On Receiver Considerations for ACT

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Overview

- In previous meetings, the following presentations discussed the Upstream ACT receiver performance:
    1. sedarat_3dm_202501.pdf
    2. ahuja_8023dm_01a_011325_on_upstream_receiver_design_and_performance_ACT.pdf
    3. Lo_3dm_02a_0125.pdf
    4. jonsson_3dm_01b_01_20_25.pdf
- Some concerns were raised about the echo modelling for Upstream ACT simulations (particularly for presentations 1 and 2 above):
    - Return Loss limit at 12.5/17 dB (Proposed ASA Limit/Previous ASA limit) is too pessimistic and is hit only when the characteristic impedance for the cable segments touches the extreme values - (47/53 ohms) or (48/52) ohms [Refer: jonsson_3dm_01_02_27_25].
    - Return loss for a link assembly will not touch the limit line at all frequencies, and therefore, assuming a flat echo response touching the limit line is too pessimistic.
- Previous studies did not account for the effect of echo from the far-side and near-side MDI components, a factor which is introduced in this study.

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Return Loss for the Upstream Channel

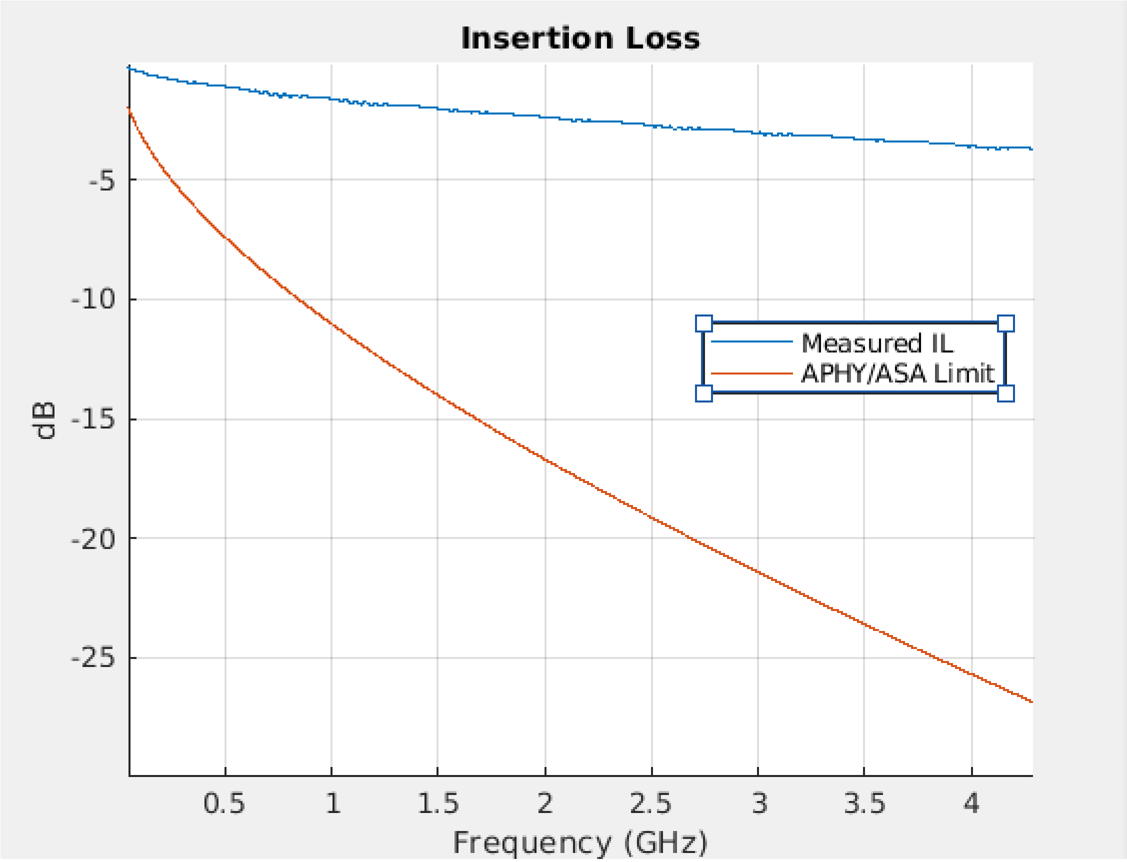
- Consider the following link assembly consisting of 5 segments:

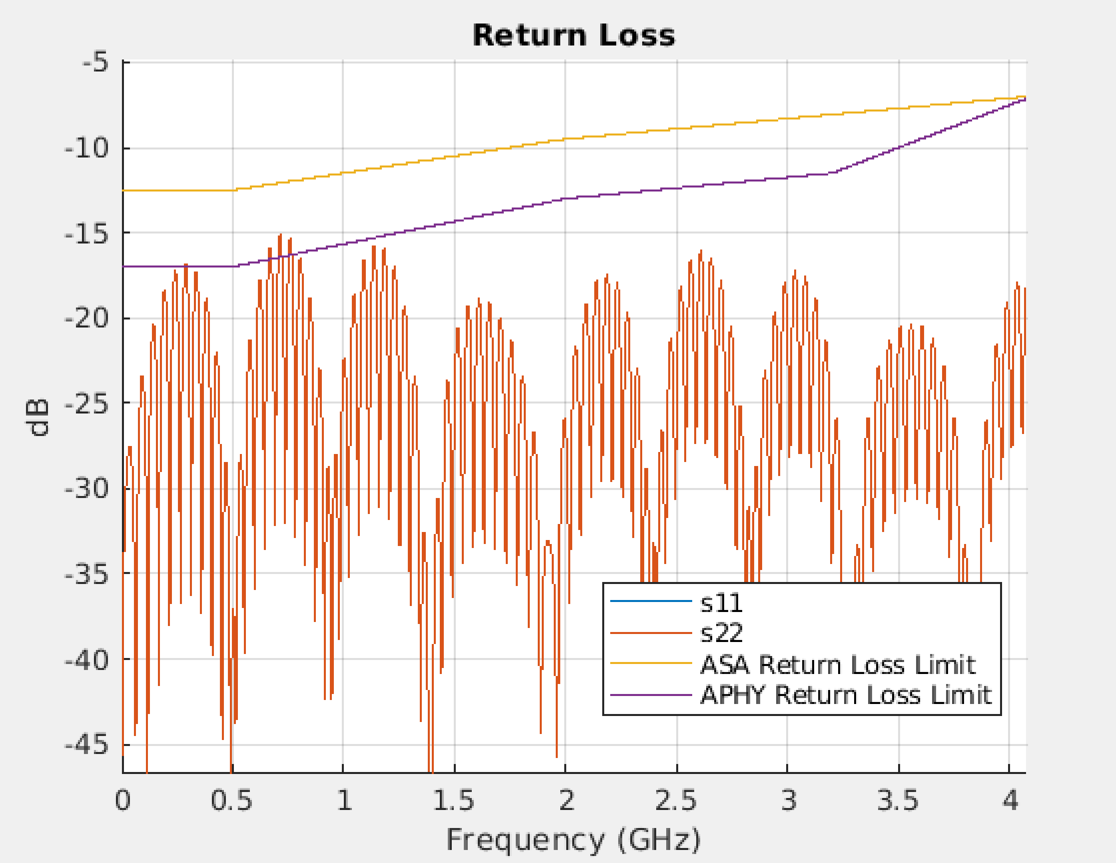
Segment Index	Cable Type	Length	Char Impedance
1	RG174	0.05 m	48 Ohms
2	RTK031	0.25 m	52.4 Ohms
3	RTK031	2.25 m	48 Ohms
4	RTK031	0.25 m	52.4 Ohms
5	RG174	0.05 m	48 Ohms

- The coaxial cable segments are modelled using a simple coaxial cable parametric model.
  - The model is not capable of accounting for micro-reflections.
- The effect of connectors is not included.
- It is also assumed that all the segments of the cable are at 105 deg C.

Return Loss for the Upstream Channel

- The achieved insertion loss and return loss is as follows:





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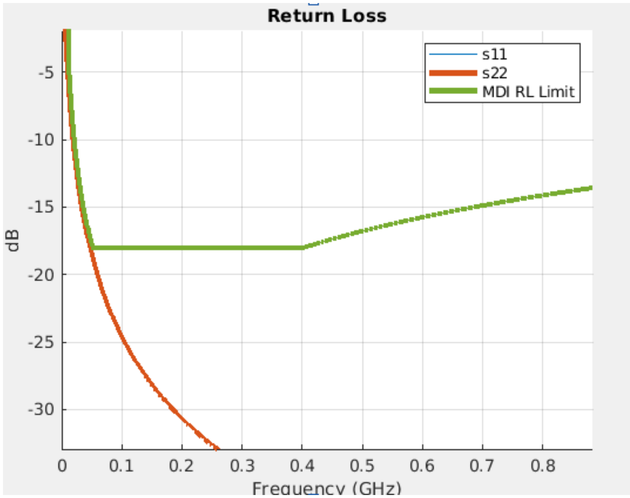
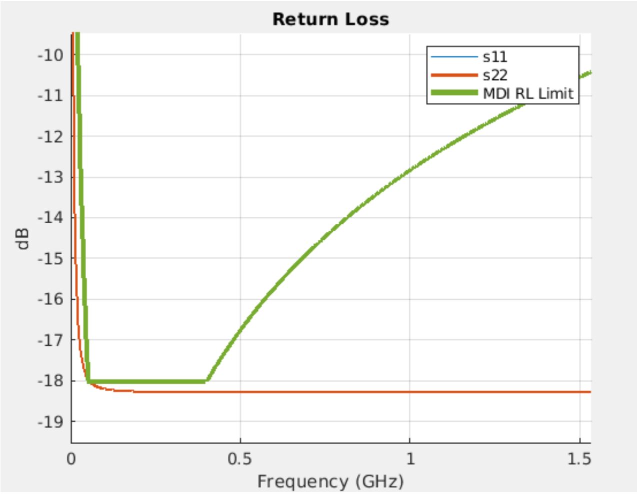
Return Loss for the Upstream Channel

- The near-end MDI is modelled as a single inductor with the following return loss characteristic:



- The far-end MDI is modelled (pessimistically) as a passive circuit with the following return loss characteristic which is close to the MDI limit.



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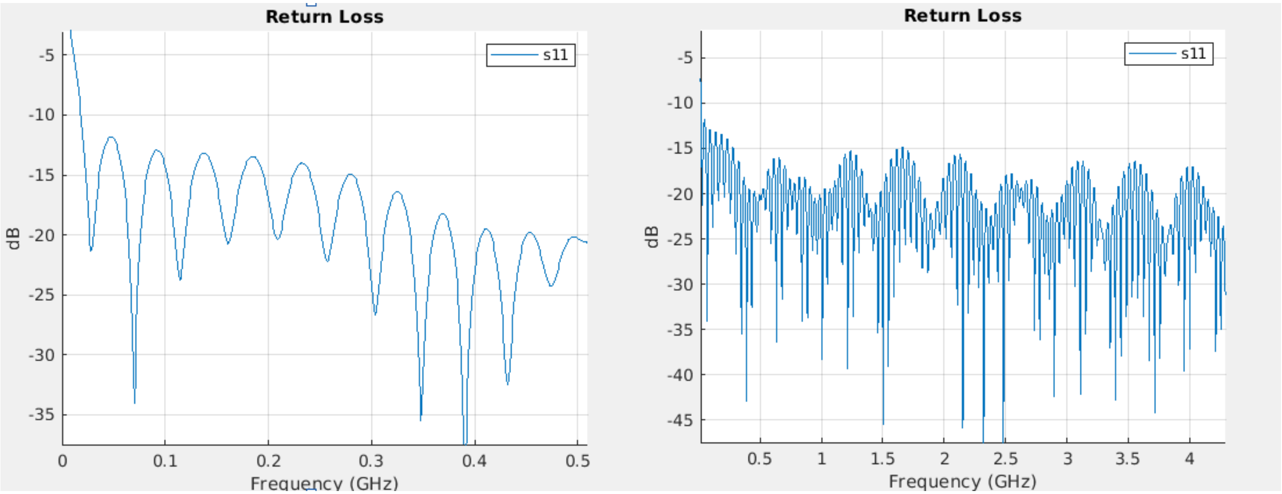
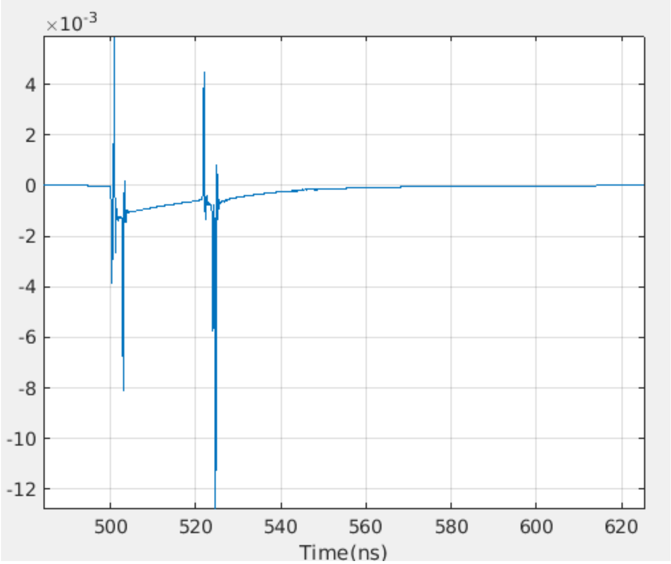
Return Loss for the Upstream Channel

- For the channel consisting of [Near-End MDI| Cable/Link Assembly | Far-End MDI], the following return loss characteristic is obtained:



- The time-domain response of the echo-path is as follows:



Return Loss for the Upstream Channel

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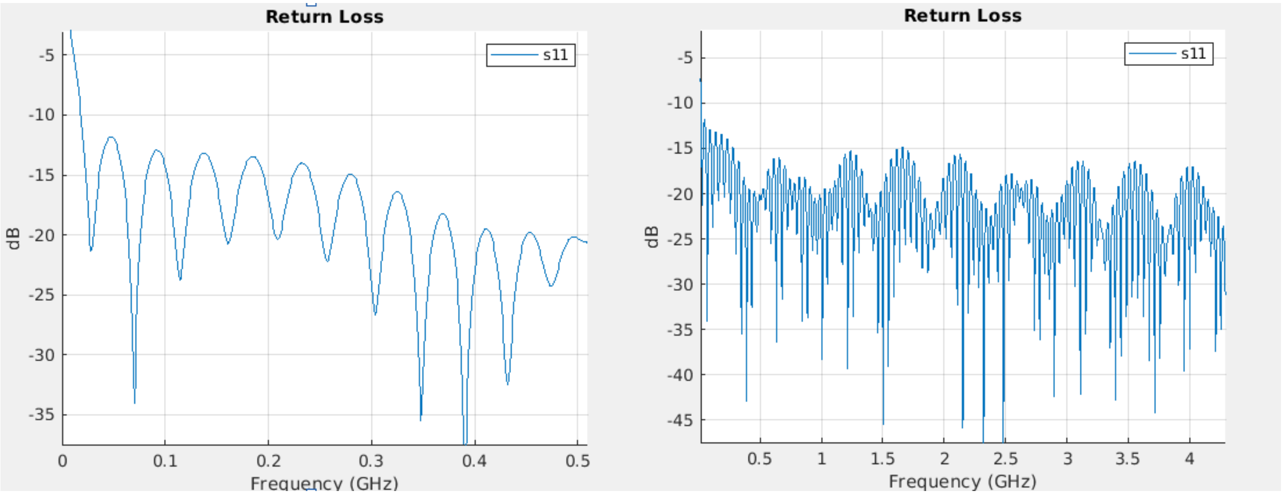

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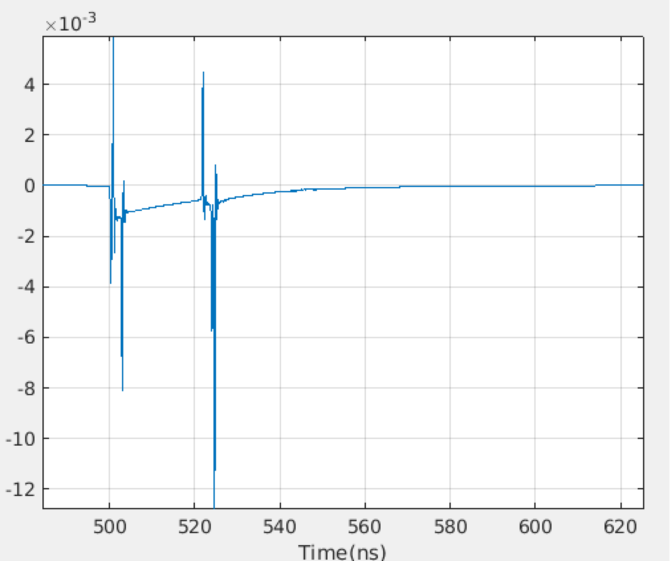

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Return Loss for the Upstream Channel

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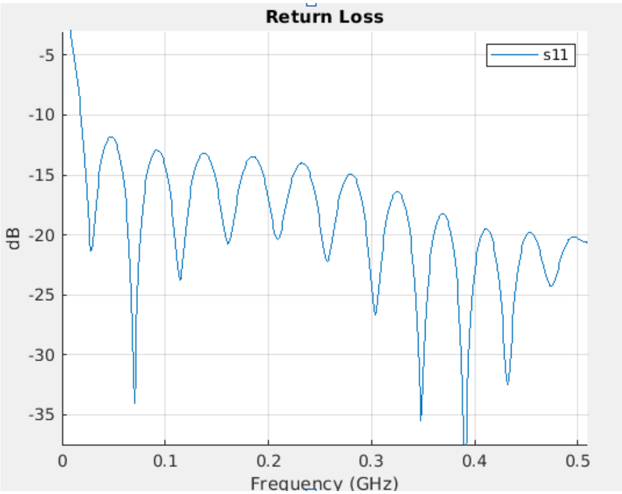

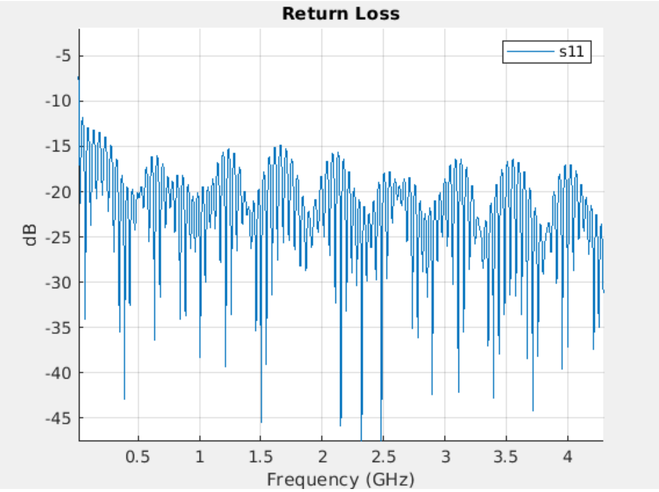

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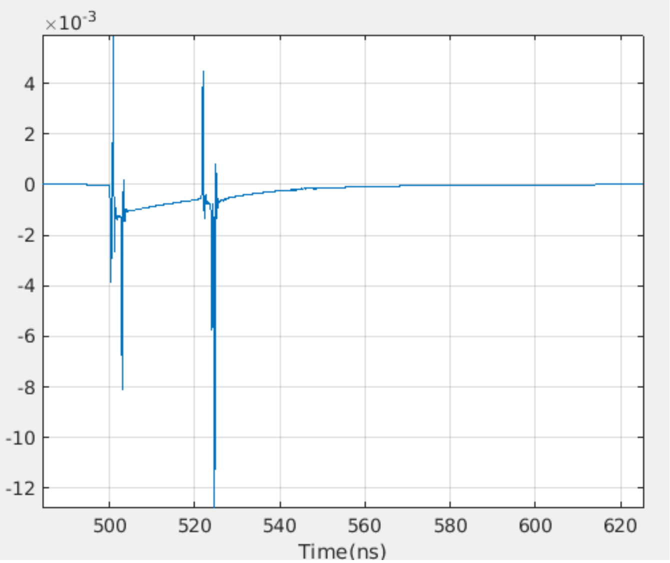

Return Loss for the Upstream Channel

- The total echo power resulting from this in a 250 MHz band from the derived echo channel is:

Configuration	Resulting Power Loss
PAM4 Downstream ->Echo Channel -> 250 MHz LPF	-14 dB
PAM4 Downstream ->Echo Channel -> HighPass (First Order 31 MHz)-> 250 MHz LPF	-16 dB

- The resulting echo power is very similar to the figures considered in sedarat_3dm_202501.pdf and ahuja_8023dm_01a_011325_upstream_receiver_design_ACT.pdf , which resulted in sub-optimal / marginal performance.

Discussion / Conclusion

- It seems that given the possibility of high echo, either echo cancellation or increasing upstream transmit power will be required for achieving adequate SNR performance.
  - Increasing transmit power for Differential Manchester Encoded upstream transmission raises concerns regarding emissions.
  - Echo cancellation will entail a digital receiver implementation and handling a long echo impulse response (due to the long-tailed impulse response produced by the inductor, and multiple reflections from the cable segment junctions) requires a fairly complex implementation.
- It may also be argued that the scenario presented in this study is pessimistic. However, the pessimistic assumption regarding return loss is made only for the far-side (Deserializer) MDI, and it is generally a good PHY design practice to make pessimistic assumptions about the far-side transceiver.

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