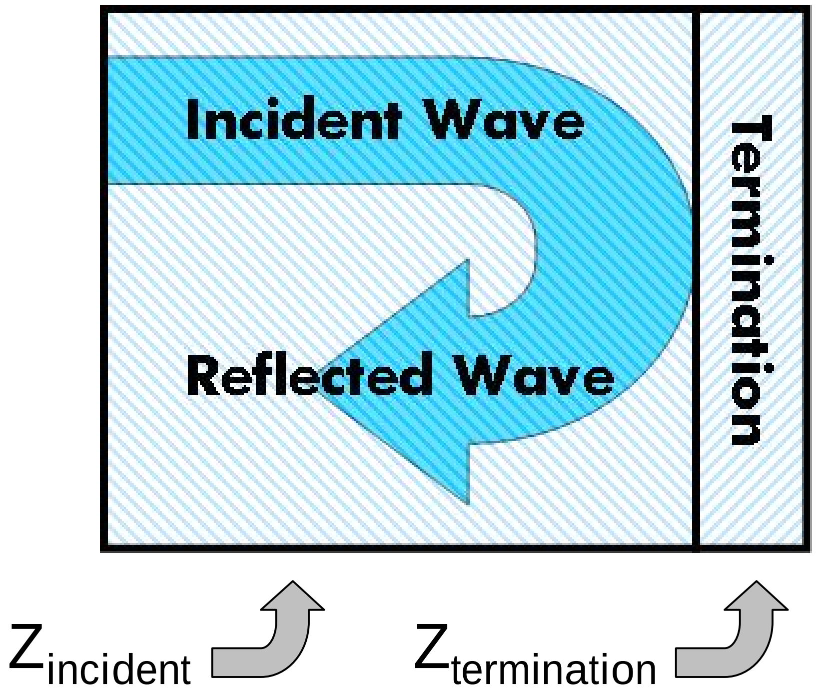
- The reflection coefficient (•) is the ratio of the amplitudes of the reflected wave to the incident wave
- It can be computed from the impedances of the incident media and termination
- For the case of a common mode impedance of 40-ohms we obtain,

$$\rho = 0.23 \ \&$$

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

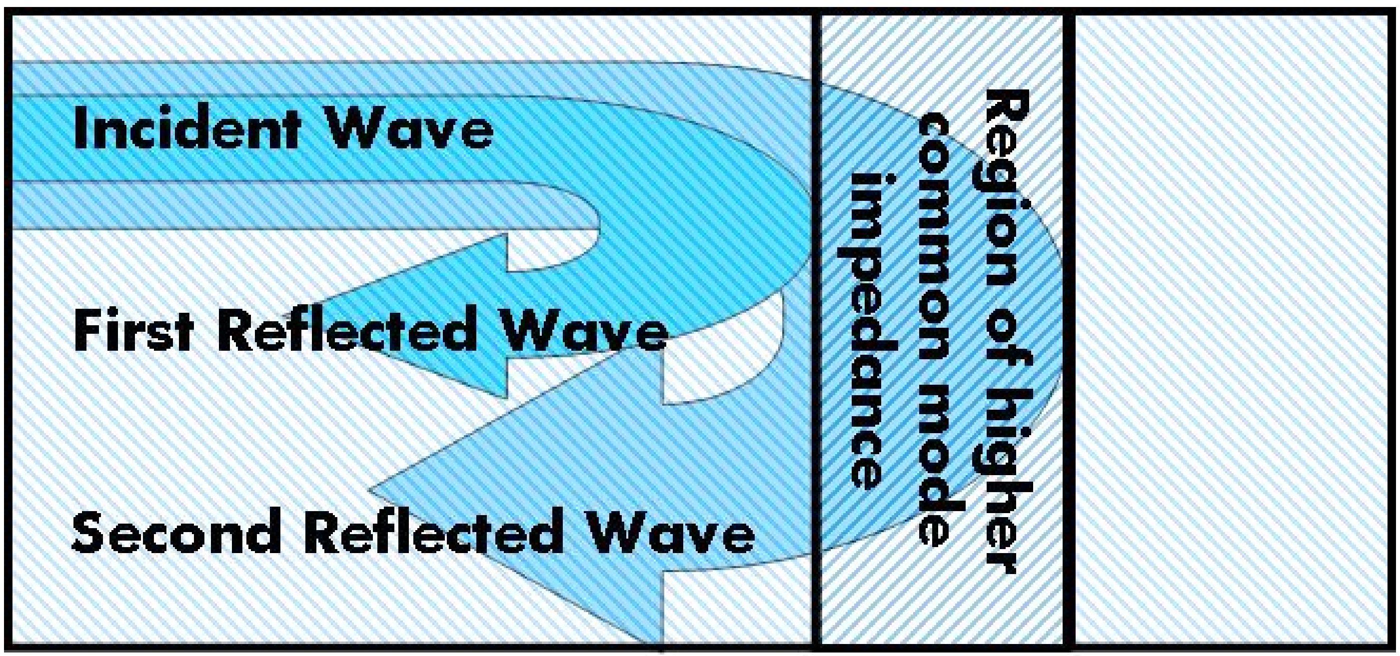
$$\Gamma = \frac{V_{reflected}}{V_{incident}} = \frac{Z_t - Z_i}{Z_t + Z_i}$$

$$S_{22} = 20\log(\mathrm{r})$$



Multiple Impedance Discontinuities

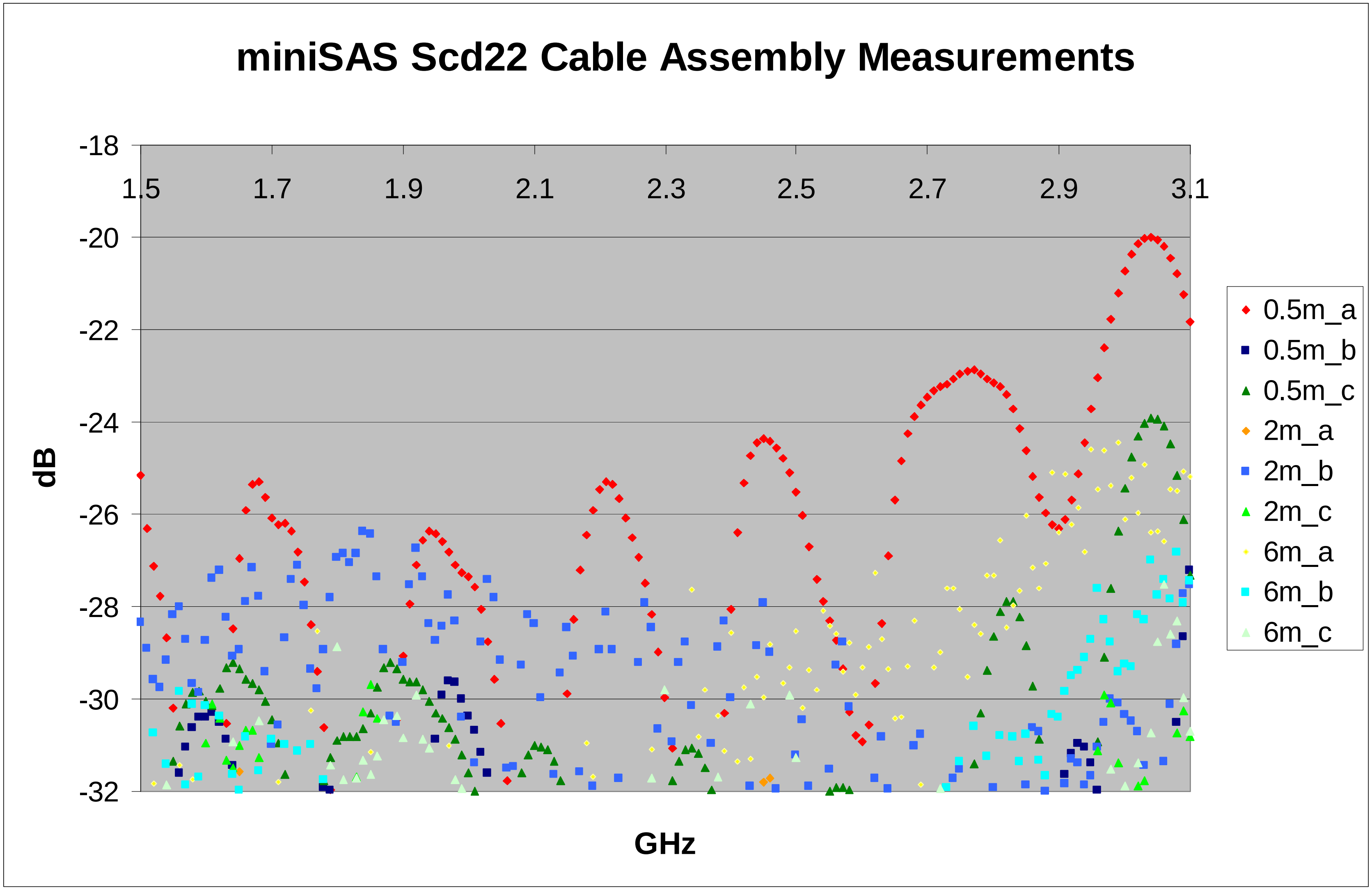
- Each change in common mode impedance will introduce a wave back to the compliance point. Multiple changes between 25 and 40 ohms will result in a return loss greater than -12.7dB at specific frequency points



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



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.

Discussion

- After discussion of the herein, the group agreed to removal of the S_{CC22} row from table 51.
- Additionally, the point was made that references made in table 51 to figures 125 and 126 of the transmitter section may be confusing the reader. The group decided to redirect those references to one or more new figures of S_{DD22}, S_{CD22} , S_{CD21} located right after table 51.

Recommended Editorial Changes

5.2.7 cable assembly and backplane S-parameters

S-parameters limits shall be calculated per the following formula. Variables are illustrated in figure 97 and specified in table 51

$$\text{Measured value} < \max [L, \min [H, N + 13.3 \log_{10}(f / 3\ \text{GHz})]]$$

where:

S	is the slope in dB/decade
H	is the maximum value (i.e., the high frequency asymptote)
N	is the value at the Nyquist frequency (i.e., 3 GHz)
L	is the minimum value (i.e., the low frequency asymptote)
f	is the frequency of the signal in Hz
max [A, B]	is the maximum of A and B
min [A, B]	is the minimum of A and B

Add section 5.2.7

Recommended Editorial Changes

Figure 97 shows the S-parameter values.

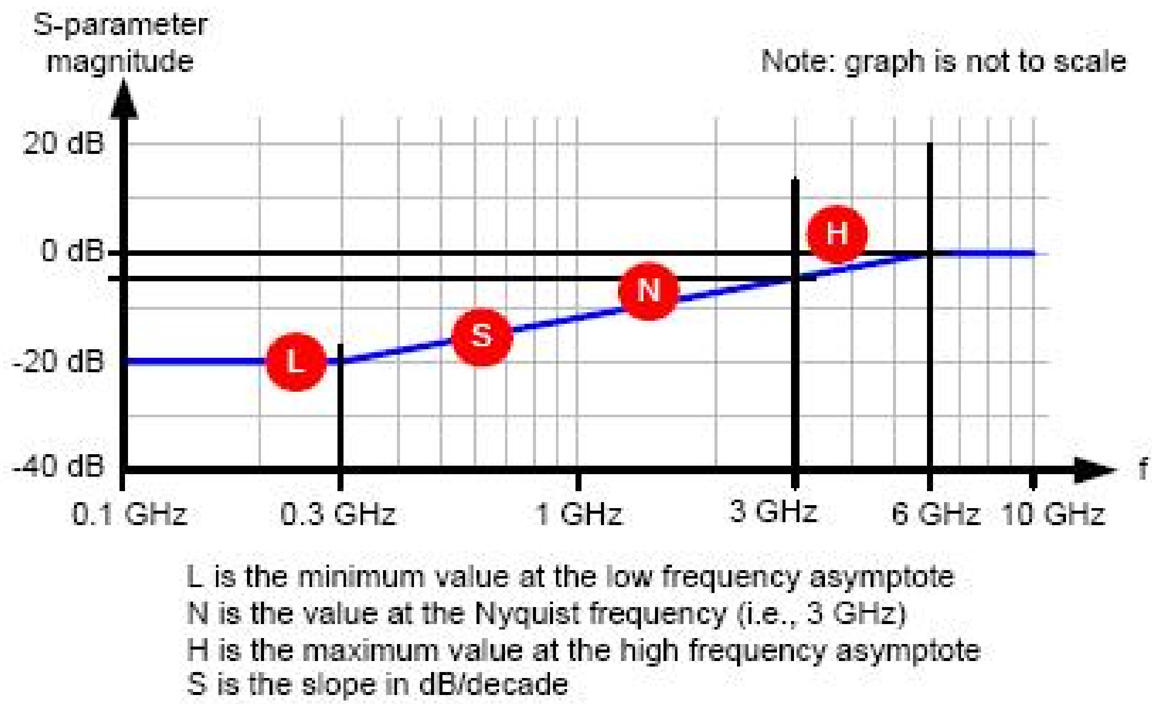


Figure 97 — S-parameter values

Add figure 97 to section 5.2.7

Recommended Editorial Changes

Table 51 — Maximum limits for S-parameters of cable assemblies and backplanes

Characteristic [a] [b] [c]	Reference	L (dB)	N (dB)	H (dB)	S (dB / decade)	f_{min} (MHz)	f_{max} (GHz)
S_{CC22}	Figure 127 (see [illegible])	[illegible]	-5.0	0	13.3	100	6.0
S_{DD22}	Figure 127	-10	-7.9	0	13.3	100	6.0
S_{CD22}	Figure 128 ~~(see 5.3.6.5.2)~~	-26	-12.7	-10	13.3	100	6.0
S_{CD21}	Figure 128	-24	-24	-24	0	100	6.0
Maximum near-end crosstalk (NEXT) for each receive signal pair [e]		-26	-26	-26	0	100	6.0

REMOVE

97

[a] All measurements are made through mated connector pairs.
[b] The range for this frequency domain measurement is 100 MHz to 6 000 MHz.
[c] Specifications apply to any combination of cables and backplanes that are used to form a TxRx connection.
[d] See figure 127 in 5.3.6.5.2 for definitions of L, N, H, S, f_{min}, and f_{max}.
[e] Determine all valid aggressor/victim near-end crosstalk transfer modes. Over the complete frequency range of this measurement, determine the sum of the crosstalk transfer ratios, measured in the frequency domain, of all crosstalk transfer modes. To remove unwanted bias due to test fixture noise, crosstalk sources with magnitudes less than -50 dB (e.g., -60 dB) at all frequencies may be ignored. The following equation details the summation process of the valid near-end crosstalk sources:

$$\mathrm{TotalNEXT}(f) = 10 \times \log \sum_{1}^{n} 10^{(\mathrm{NEXT}(f)/10)}$$

where:

f frequency

n number of the near-end crosstalk source

All NEXT values expressed in dB format in a passive transfer network shall have negative dB magnitude.

Modify table 51 and move to section 5.2.7

Recommended Editorial Changes

Figure 98 shows the **cable assembly and backplane** S_{DD22}, S_{CD21} and S_{CD22} limits.

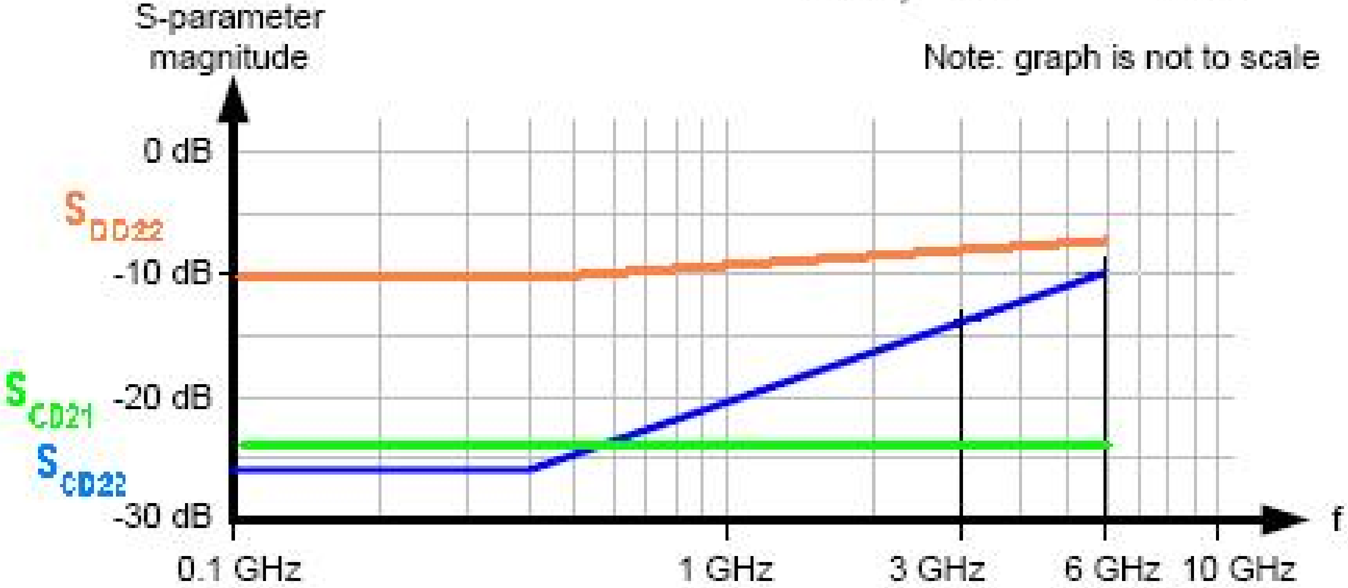


Figure 98 — **cable assembly and backplane** S_{DD22}, S_{CD21} and S_{CD22} limits.

Add figure 98 to section 5.2.7