AMP

EMI Evaluation of the FireWire/IEEE1394 Interconnect

Updated from March to include comparative evaluation of receptacle termination approaches and skew effects at S400/S800 data rates.

Information presented at the March 1394B meeting is included in this document

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General Information

This paper is a brief evaluation of the Electro-Magnetic Interference (EMI) characteristics of the 1394 interconnect. The effects of receptacle termination with or without line-to-line skew are presented here. This is a continuation of data that has been presented at various P1394B working group meetings. Information that was presented at the March 1394B meeting but not posted to the web site has been updated and included in this document.

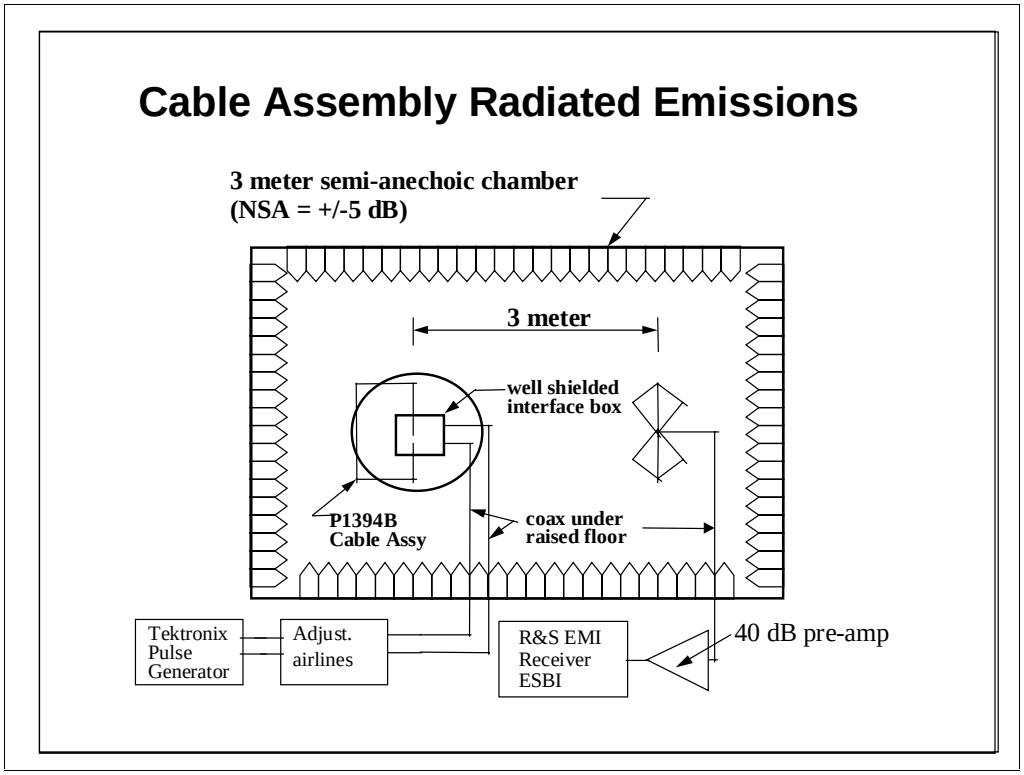
EMI performance

The signal chosen was a 40 bit sequence 3EAA2AAAA.

0011 1110 1010 1010 0010
1010 1010 1010 1010 1010

This data sequence has a significant clock content, and therefore may give excessive values at the 1/2, 3/2, and 5/2 data rate points. The signal source used for all testing was the Tektonix GigaBERT 1400™ that provided a risetime in the 200ps range at the DUT. At 1 Ghz, a preamplifier was added to improve the noise floor performance.

Slide 1, EMI Test Setup



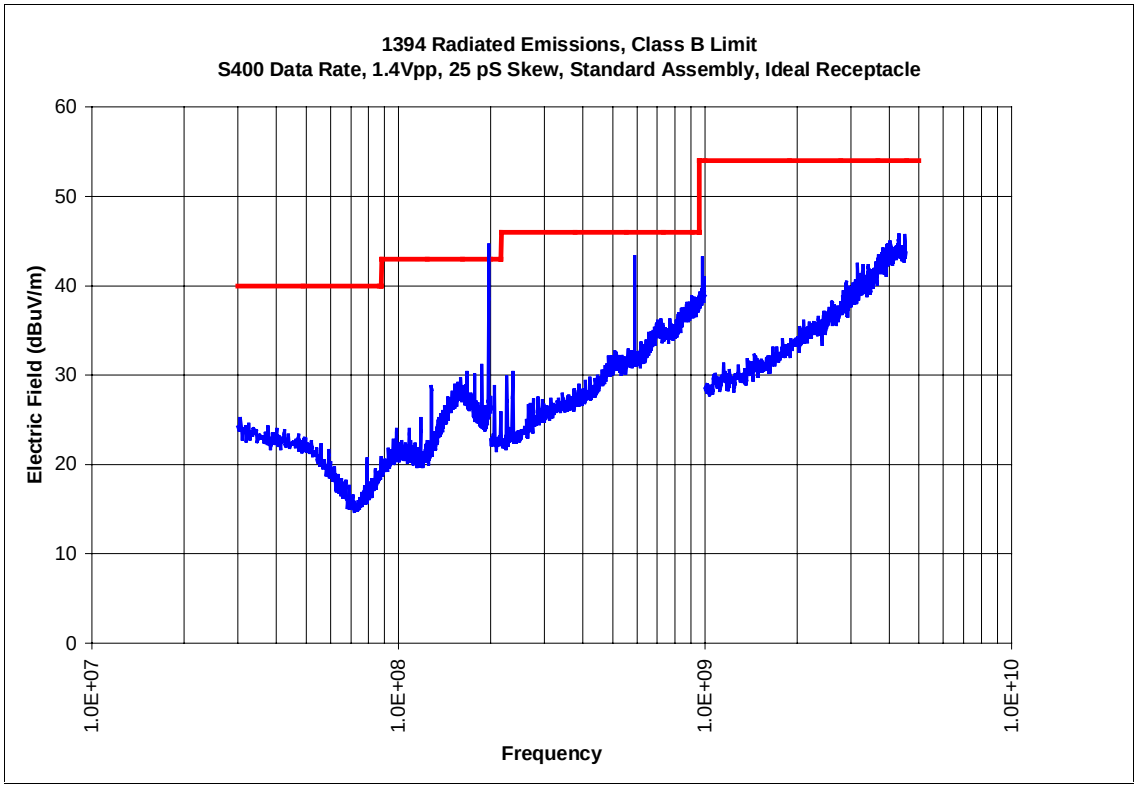
The assembly selected for the majority of testing was a 4.5m assembly mated to a horizontal surface-mount receptacle. In some cases, shorter assemblies have been evaluated.

Three different configurations of receptacle to bulkhead termination were evaluated. To determine a 'best case' termination, the receptacle was soldered to the external bulkhead (see Figure 7). This gives a reasonable idea of the best shielding effectiveness that can be obtained without fundamental changes to the plug-to-receptacle termination or to the cable itself. This is referred to as an 'Ideal Termination'.

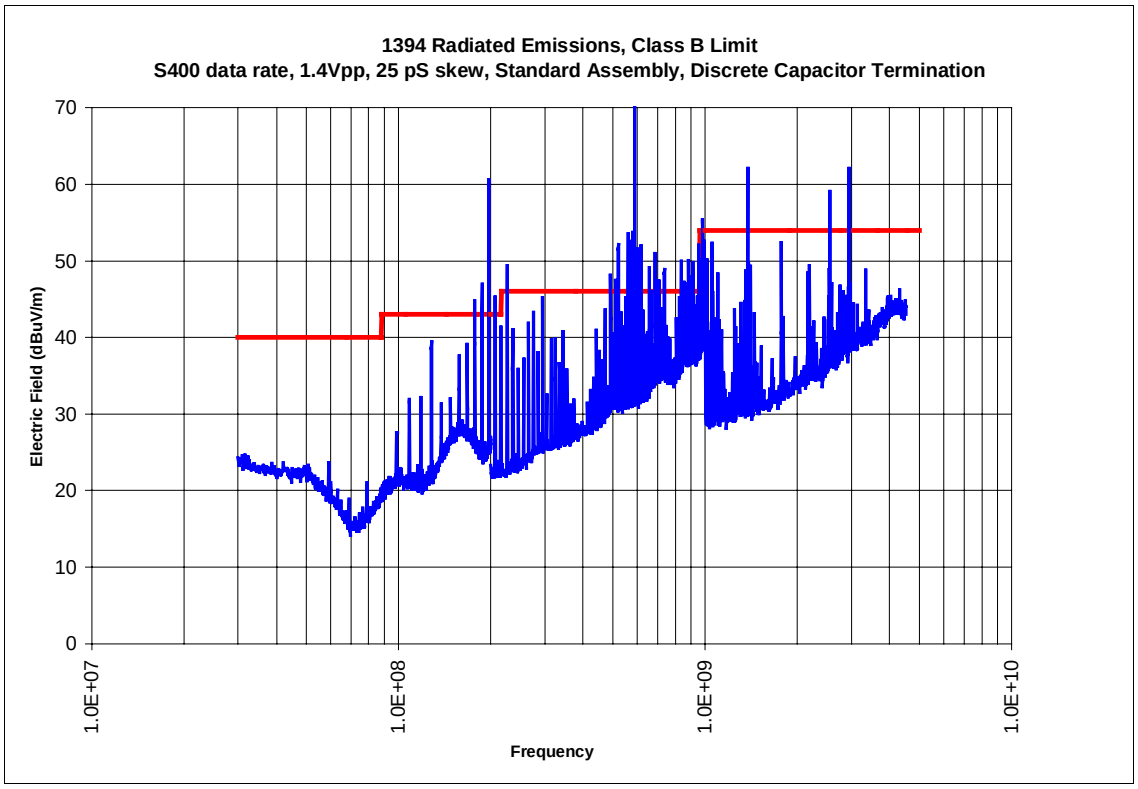
The second termination approach utilized DC isolation between the receptacle and bulkhead, and relied upon capacitors at the board level to provide contact back to the panel (see Figure 8). This is referred to as the 'Discrete Capacitive Termination'. This is an approach that many customers intend to use to provide DC isolation between devices.

The third configuration was to create a multiple capacitor gasket that would combine DC isolation with improved EMI performance over the capacitive termination(see Figure 9).

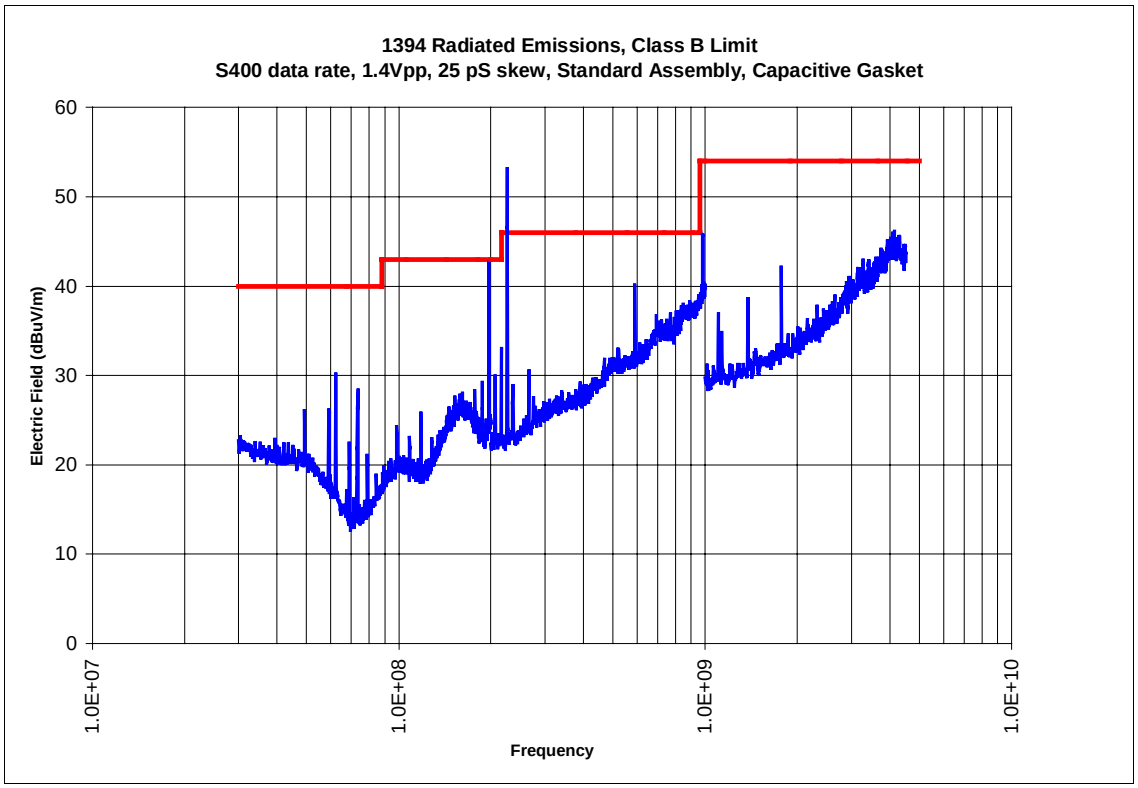
Slide 2, EMI Data, S400, Ideal Termination



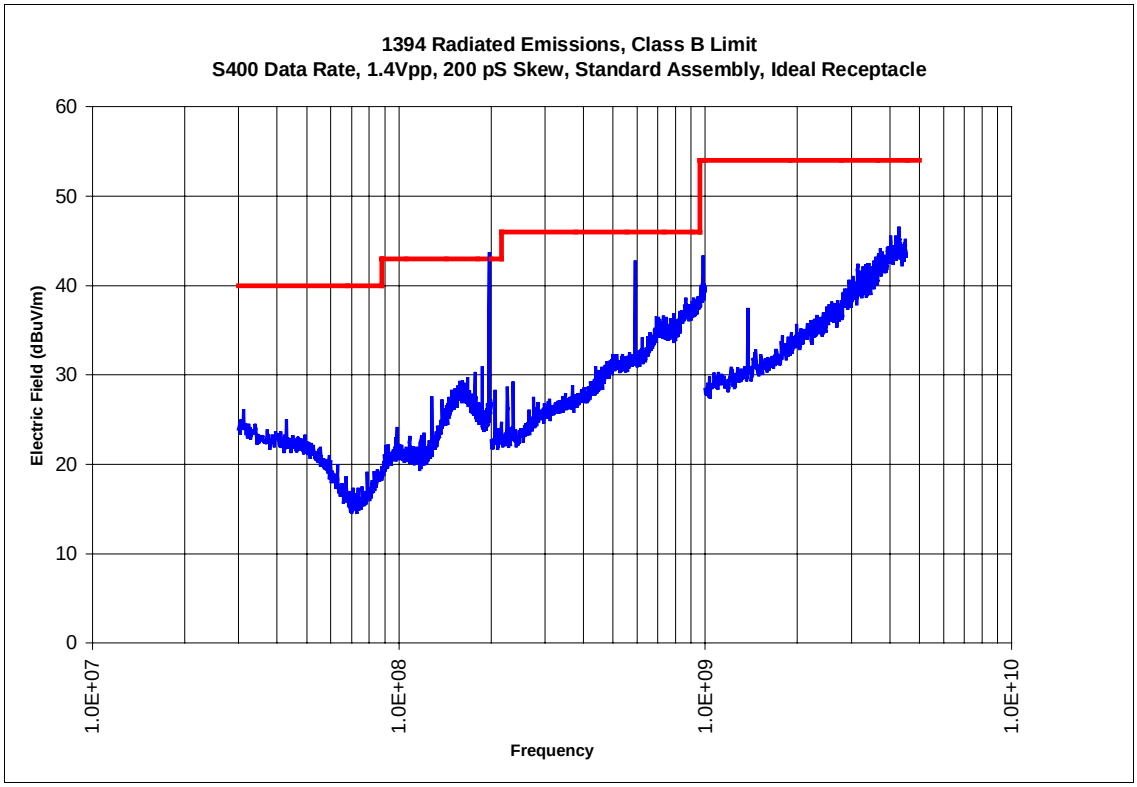
Slide 3, EMI Data, S400, Discrete Capacitor Termination



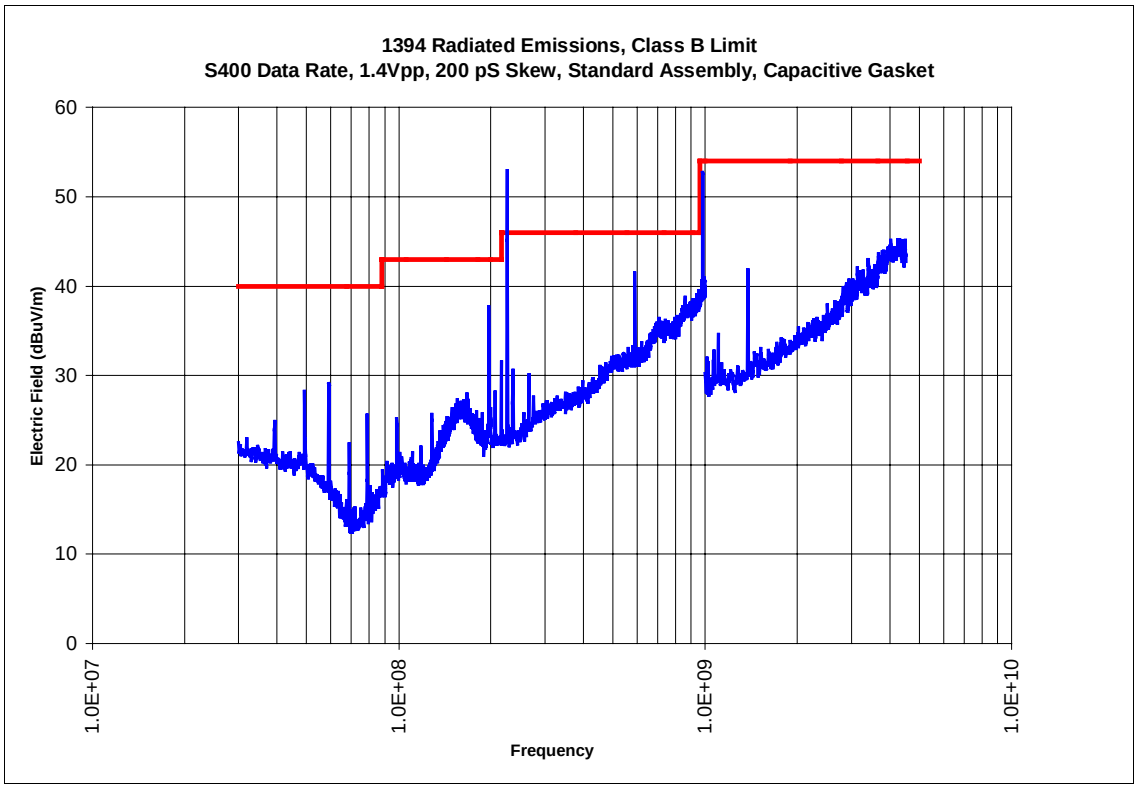
Slide 4, EMI Data, S400, Capacitive Gasket Termination



Slide 5, EMI Data, S400, 200ps Skew, Ideal Termination



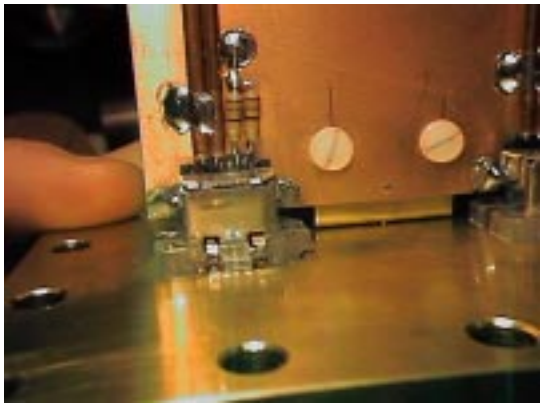
Slide 6, EMI Data, S400, 200ps Skew, Capacitive Gasket Termination



Slide 7, Fixturing Detail, Ideal Termination

Slide 8, Fixturing Detail, Capacitive Termination

Slide 9, Fixturing Detail, Capacitive Gasket



S800 Data

Figure 10, EMI Data, S800, Ideal Termination

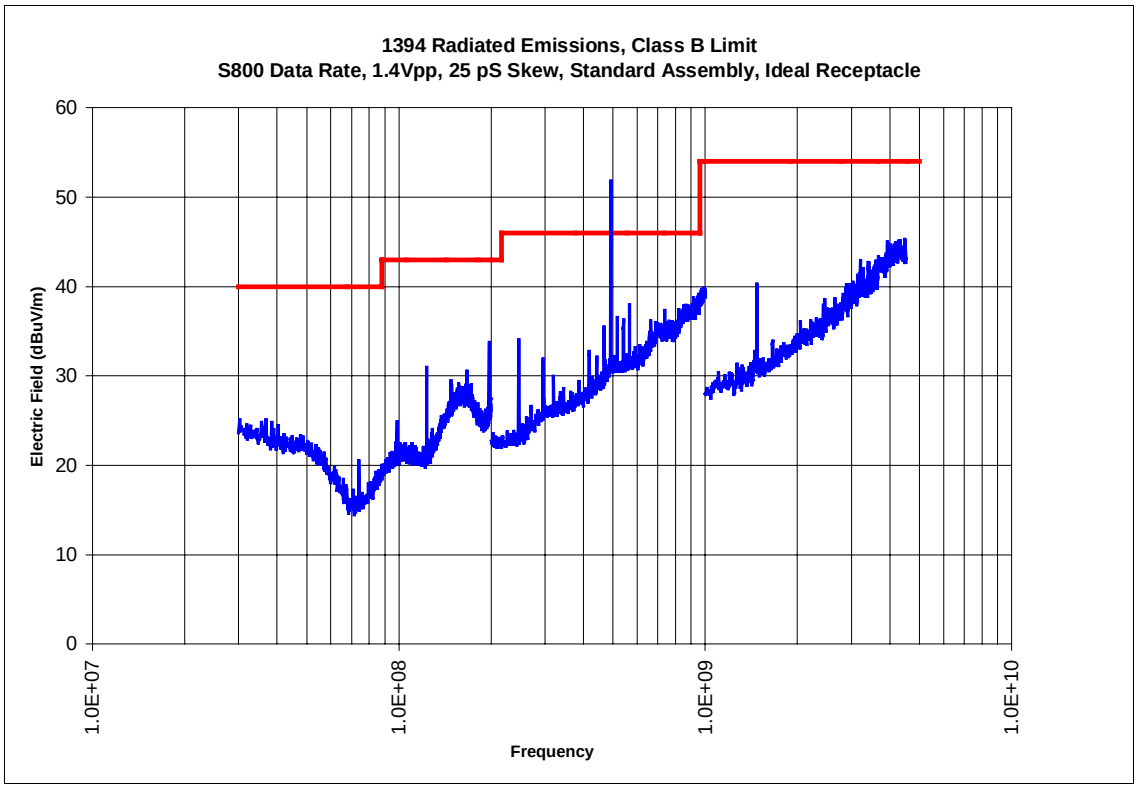


Figure 11, EMI Data, S800 Capacitive Gasket Termination

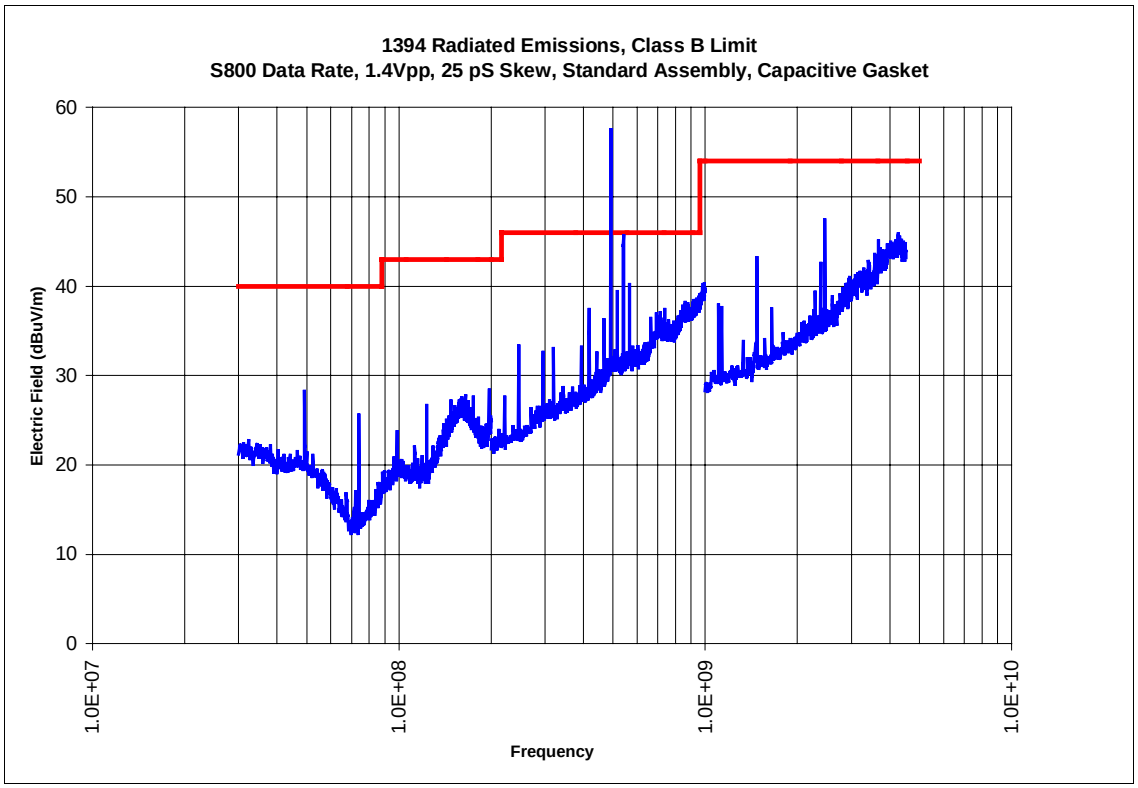


Figure 12, EMI Data S800, 200ps Skew, Ideal Termination

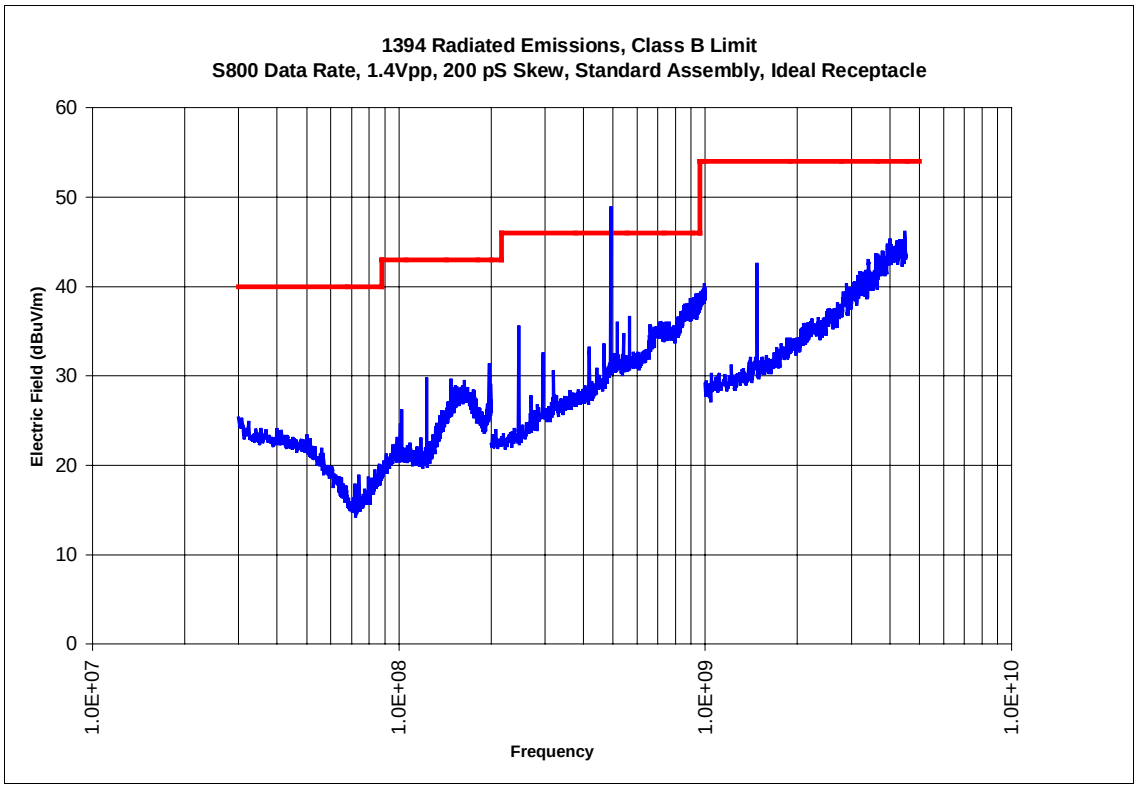
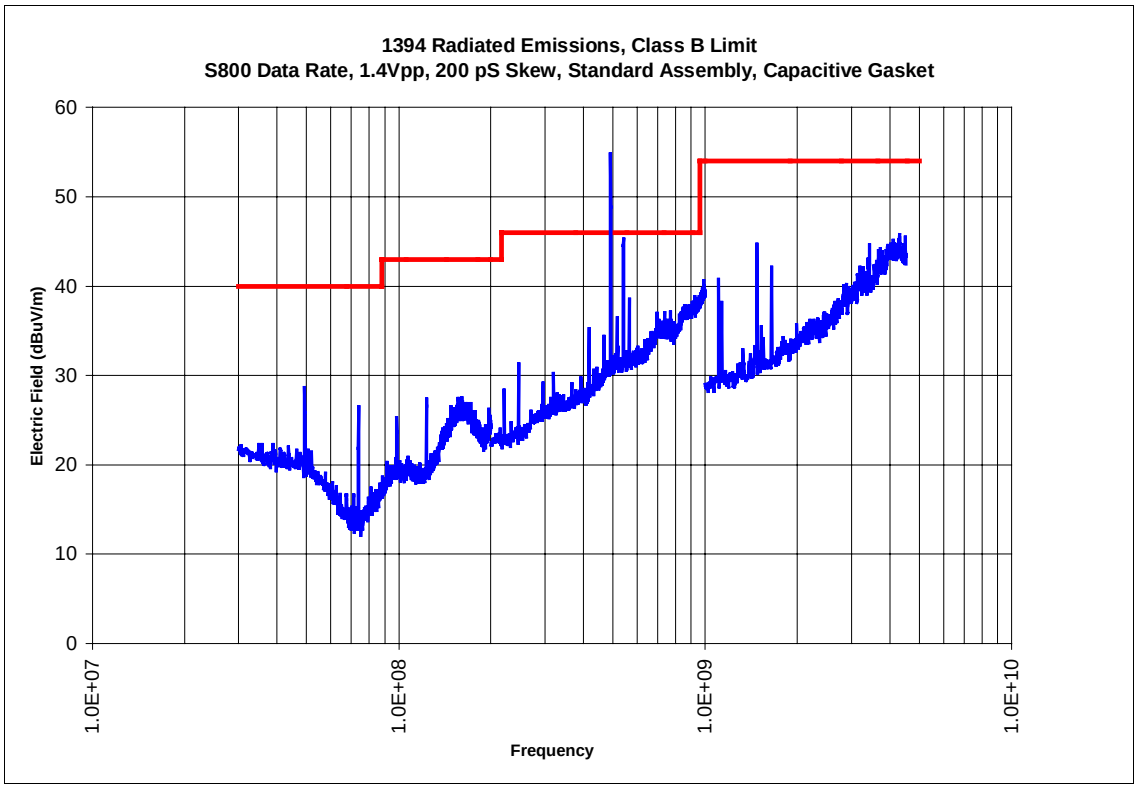


Figure 13, EMI Data, S800, 200ps Skew, Capacitive Gasket Termination



Summary

The use of a capacitive gasket results in up to a 20dB improvement over the discrete capacitor termination approach. A comparison of Figures 2, 3, and 4 shows the effects of improving receptacle termination.

In the data presented in this report, a very fast risetime was used. In real world applications, the higher spectral content from the fast risetime would be reduced, and less energy would be concentrated at the fundamental frequency value thereby resulting in an overall lowering of radiated emissions.

The receptacle has the advantage of being under control the OEM. Since the receptacle termination can potentially be the most significant source of EMI, this allows the ability to prevent most problems. If ground loops are not expected to be a problem, a flange mount termination to the enclosure is recommended. If this is not acceptable, multi-point capacitive termination must be used.

Improvements can be made to the cable construction and connector shielding to further improve EMI performance. These include improvements in wire-to-wire skew performance, improvements in wire termination, and improvements to the plug to receptacle interface. These improvements may be necessary in critical or noisy environments or in areas where the potential exists to upgrade to S800 data rates. Further study will be necessary to determine the suitability of the 1394 interconnect for S1600 data rates.