**Vaden_01-06-13_Channel models**

***Portland, OR June 2013***

**[Gray shading indicates required elements; yellow shading]**

**DOCUMENT SUBMITTED TO:** ***IEEE 802.3 channel modeling adhoc***

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|---|---|---|
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**ABSTRACT: Cabling channel models developed in ANSOFT**

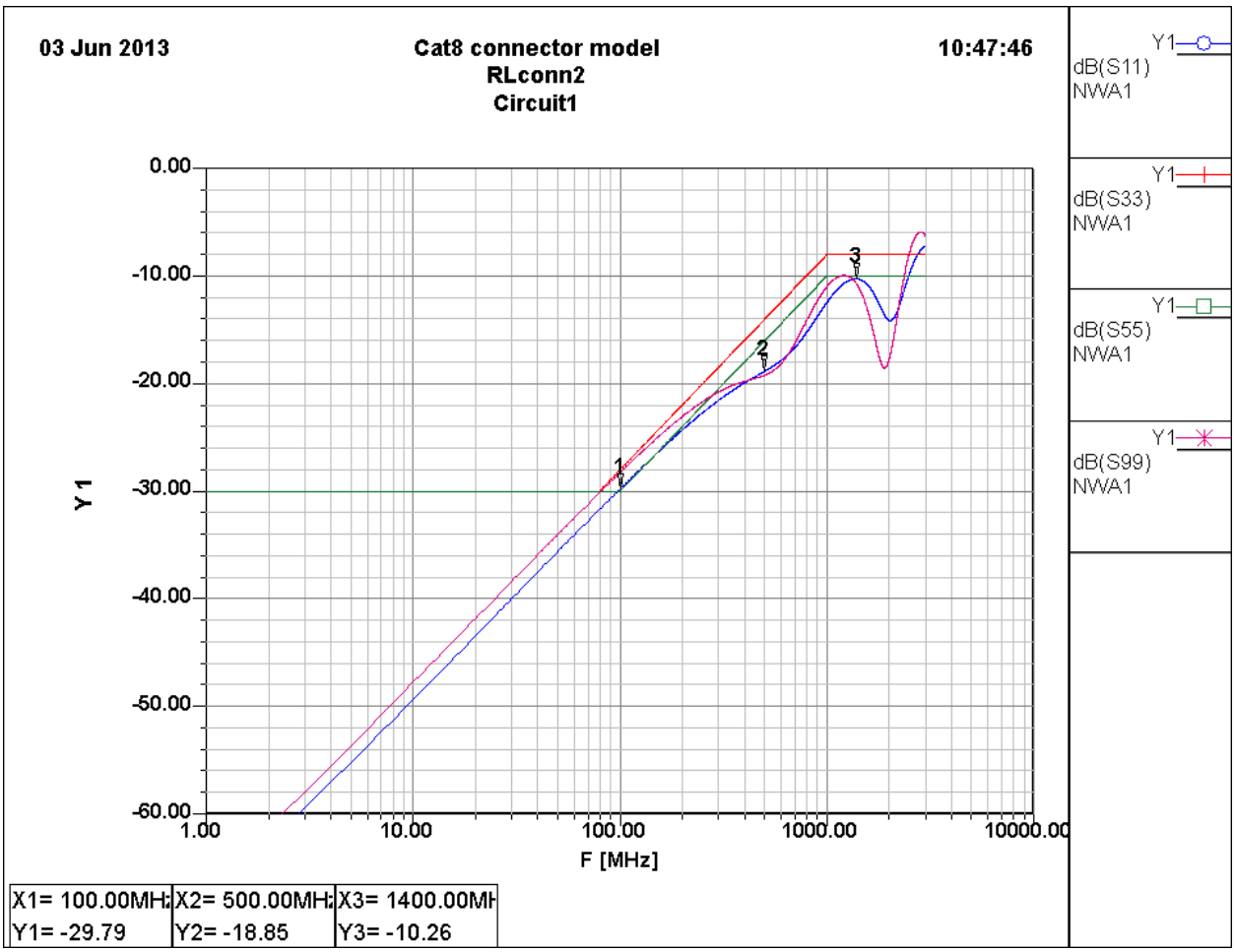


**Figure 1 Cat8 connector model return loss**

Cat8 connector RI draft requirements are 30-20log( $f$ /100) (TBD), with a plateau of 8 (TBD). The graph shows the 30 dB limit with a plateau of 10 dB (green) and a 28 dB limit with a plateau of 8. The blue response is the connector model coinciding with 30 – 10 limit. The red response is with the addition of measurement system effects. The measurement system effects were determined by measurement of a 2" twinaxial lead, and then matching the Ansoft model to the measured response.

The next chart shows the modeled connector insertion loss compared to the TIA category 8 connector limit. The red trace is the limit line, the blue response is the connector model, and the black response is including the measurement effect. The green response is the insertion loss of the connector if there were no impedance offsets through the connector (everything perfect 100 Ohm). The overall length of the connector model is 3.2 inches.

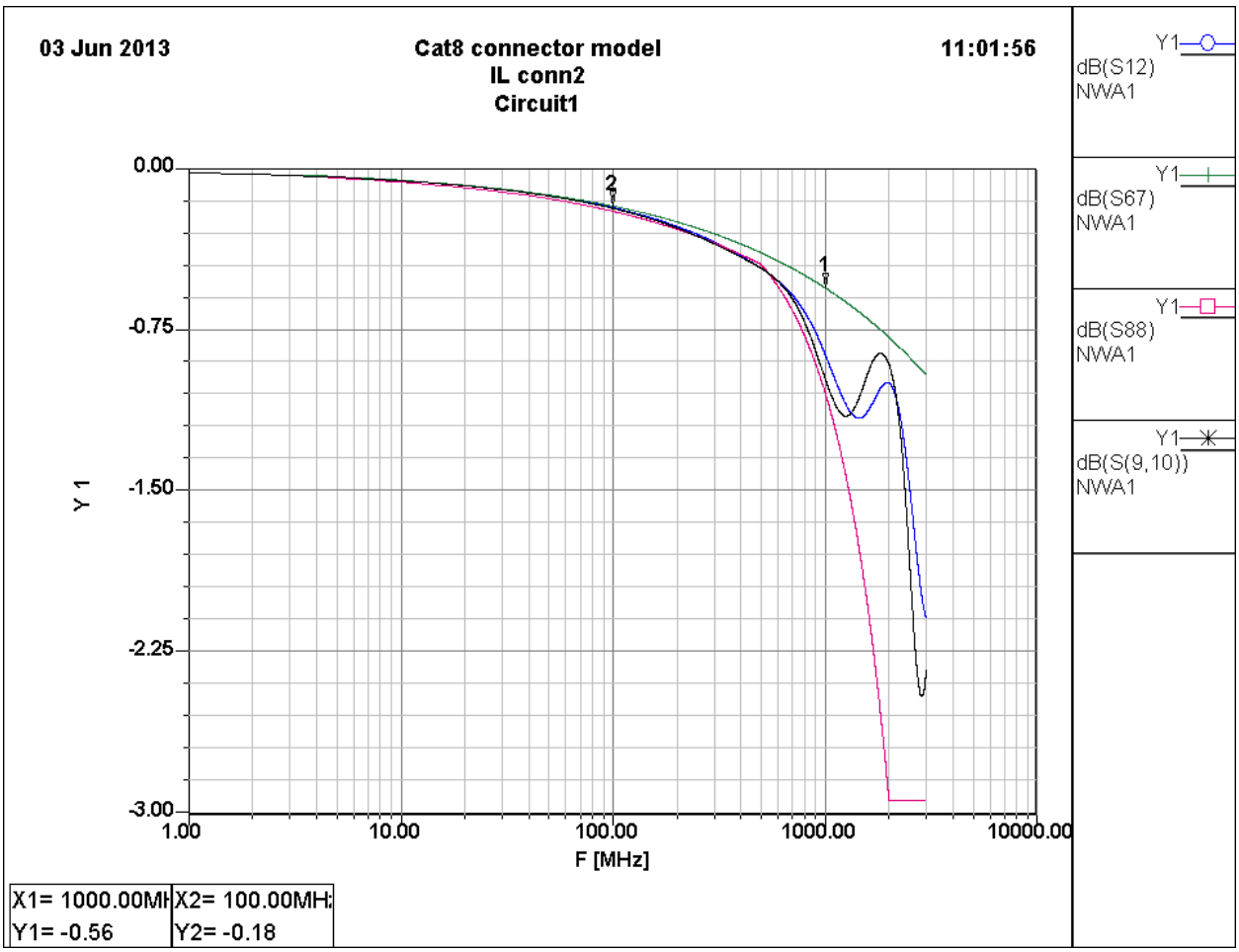


**Figure 2 Cat8 connector model insertion loss**

The next thing to model is the cable response. We want the cable model to be within the Category 8 return loss limits, and the insertion loss to be within the Category 8 insertion loss limits. We also want the model to be scaleable. It is a challenge to model a cable such that the response is easily adjustable, the model can cover a range of lengths, and the response is reflective of measured results. The following chart shows return loss model for  a 10m cable compared to a measured 10m cable. The measured cable is not compliant to the limit line. The goal of the model is to create a relatively uniform response without major peaks and valleys for the structural cable return loss.

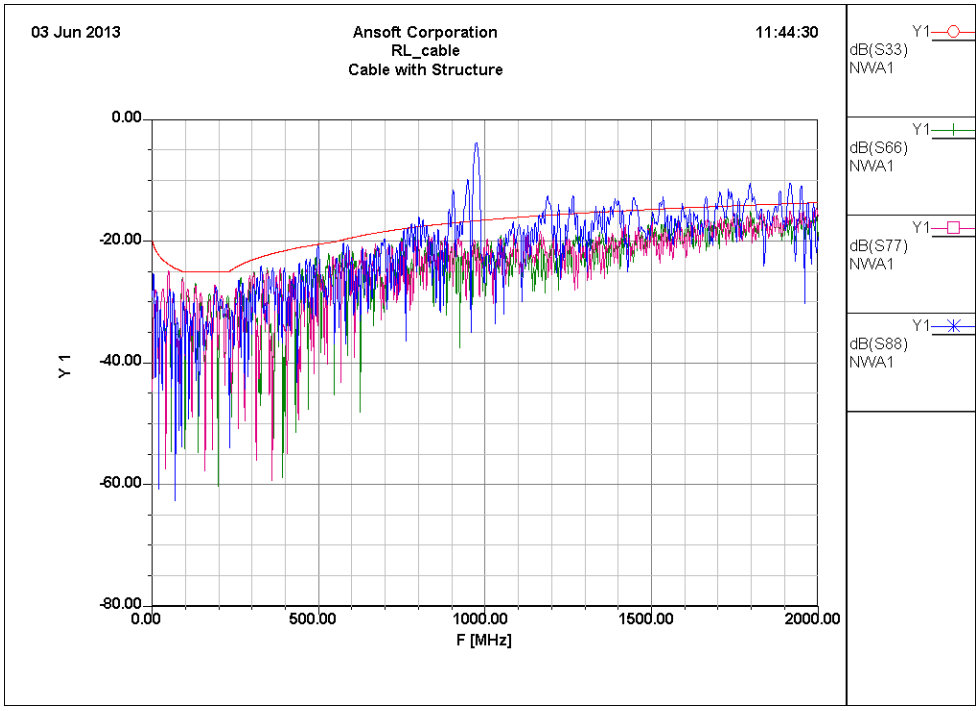


**Figure 3 Return loss model of 10m cable compared to measured cable and Cat8 limit line.**

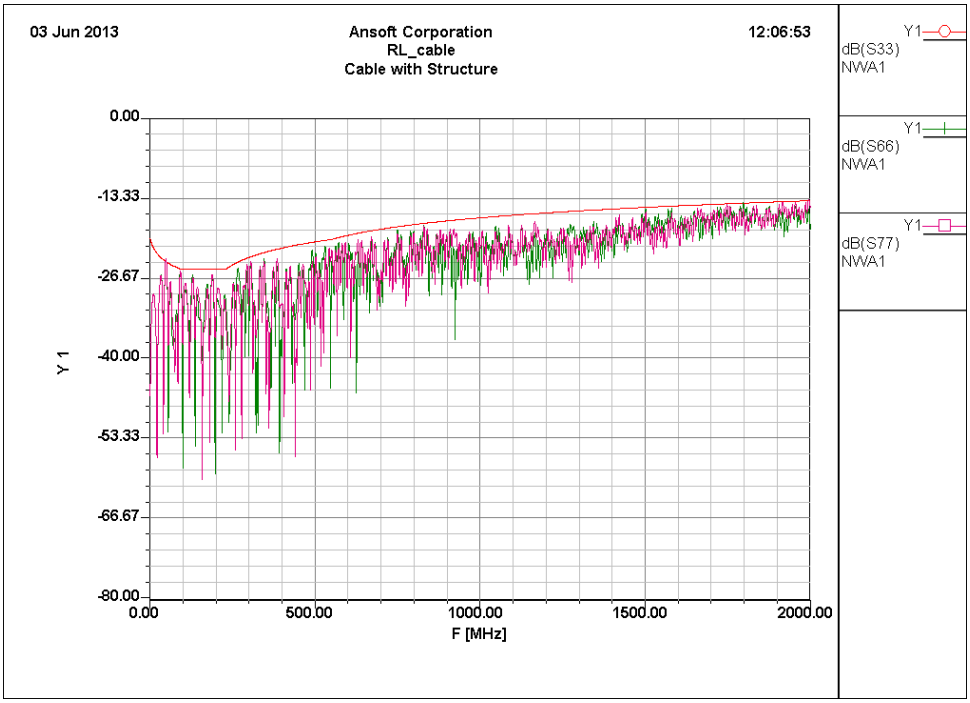


**Figure 4 Return loss model of 10m cable compared to Cat8 limit line.**

Channel modeling.

The first two channels modeled are the 0.5-3-0.5 channel and the 1-10-1 channel. The cables and equipment cords are based upon +/- 5 Ohm offsets. The 1-10-1 channel is modeled with the cable model with structure. The 0.5-3-0.5 model is modeled with a horizontal cable with a single offset impedance.

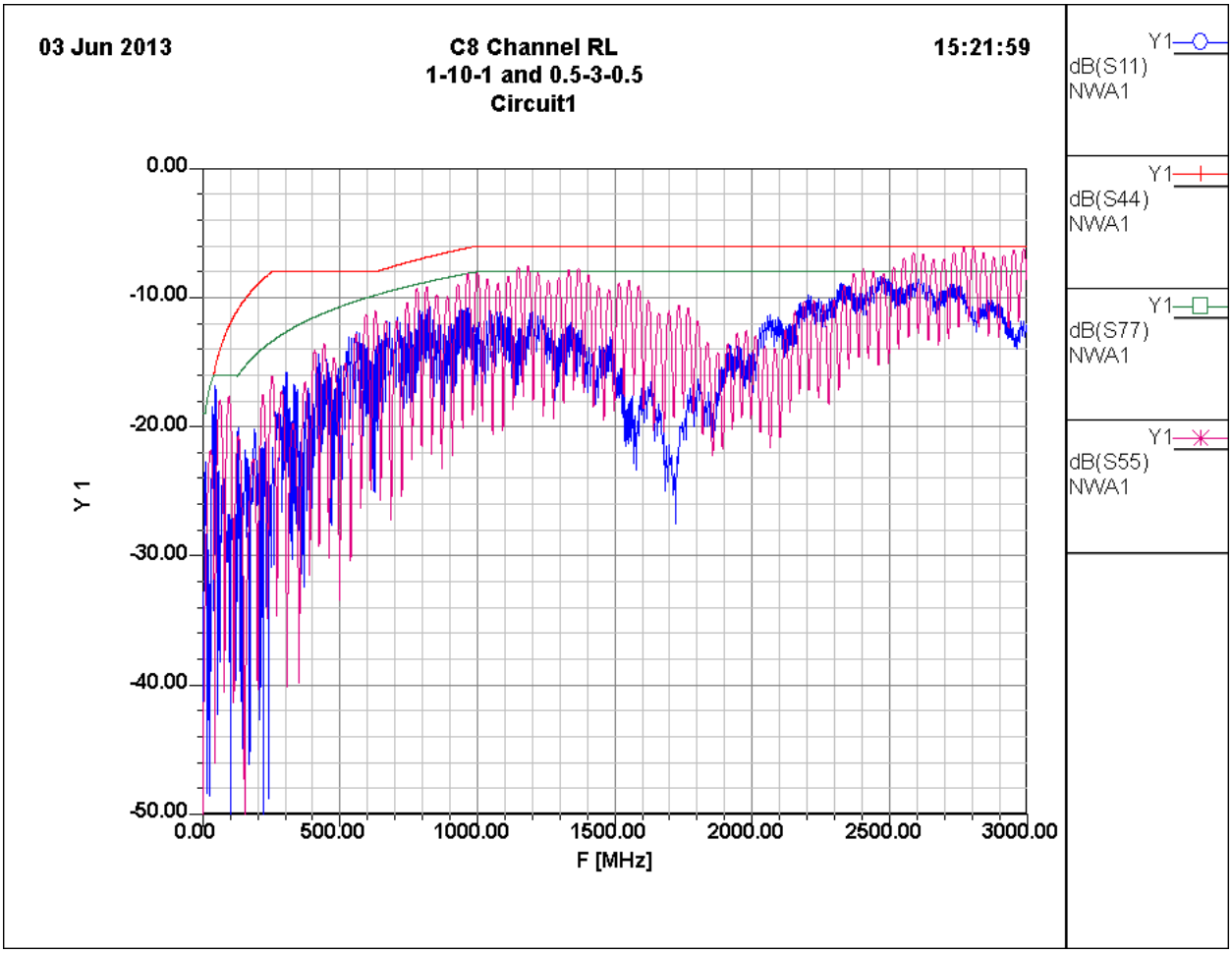


**Figure 5 Channel return loss models 0.5-3-0.5 and 1-10-1**

The 1-10-1 channel would meet an 8 dB minimum return loss plateau whereas the 0.5-3-0.5 channel model would only meet the 6 dB minimum return loss plateau. Note that the existing channel return loss limit with the 6 dB plateau leaves quite a bit of margin between the 40 and 631 MHz. Also note that there is a peak of return loss at the low frequencies in the range of roughly 30 to 100 MHz due to the cable impedance offset. This can be seen more clearly on a log scale. The 1-10-1 channel is blue and the 0.5-3-0.5 channel is red. The green limit line is a proposal for Category 8 that aligns with ISO/IEC 11801-99-1 2ndPDTRClass II Channel above 631MHz.

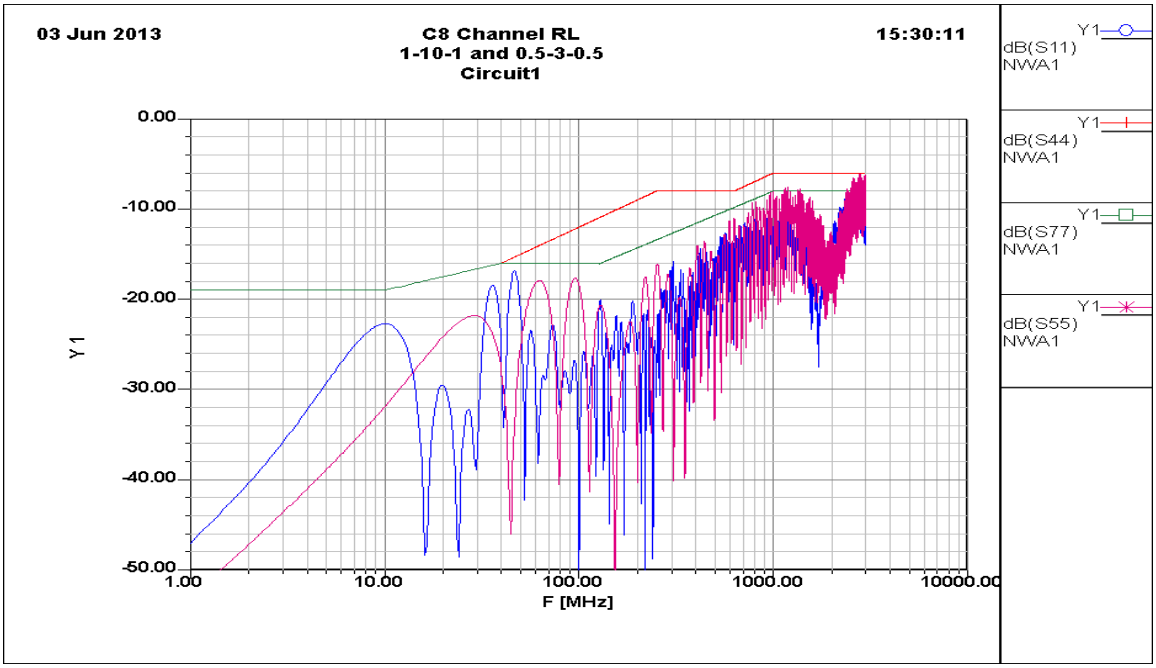


**Figure 6 Channel return loss models 0.5-3-0.5 and 1-10-1 log frequency plot.**

Neither of the above channel is the longest or shortest.

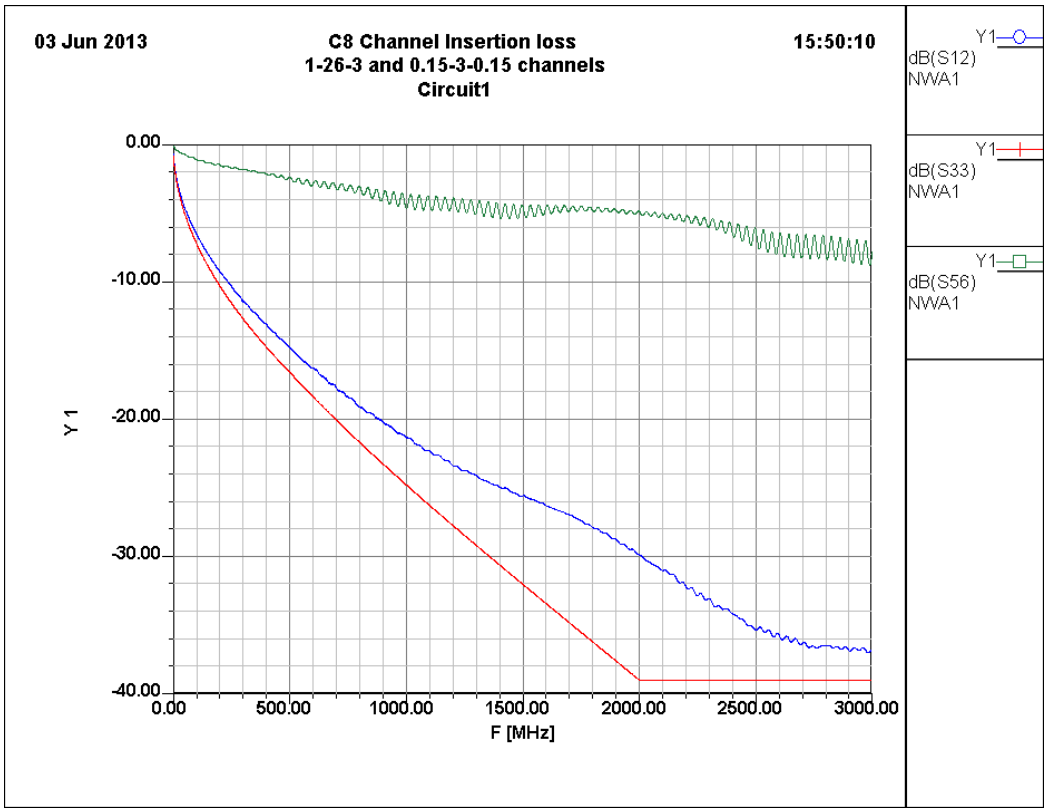


**Figure 7 Channel insertion loss for 1-26-3 and 0.15-3-0.15 channels**

Return loss for 1-26-3 and 0.15-3-0.15 channels

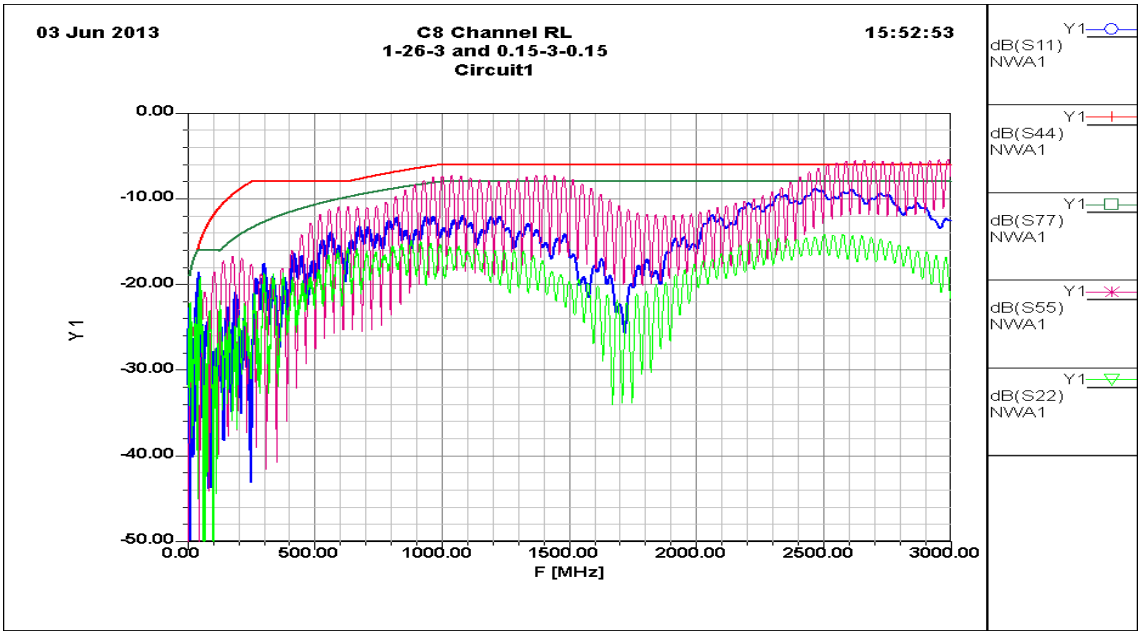


**Figure 8 Channel return loss 1-26-3 and 0.15-3-0.15 channels**

The shortest channel is the red curve, the longest channel is the blue and green curves. The blue curve is looking into the 1m equipment cord end, whereas the green curve is looking into the 3m equipment cord end. Note that the longer cord yields approximately a 5 dB improvement in the worst case magnitude. The effect of the longer equipment cord holds true regardless of overall channel length. Note how the red curve is improved in the following.

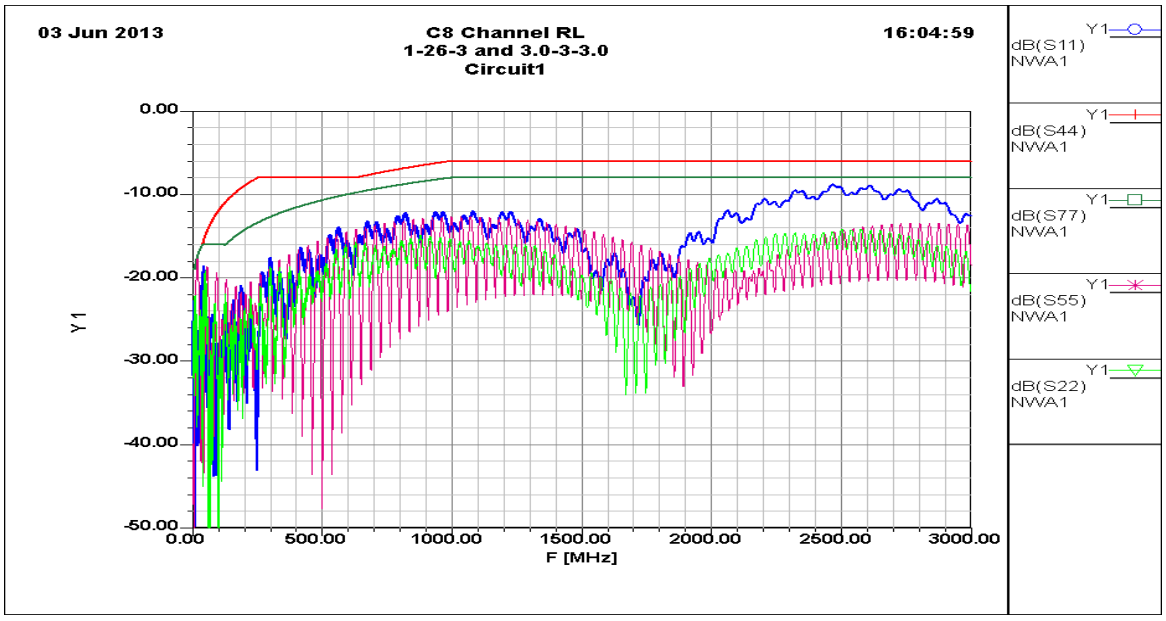


**Figure 9 Channel return loss 1-26-3 and 3.0-3-3.0 channels**

Now for the other long channels. The other channel assumed worst case is the 1-24-5 model. This is still not worst case for insertion loss, however which assumes 10m total patch cordage.

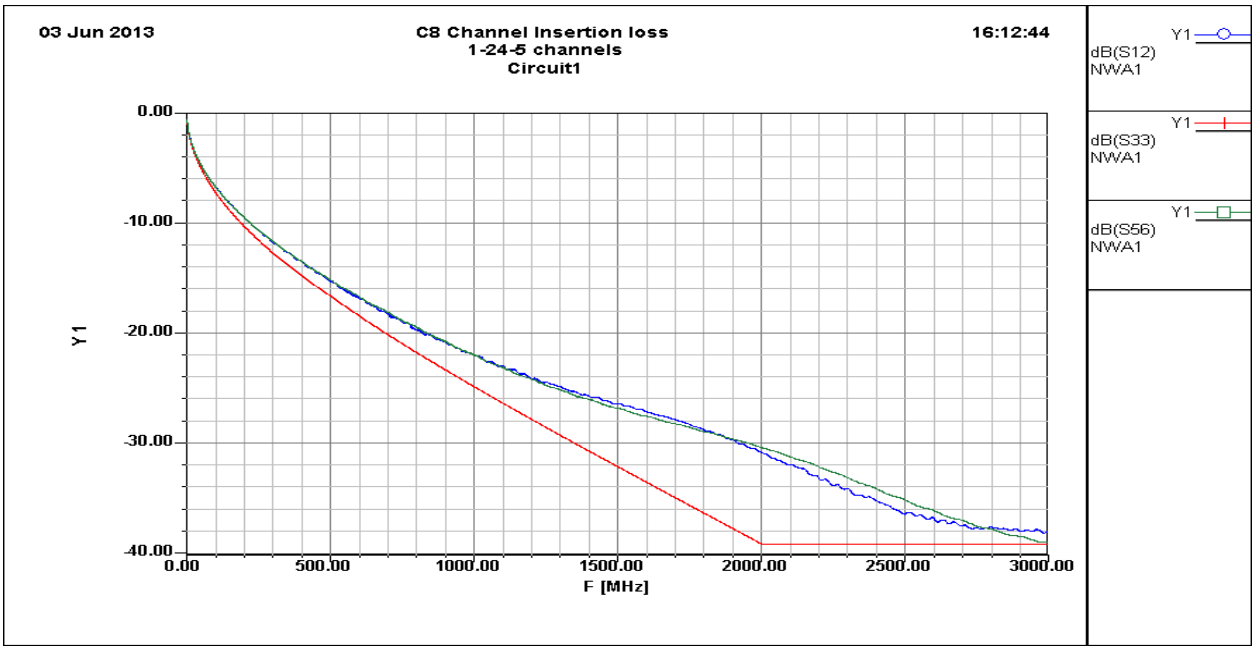


**Figure 10 Channel insertion loss for 1-24-5 channel with and without cable structure**

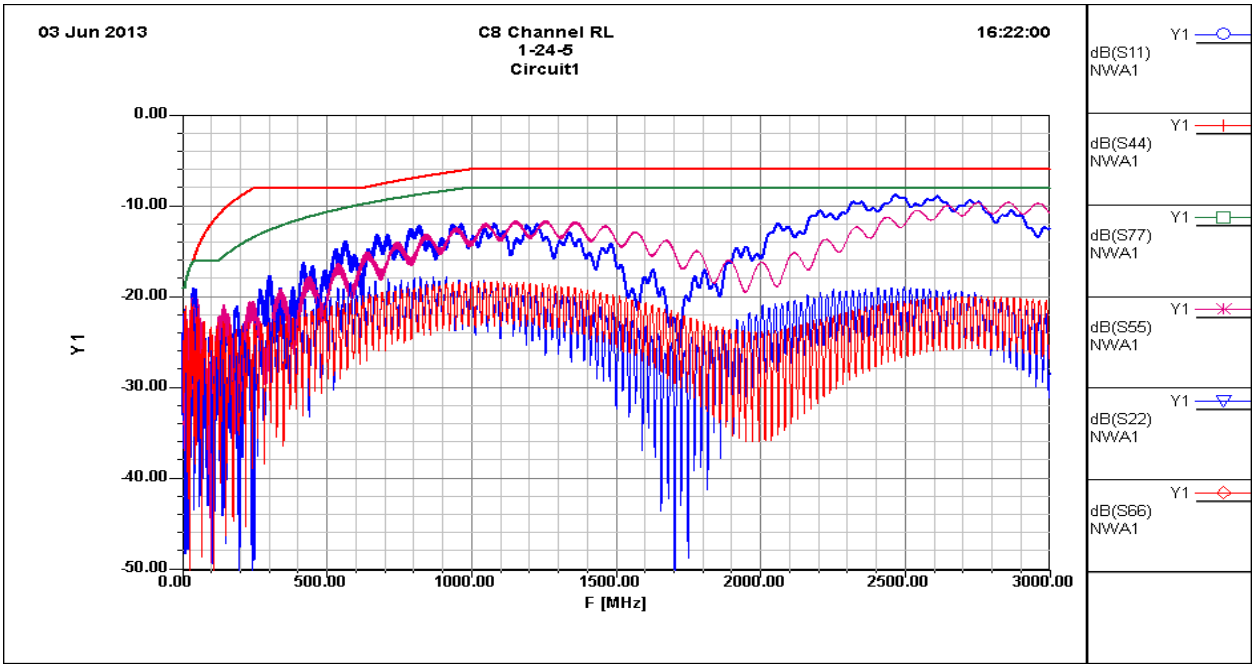


**Figure 11 Channel return loss for 1-24-5 channel with and without cable structure**

Note that the blue traces are opposite ends of the channel with cable structure. The red traces are opposite ends of the simple cable model.

And finally let's look at a 5-20-5 channel.

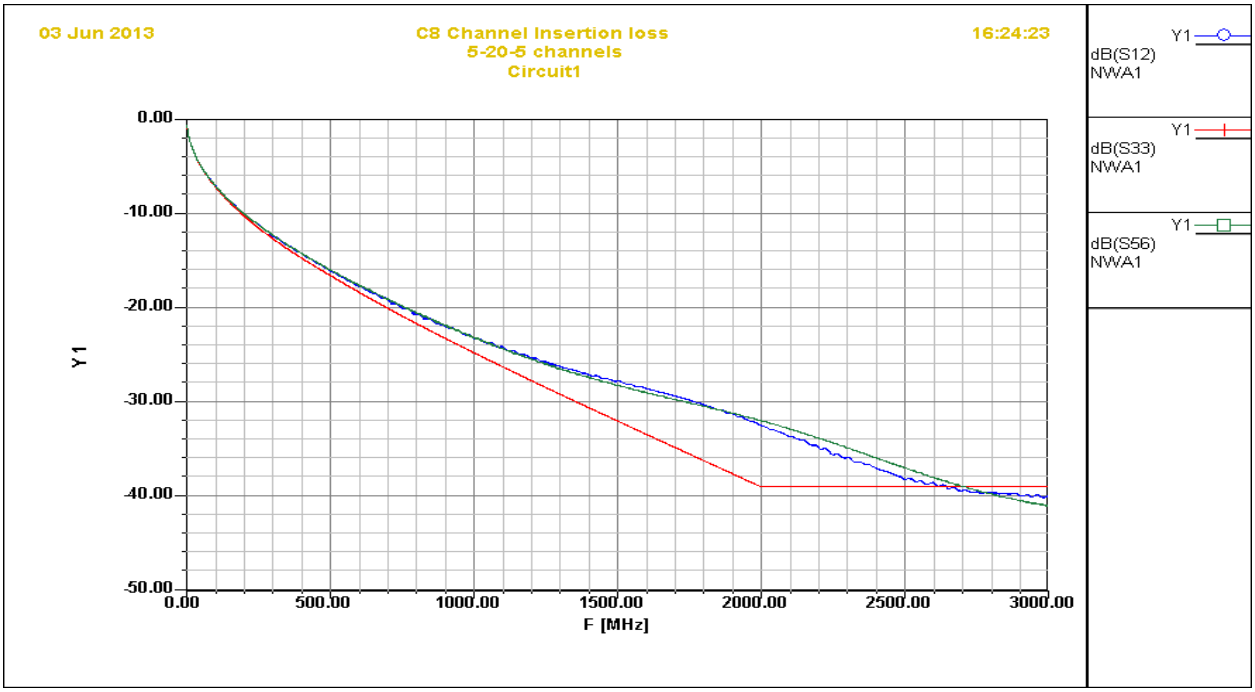


**Figure 12 5-20-5 channel insertion loss model.**

Note that there is margin to the limit even with the longest cords.

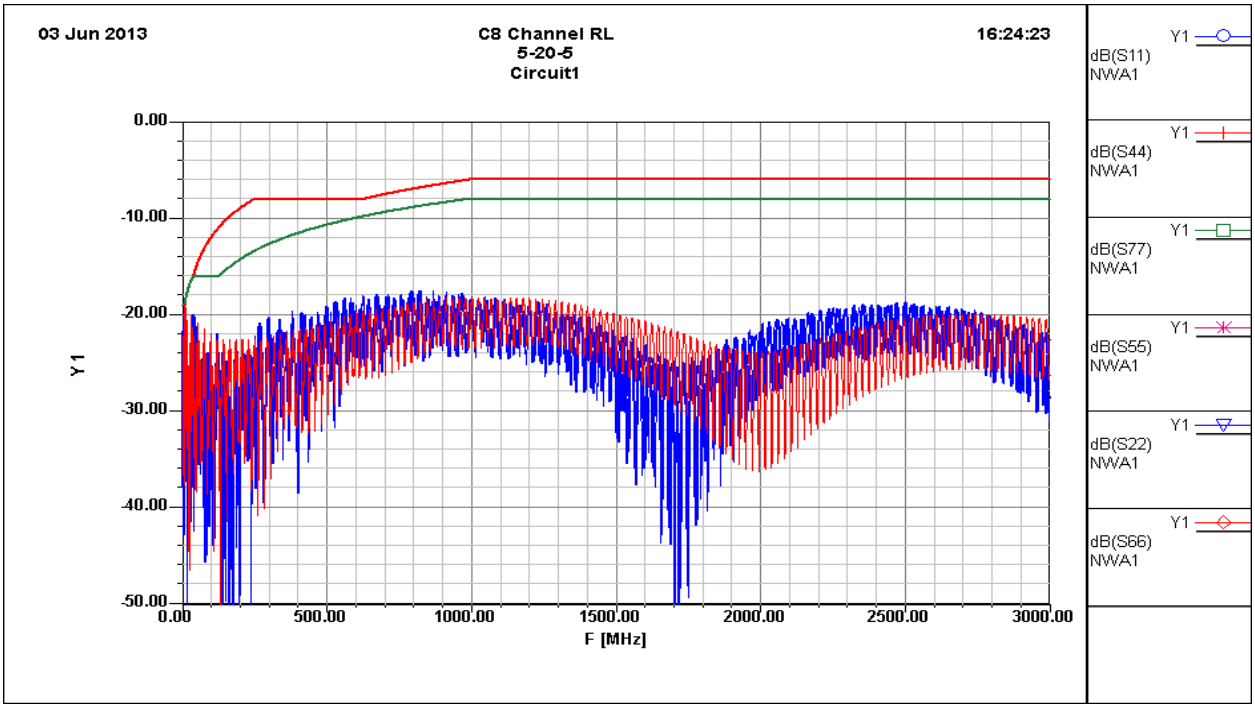


**Figure 13 Channel return loss for 5-20-5 channel.**