Return loss and impedance

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Some issues related to return loss and impedance

- Clause 136 (CRn) Comment no.
  1. COM with non-neutral termination impedances is inaccurate
     1. Fixed for KRn, needs fixing for CRn. COM impedances should be moved towards neutral, as explained in D2.0 comment 71 and 113 47
     2. With COM to a neutral impedance basis, using 109.8 ohm PCB impedance seems inconsistent 48
  2. It seems the test channel RL (Rx end) needs some tightening, even if not as much as in D2.0 comment 72 45
- Clause 137 (KRn)
  1. Return loss in is either too restrictive for devices and not restrictive enough for channels
     25, 27, 28
  2. Tx RL is too tight at low frequencies 52
  3. Rx RL is too tight 37
     - The same problem that applied to Tx now applies to Rx

Effect of moving COM to neutral termination

- Previously, COM calculation on channel:

Tx		Channel	Rx	
Term	Pkg	Channel	Pkg	Term
High	Low	under test	Low	High

- Receiver interference tolerance test:

Test Tx		Channel	Rx	
Term	Pkg	Channel	Pkg	Term
Neutral	Neutral	Neutral?	Under test	

- Some receiver return loss was in the RITT channel COM calibration, so it was expected that real receivers should not be much worse than the COM termination

This and next slide apply to C2C and KRn. How much do they apply to CRn?

Effect of moving COM to neutral termination

- Now, COM calculation on channel:

Tx		Channel	Rx	
Term	Pkg	Channel	Pkg	Term
Neutral	Neutral	under test	Neutral	Neutral

- Receiver interference tolerance test:

Test Tx		Channel	Rx	
Term	Pkg	Channel	Pkg	Term
Neutral	Neutral	Neutral?	Under test	

- Very little receiver return loss is in the RITT channel COM calibration, so it is now the receiver's own responsibility and can be traded off with other receiver attributes
- Now there is no need to try to match modelled COM RL and product RL limit

What do we want the RL specs for now?

1. Contain Tx to channel double reflections
2. Contain channel to neutral Rx double reflections
3. No longer – contain neutral channel to product Rx double reflections
4. Contain Tx to Rx double reflections
   - At all but the lowest frequencies, channel loss makes these insignificant

How are we doing? KRn

1. Contain Tx to channel double reflections
   - Channel RL spec and recently tightened (P802.3bs D3.1) Tx RL spec address this
     - Very tight (12 + 14.25 dB) at low f, looser in few GHz range
2. Contain channel to neutral Rx double reflections
   - Channel RL spec addresses this
3. No longer – contain neutral channel to product Rx double reflections
4. Contain Tx to Rx double reflections
   - Overkill: 14.25 + 14.25 dB near DC, even more attenuated at other frequencies where channel loss is higher

Proposed remedies

1. Tx RL at low frequencies can be relaxed
2. Channel RL at very low frequencies could be tightened
   - Or, we can just accept that it will be OK
3. –
4. Rx RL should be relaxed significantly
   - Use Eq 93-3 that we had before as a backstop – probably overkill but the industry is used to it

Detail: comment 52, KRn transmitter differential output return loss

- Refers to P802.3bs Table 120D–1
- Now that COM is defined with a near-neutral termination and package impedance, we can't expect transmitter return loss to align to the COM model any more
- This RL spec is much tighter than CEI-56G-LR at low (and high) frequency (although apparently looser between 4 and 9 GHz). Also it is tighter at low frequencies than the channel RL limit, which seems wrong.
- The effect of (good) RL at low frequency is much less than the less good RL at higher frequencies anyway
- There is less concern about end-to-end reflections in KRn than in C2C because the loss is ~10 dB higher when the receiver is challenged
- The low frequency RL at 14.25 dB is insignificant for signal integrity compared with the 8.7 dB at 6 GHz
  - i.e., the spec is unnecessarily stringent
- So we can go back to what we had a few drafts ago
- If bs doesn't fix this, add another exception and create new equation for Tx RL that is similar to the Cl.93 and the channel RL at low frequencies;
- 12 -0.625f, 8.7-0.075f. Add figure to illustrate. Refer to new equation instead of existing 137-1

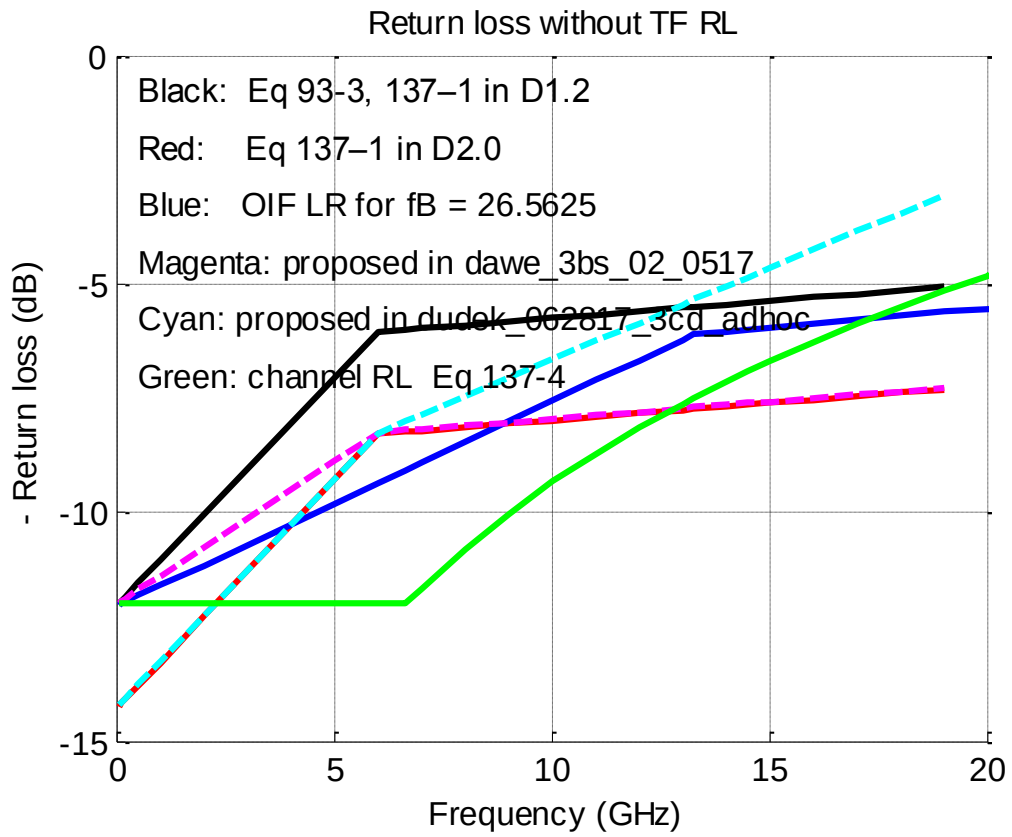
For info: P802.3bs D3.3 comment 34 (C2C receiver differential input return loss)

- Changing the return loss spec for the receiver was a mistake, because the effects of receiver reflections to a nominal-impedance channel and transmitter are in the receiver interference tolerance test, and the extra reflections to a channel and transmitter with different impedances are controlled/accounted for by the channel COM, now based on nominal impedances, the new channel return loss spec and the transmitter return loss spec.
- From the simple formula for reflection at an impedance mismatch, one can see that these effects are close to additive, so controlling/accounting for them separately is OK. In other words, the receiver pays for its own reflections in the interference tolerance test, so **we don't have to tell the receiver designer how to do his job** in this regard.
- **In Table 120D–5, revert 120D.3.1.1, Equation (120D-2) to 93.8.1.4, Equation (93-3).**

Detail: comment 30, KRn receiver differential input return loss

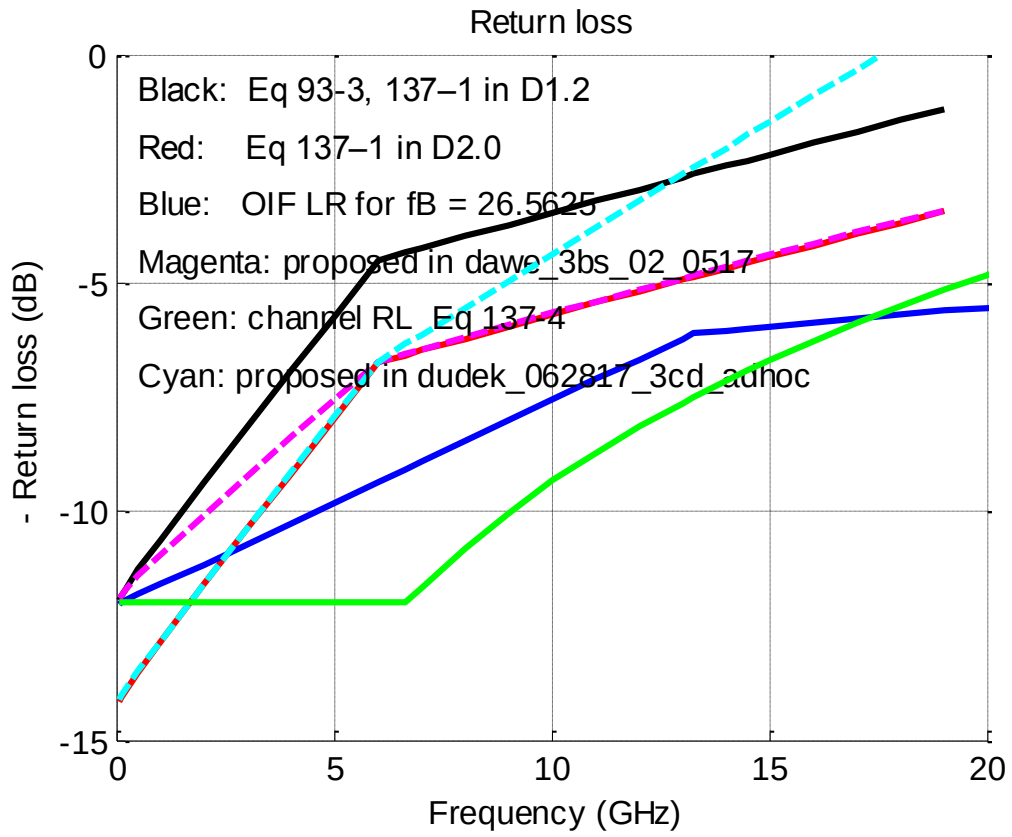
- Now that COM is defined with a near-neutral termination and package impedance, receiver mismatch is the receiver designer's concern, not the standard's, unless it is very extreme, because the receiver interference tolerance test finds its effect combined with other receiver attributes
- We don't expect or need receiver RL to align to the COM model any more
- This RL is much tighter than CEI-56G-LR at low (and high) frequency (although apparently looser between 4 and 9 GHz)
- At low frequencies it is tighter than the channel RL limit, which seems wrong
- The effect of (good) RL at low frequency is much less than the less good RL at higher frequencies anyway
- There may be less concern about end-to-end reflections in KRn than in C2C because the loss is ~10 dB higher when the receiver is challenged
- So we can go back to what we had a few drafts ago
- Change "shall meet Equation (137-1)" to "shall meet Equation (93-3)" and delete Eq 137-1 and Fig 137-3. Or, change 14.25 - f to 12 -0.625f, revise the figure.
- If P802.3bs fixes this, we can refer to Table 120D–5 and remove 137.9.3.1 (comment 30)

Showing various return loss limits

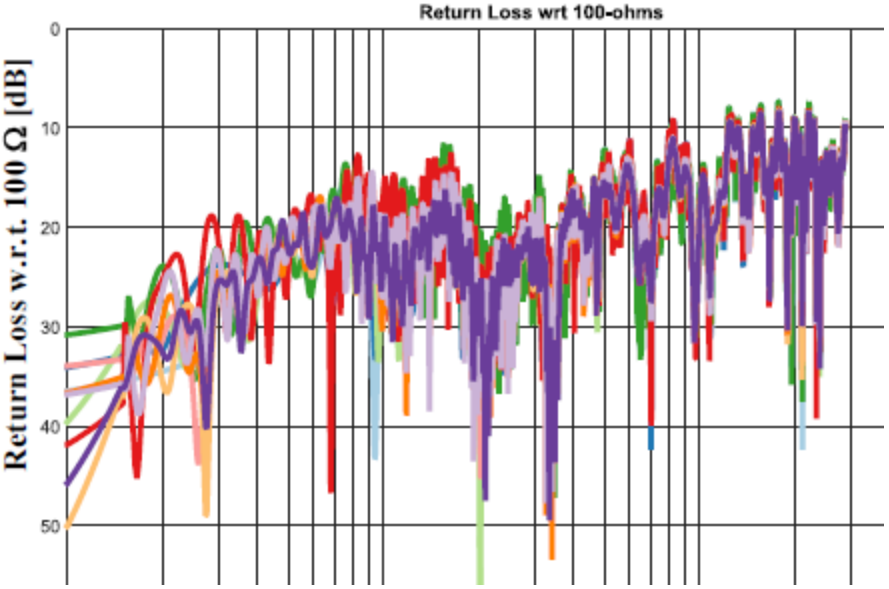


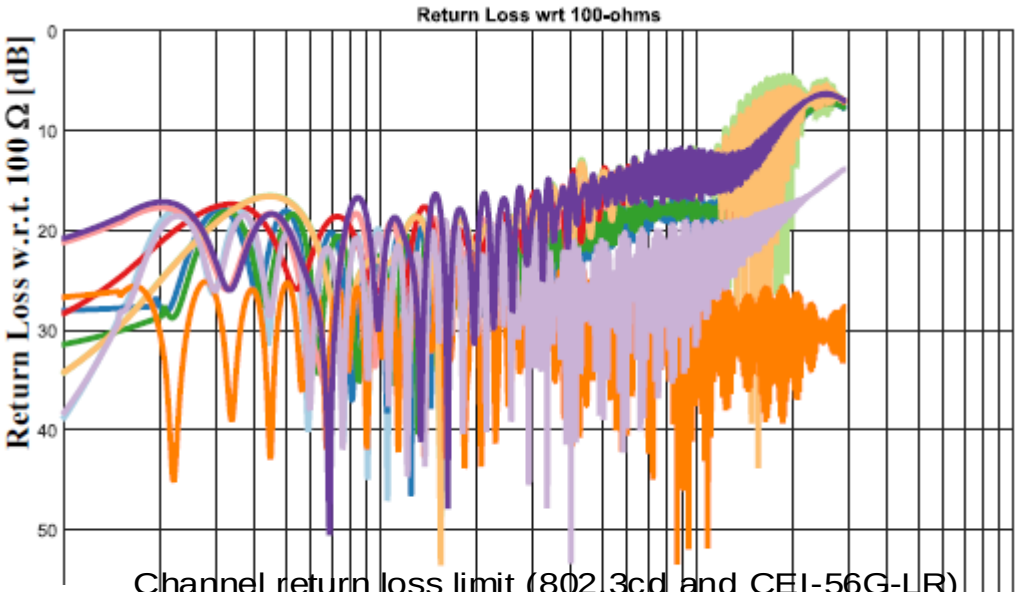
Nominal return losses: channel and OIF at IC, others at test fixture

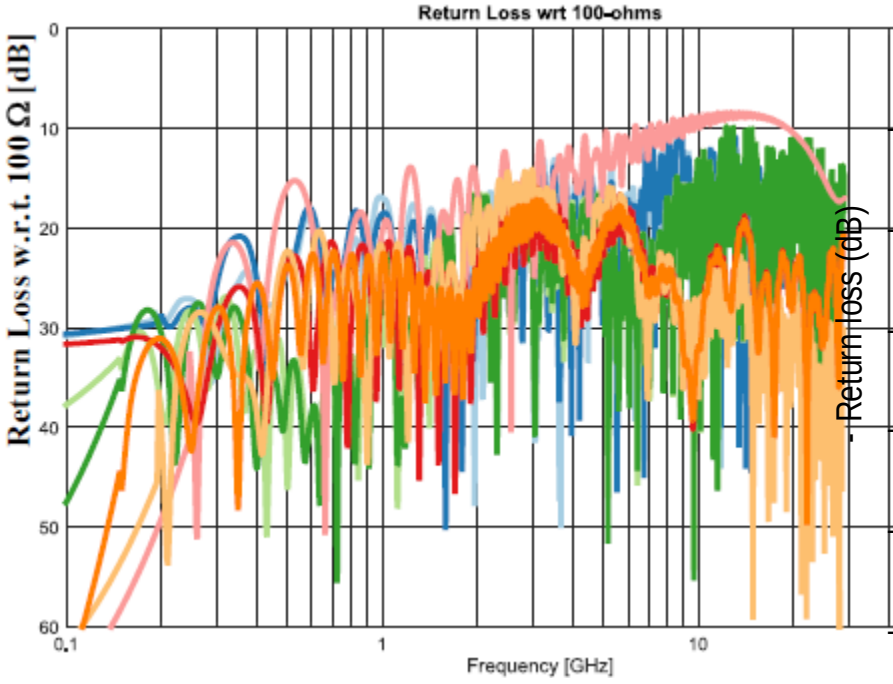
Adjusting for test fixture IL but not its RL

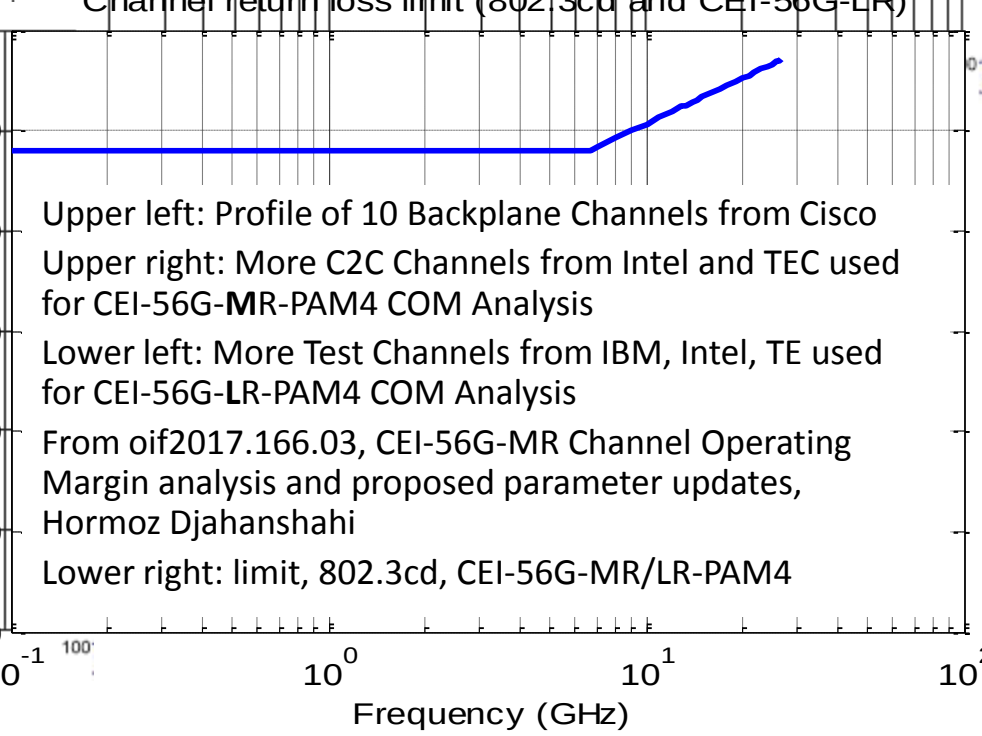


- Compare previous slide
- Red and cyan are too tight at low f
- Cyan is too loose at high f
- Black is too loose at mid f
- Green – channel (compare next two slides)









Upper left: Profile of 10 Backplane Channels from Cisco

Upper right: More C2C Channels from Intel and TEC used for CEI-56G-**M**R-PAM4 COM Analysis

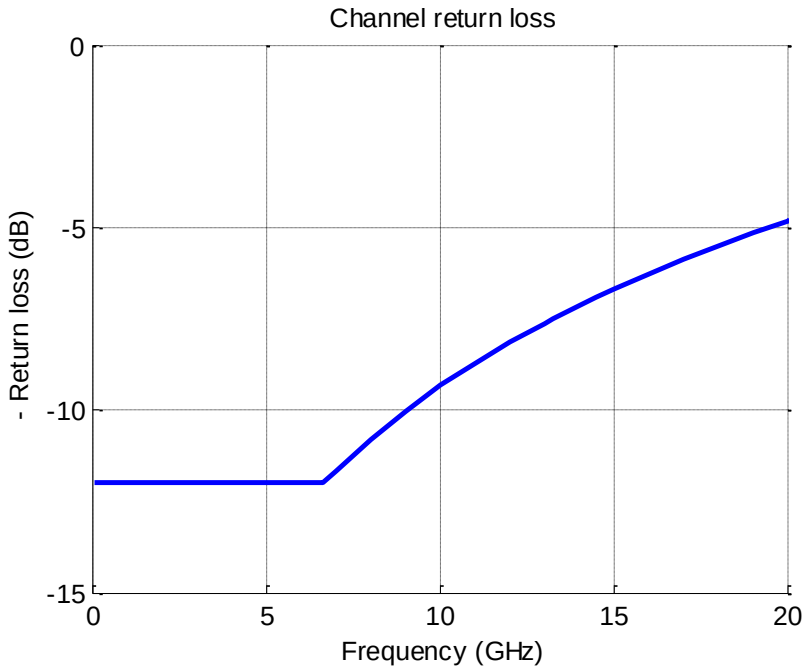
Lower left: More Test Channels from IBM, Intel, TE used for CEI-56G-**L**R-PAM4 COM Analysis

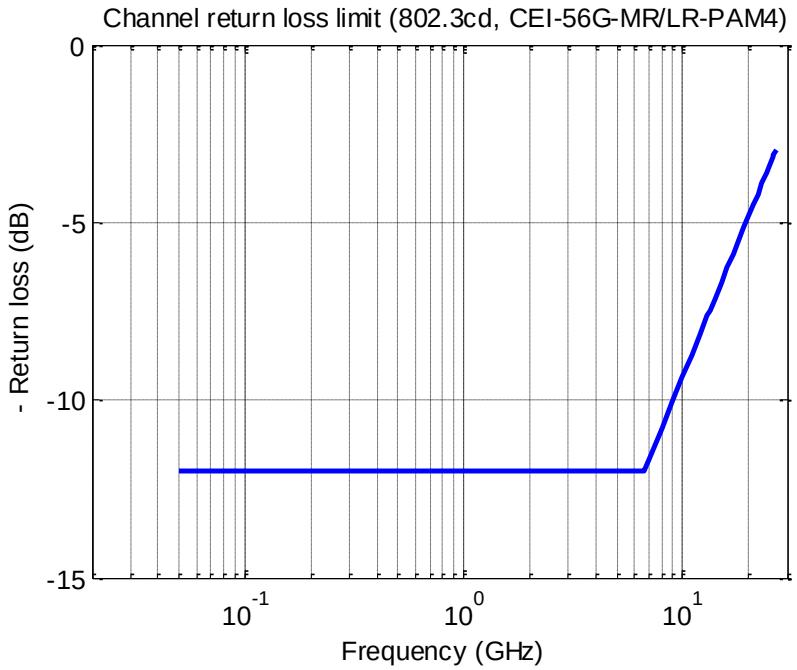
From oif2017.166.03, CEI-56G-MR Channel Operating Margin analysis and proposed parameter updates, Hormoz Djahanshahi

Lower right: limit, 802.3cd, CEI-56G-MR/LR-PAM4

It appears that channel RL will be much better than spec << 1 GHz

Channel return loss





- Channel return loss (at TP0 or TP5) from 802.3bs Eq. 120D-12, 802.3cd Eq. 137-4
- Also OIF CEI-56G-MR-PAM4 Eq 17-3 and LR-PAM4 Eq 21-3