IEEE P802.3dd 10BASE-T1L Droop

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Introduction

- The task force has voted to increase the droop limit from 10% to 25%
- A previous presentation addressed the issue of size and cost of power magnetics and the rational for the increase to 25%
  - https://www.ieee802.org/3/dd/public/Stewart_3dd_01_08312021.pdf
- This presentation is in relation to the following comment

Technical	26	146.5.4.2	24	Implementers indicate that receivers are insensitive to droop of 30%, and that it improves economic feasibility for 10BASE-T1L transceivers with inline power.	Change "25%" to "30%" at P26 L24

- We have included some simulations results on the measurement of the droop to provide some background and context
  - We have also included some more lab results to backup the change to 25% already voted on
- We propose keeping the 25% droop limit
- And propose additional language to ensure measurement effects are properly taken into account

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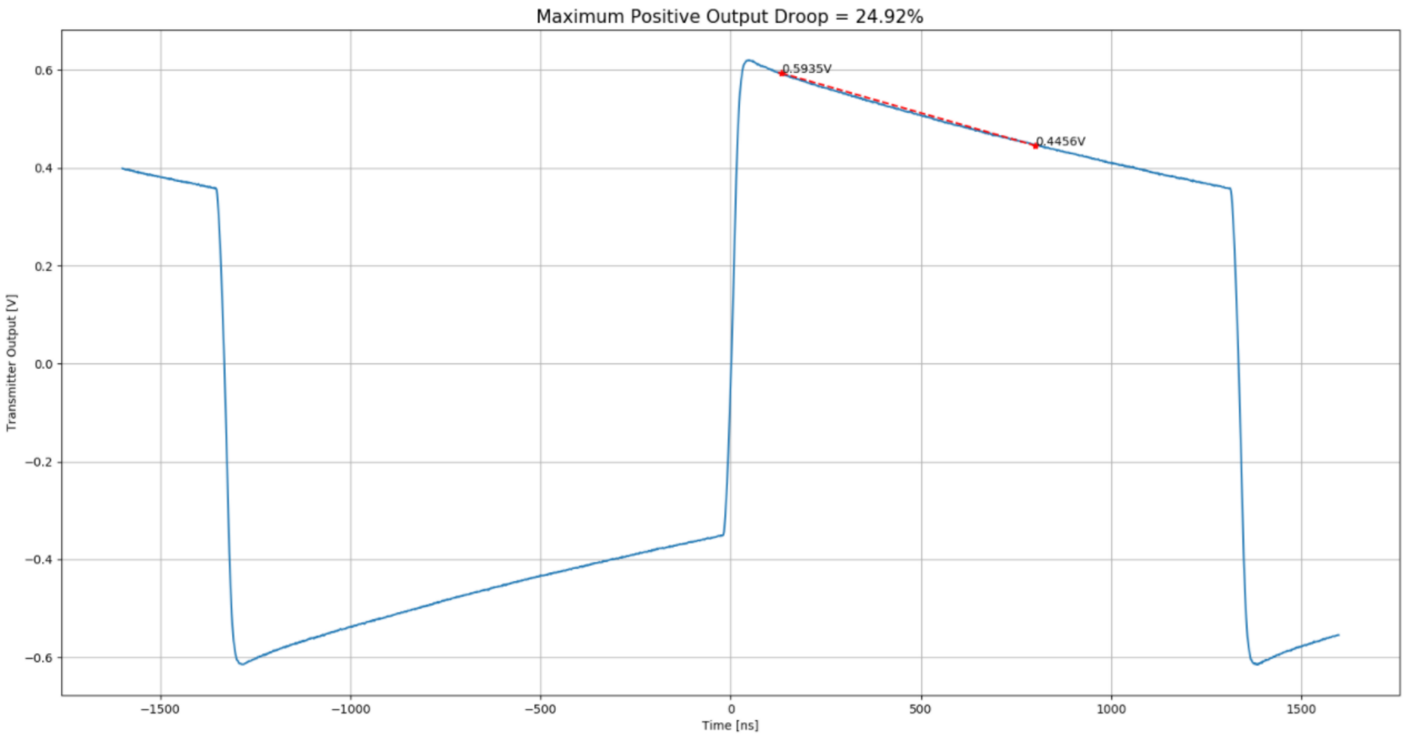
Droop Measurement Points

- IEEE Std 802.3cg specifies that droop is computed using measurements made 133.3ns and 800ns after the zero-crossing
  - The delay to the first measurement point is insufficient to allow the signal to settle after the edge
  - The signal can be affected by ringing and reflections associated with the measurement setup
  - As droop increases the midpoint of the edge is delayed relative to the zero crossing

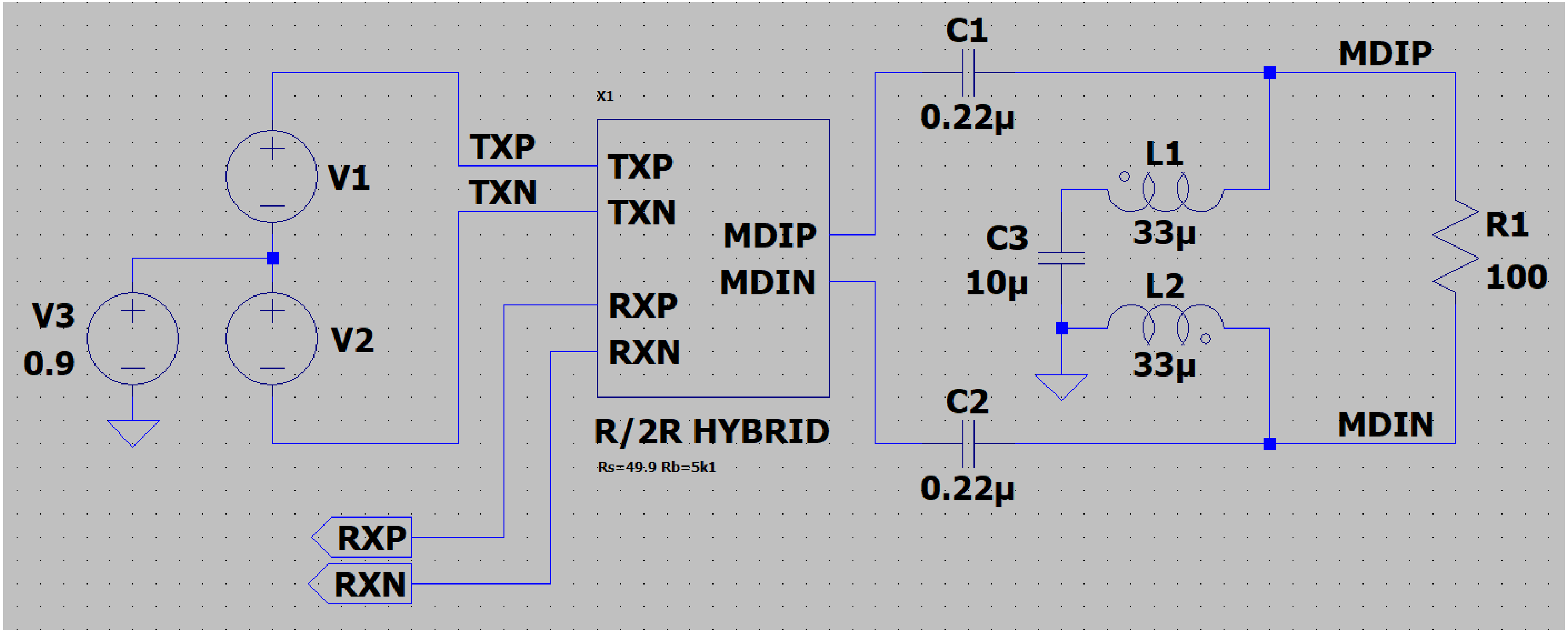


Proposed Droop Measurement Points

- Proposal is to compute droop using measurements made 400ns and 1066.7ns after the zero-crossing
  - Droop is computed over an interval of 5 symbol periods as before
  - In a system with a dominant pole the computed droop is unchanged by the delay

Example Circuit with Droop Close to 25%

Using a 33uH coupled inductor for power coupling



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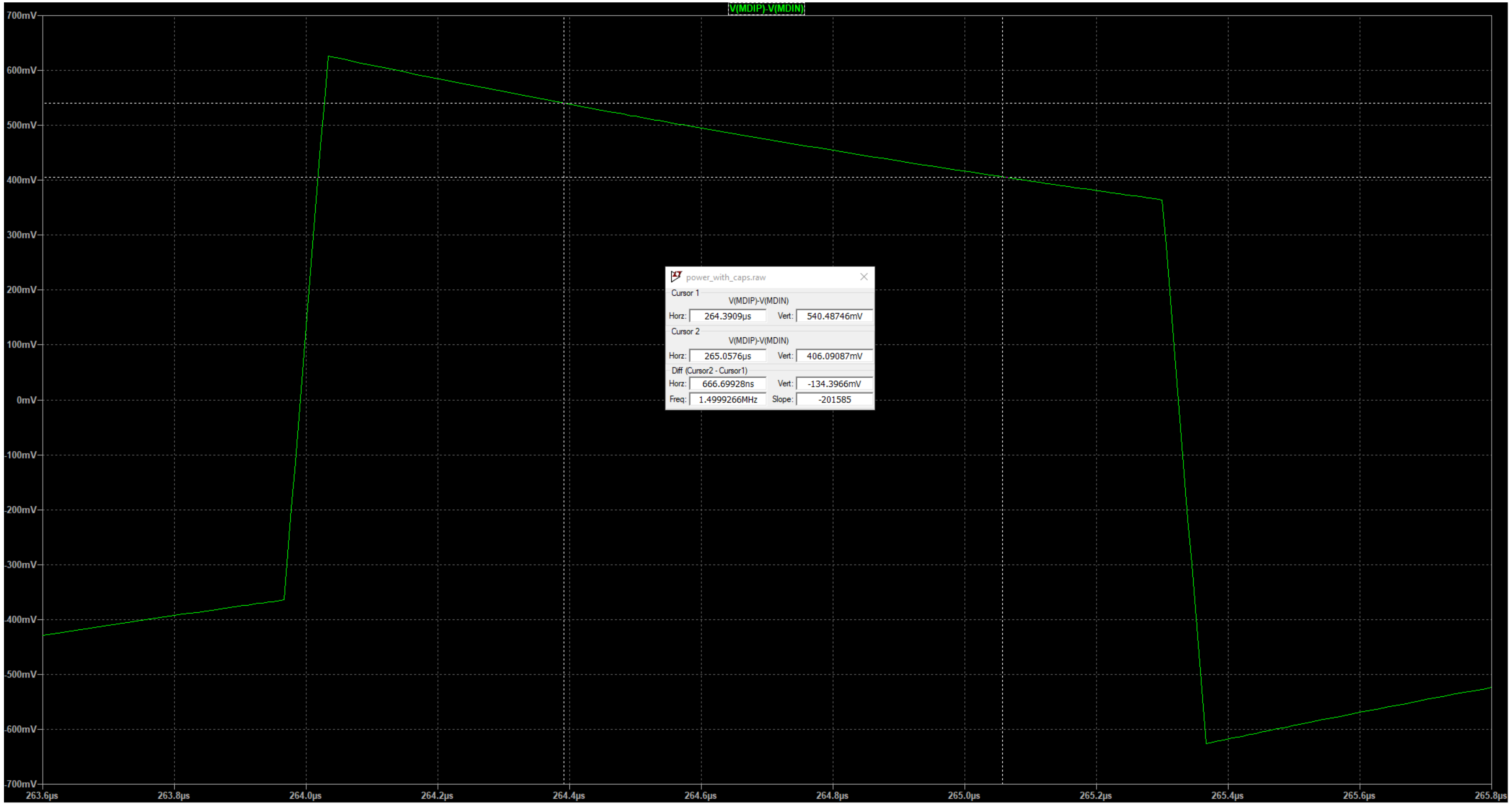
Droop Computed at Proposed Measurement Points

- With the new measurement points the droop is 24.9% vs 24.4% using the original points from clause 146



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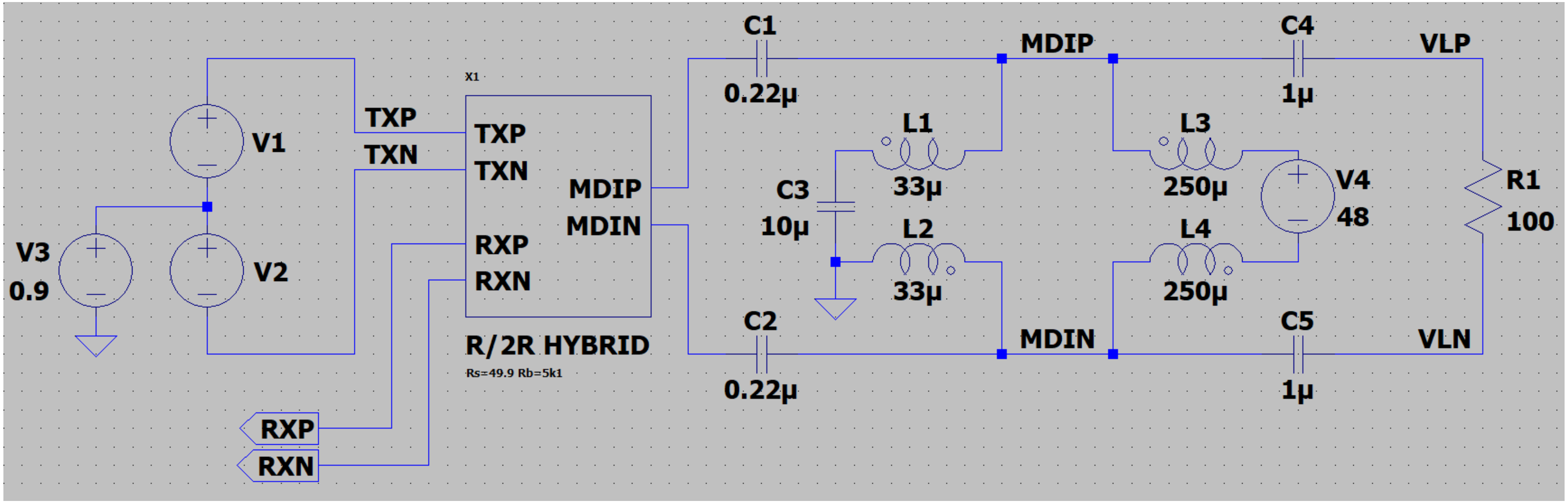
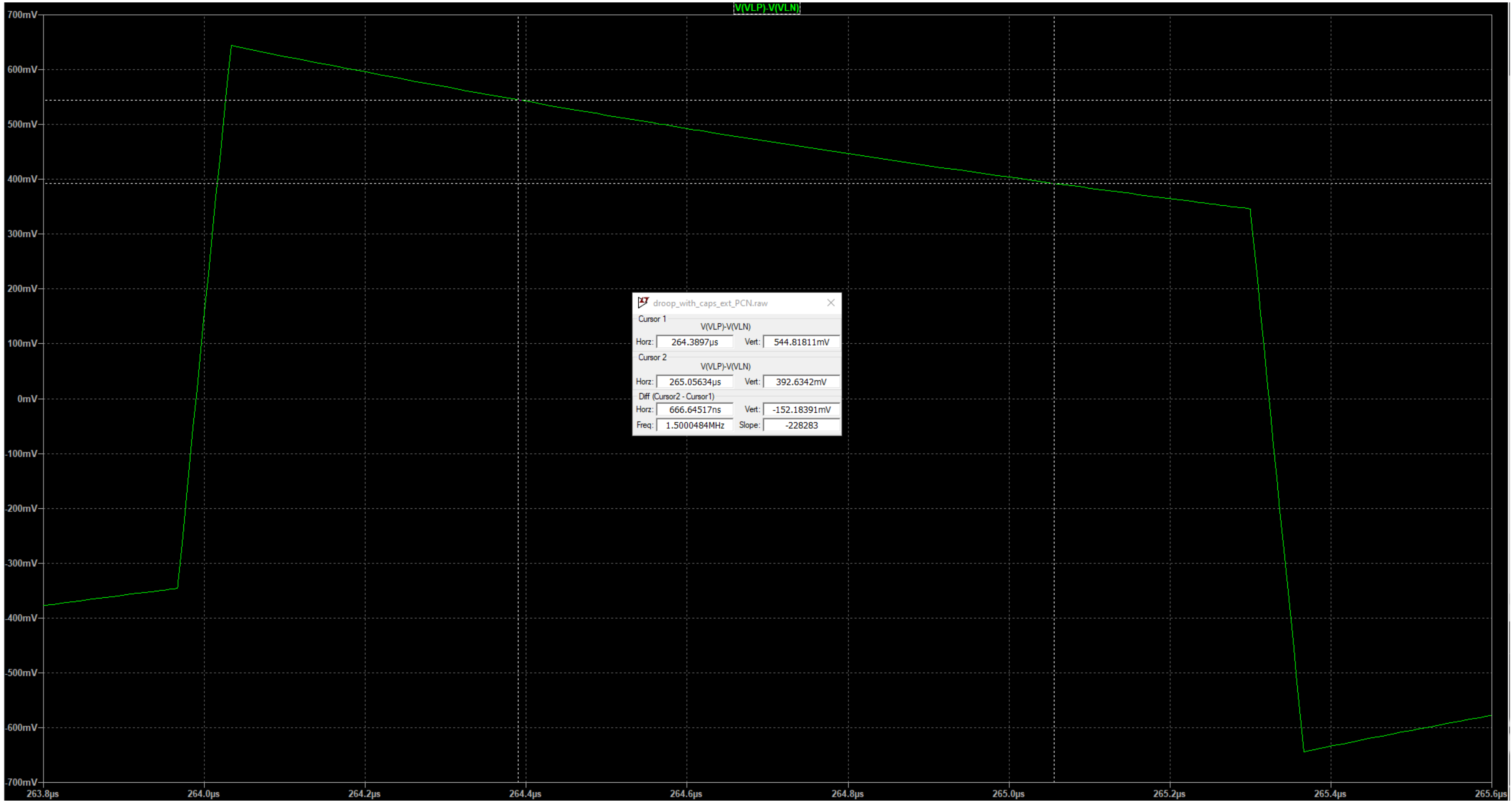
Measuring Droop of a Powered Device

- It may be necessary to provide power to a PD in order to allow the droop to be measured
  - This will require the measurement system to add an external power coupling network (PCN)
    - In this example we have used 1mH of inductance
  - Capacitors will also be required in series with the load to remove the DC



Droop Including External PCN

- In this example the external components required to make the measurement have increased the droop from 24.9% to 27.9%



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Effect of Measurement Noise

- Common approach is to measure droop multiple times and take the worst value
  - Droop measurement is therefore affected by the peak-to-peak noise in the system
  - Most of this noise is expected to be in the measurement itself
- Consider 10mV peak-to-peak noise
  - In our last example the values 544.8mV and 392.6mV would become 549.8mV and 387.6mV giving droop of 29.5%
  - A PHY having droop of less than 25% would give a measured droop of close to 30%

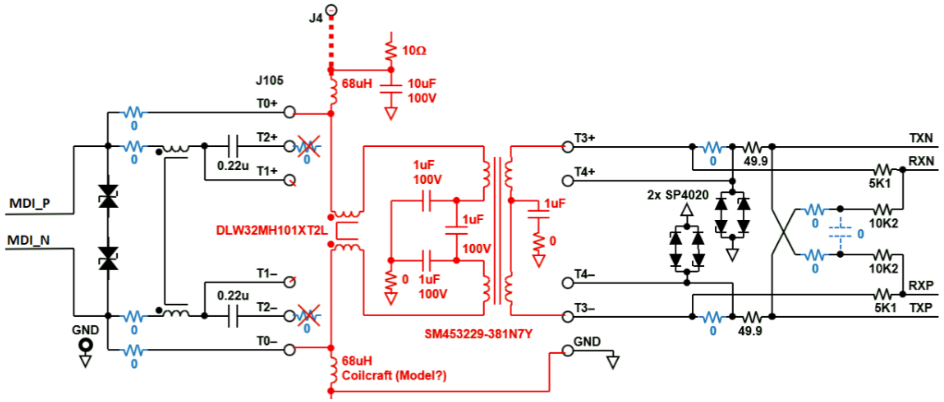
Implications for Droop Specification

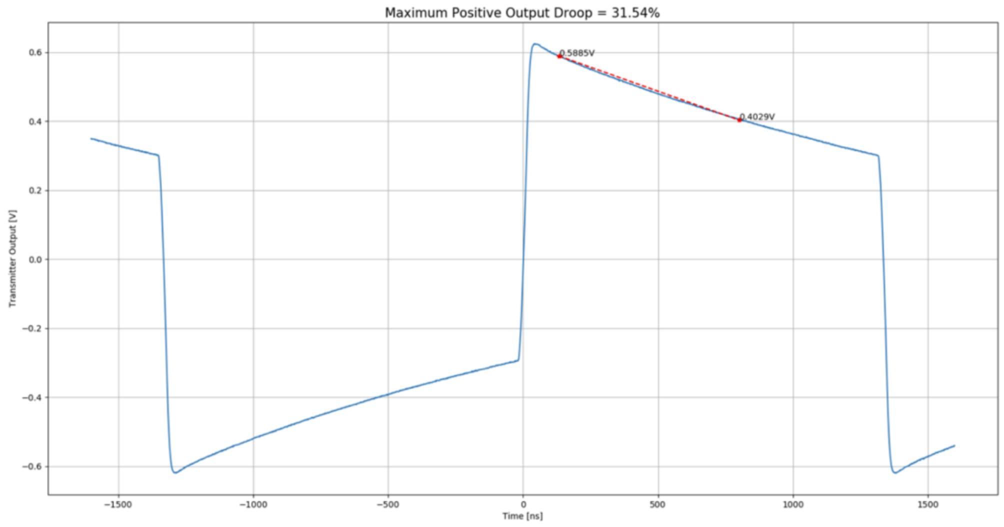
- A previous presentation addressed the issue of size and cost of power magnetics
  https://www.ieee802.org/3/dd/public/Stewart_3dd_01_08312021.pdf
- The task force voted to increase the droop limit from 10% to 25% for PSEs and PDs
  - The intent was to allow the use of more cost-effective power magnetics and not to create margin for dealing with measurement issues

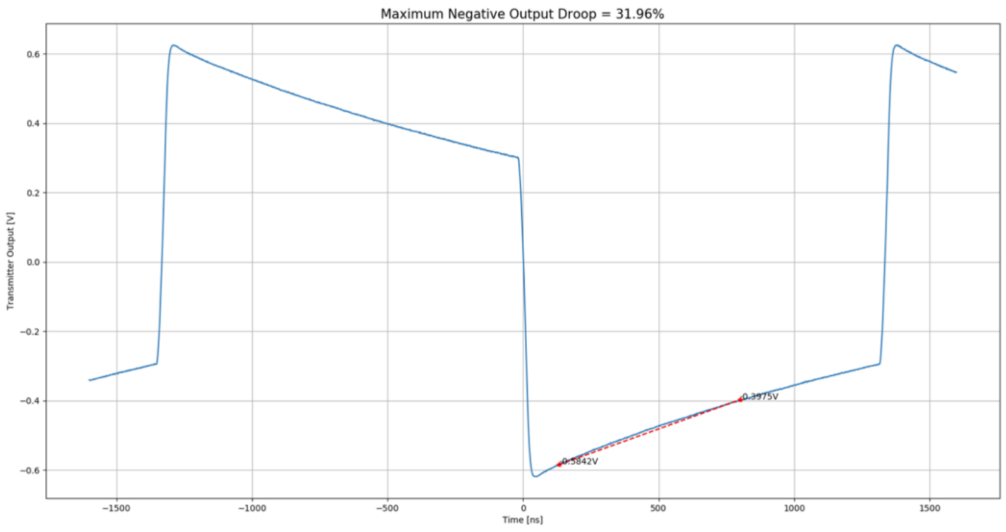
- This specification is intended to be made for the PHY at the MDI with MDI loading
  - Addition of power coupling networks can increase the apparent droop by up to 3%
  - And measurement noise case can further increase the droop by as much as 2%
- These effects should be considered and corrected for in measurements according to the measurement configuration being used
  - To ensure that the 25% droop is reserved for the PHY

Measured PHY Performance for Droop About 28%

- Using two 68uH inductors for power coupling
  - And transformer for galvanic isolation
- Droop is measured at 32% which corresponds to about 28% actual droop
- Performance is measured with the same circuitry on both sides

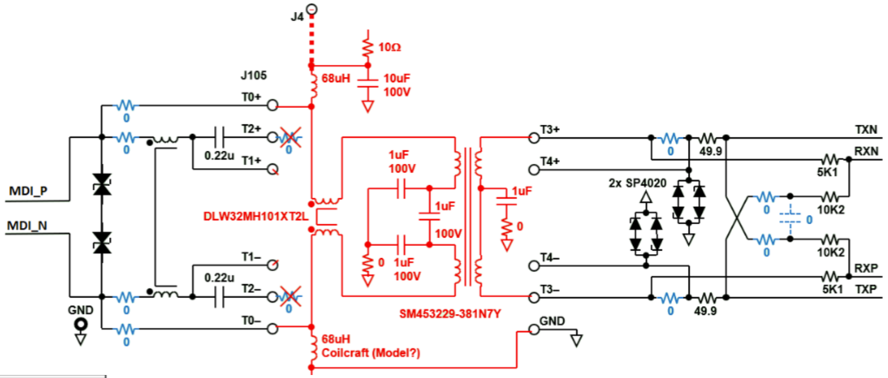


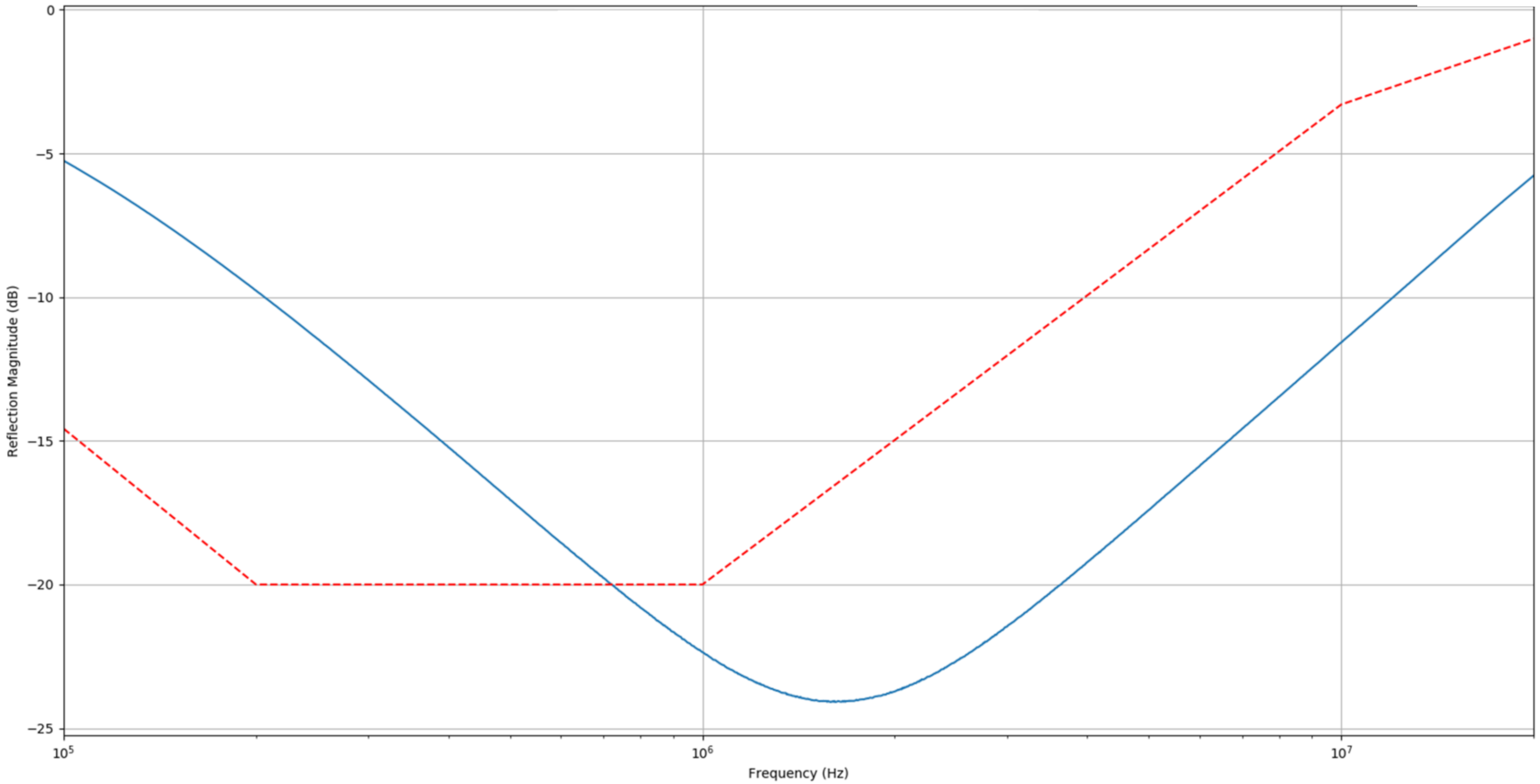




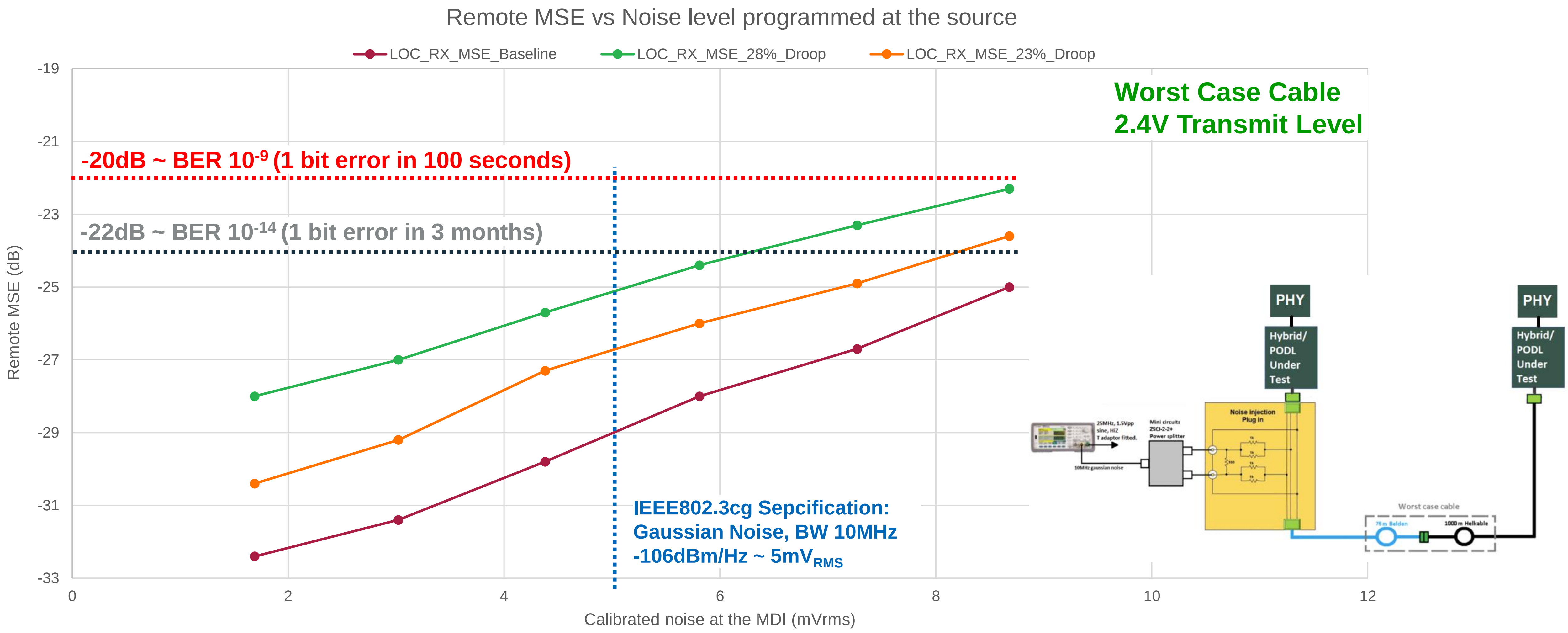
Measured PHY Performance for Return Loss

- Return Loss is measured on this circuit and it is shown that it fails the return loss limit
  - Crossing the -20db beyond 500kHz
  - This is expected as the droop is > 25%





PHY Performance for Droop of About 28% with Alien Crosstalk Noise



Summary and Suggested Remedy

- Summary:
  - Experiments have shown there is sufficient margin to permit relaxation to 25% droop without any issue of performance or interoperability problems
  - Ringing of the clause 104 power coupling/decoupling network suggests moving the measurement points to 400ns and 1066.7ns in 146.5.4.2 for devices implementing Clause 104
  - Experience with measurement sensitivities suggests additional cautionary language is necessary to not consume the margin for droop

- Suggested Remedy: Change 3rd paragraph in 146.5.4.2 (inserted by 802.3dd, see lines 23-28 on page 26 of D3.0) to read (yellow highlight shows changes):

When a Clause 104 Type E PSE or PD PI is encompassed within the MDI, the magnitude of both the positive and negative droop shall be less than 25% measured with respect to an initial value at 400 ns after the zero crossing and a final value at 1066.7 ns after the zero crossing. Implementers should consider transmitter amplitude limitations when appropriate to the application such as those applications addressed in Annex 146A. This specification is intended to be made for the PHY at the MDI with MDI loading. Addition of power coupling networks and measurement noise can increase the apparent droop. For example, a power coupling network might add 3% and noise might further increase droop by 2%, adding up to 5%. Limiting additional apparent droop due to test setup is strongly encouraged and should be corrected for according to the measurement configuration being used.

Thank you