Transmit PSD, MDI Return Loss, Droop

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IEEE802.3dg Task Force
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Topics

- ▶ Transmit PSD
- ▶ MDI Return Loss
- ▶ Transmitter Droop

Transmit PSD Mask

Transmit Power Spectral Density

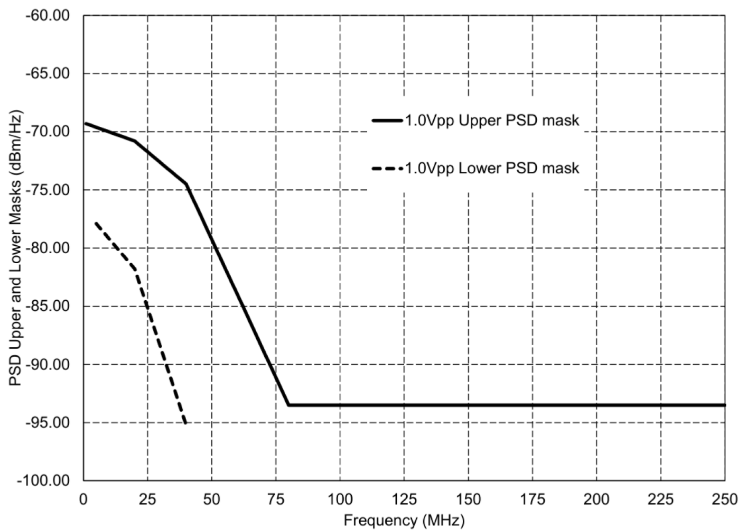
- Equations in the standard form for the PSD for 1.0V and 2.0V transmit levels
- A plot of these equations showing the upper and lower masks
- A comparison of the 100BASE-T1L PSD mask with the 100BASE-T1 mask, to highlight the differences
- A plot of the measured PSD of a 100BASE-T1L Idle test pattern against the proposed 100BASE-T1L PSD mask

Transmitter Power Spectral Density and Power Level

► Equations for the 1 Vpp transmit signal amplitude:

$$\text{Upper PSD}(f) = \begin{cases} -69.3 - 1.5 \times \dfrac{f-1}{19} & \text{dBm/Hz for } 1\text{ MHz} \le f < 20\text{ MHz} \\ -70.8 - 3.7 \times \dfrac{f-20}{20} & \text{dBm/Hz for } 20\text{ MHz} \le f < 40\text{ MHz} \\ -74.5 - 19 \times \dfrac{f-40}{40} & \text{dBm/Hz for } 40\text{ MHz} \le f < 80\text{ MHz} \\ -93.5 & \text{dBm/Hz for } 80\text{ MHz} \le f \le 250\text{ MHz} \end{cases} \quad (199\text{–}6)$$

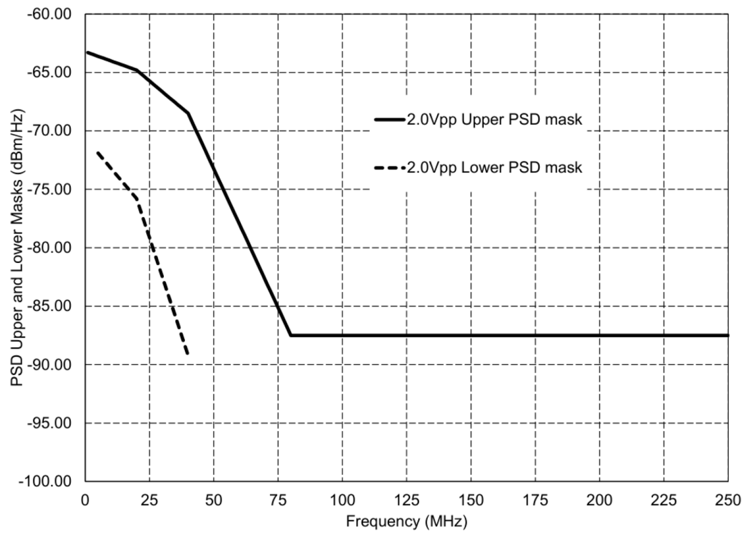
$$\text{Lower PSD}(f) = \begin{cases} -77.9 - 3.9 \times \dfrac{f-5}{15} & \text{dBm/Hz for } 5\text{ MHz} \le f < 20\text{ MHz} \\ -81.8 - 13.4 \times \dfrac{f-20}{20} & \text{dBm/Hz for } 20\text{ MHz} \le f \le 40\text{ MHz} \end{cases} \quad (199\text{–}7)$$



► Equation

$$\text{Upper PSD}(f) = \begin{cases} -63.3 - 1.5 \times \dfrac{f-1}{19} & \text{dBm/Hz for } 1\text{ MHz} \le f < 20\text{ MHz} \\ -64.8 - 3.7 \times \dfrac{f-20}{20} & \text{dBm/Hz for } 20\text{ MHz} \le f < 40\text{ MHz} \\ -68.5 - 19 \times \dfrac{f-40}{40} & \text{dBm/Hz for } 40\text{ MHz} \le f < 80\text{ MHz} \\ -87.5 & \text{dBm/Hz for } 80\text{ MHz} \le f \le 250\text{ MHz} \end{cases} \quad (199\text{–}8)$$

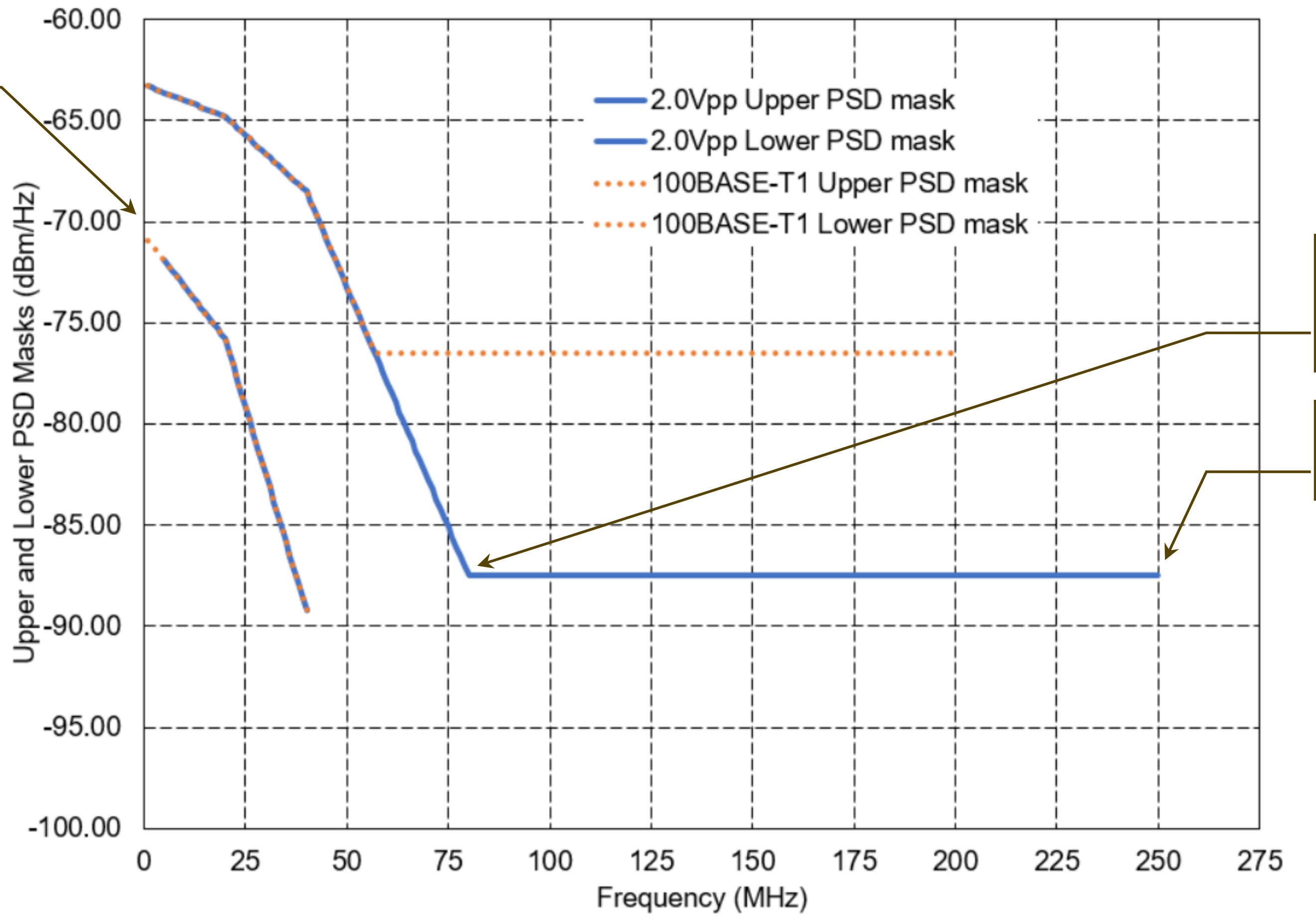
$$\text{Lower PSD}(f) = \begin{cases} -71.9 - 3.9 \times \dfrac{f-5}{15} & \text{dBm/Hz for } 5\text{ MHz} \le f < 20\text{ MHz} \\ -75.8 - 13.4 \times \dfrac{f-20}{20} & \text{dBm/Hz for } 20\text{ MHz} \le f \le 40\text{ MHz} \end{cases} \quad (199\text{–}9)$$



Transmitter PSD – 100BASE-T1L versus 100BASE-T1

▶ The following compares the 100BASE-T1L PSD mask with 100BASE-T1

- Stop lower limit line at 5 MHz

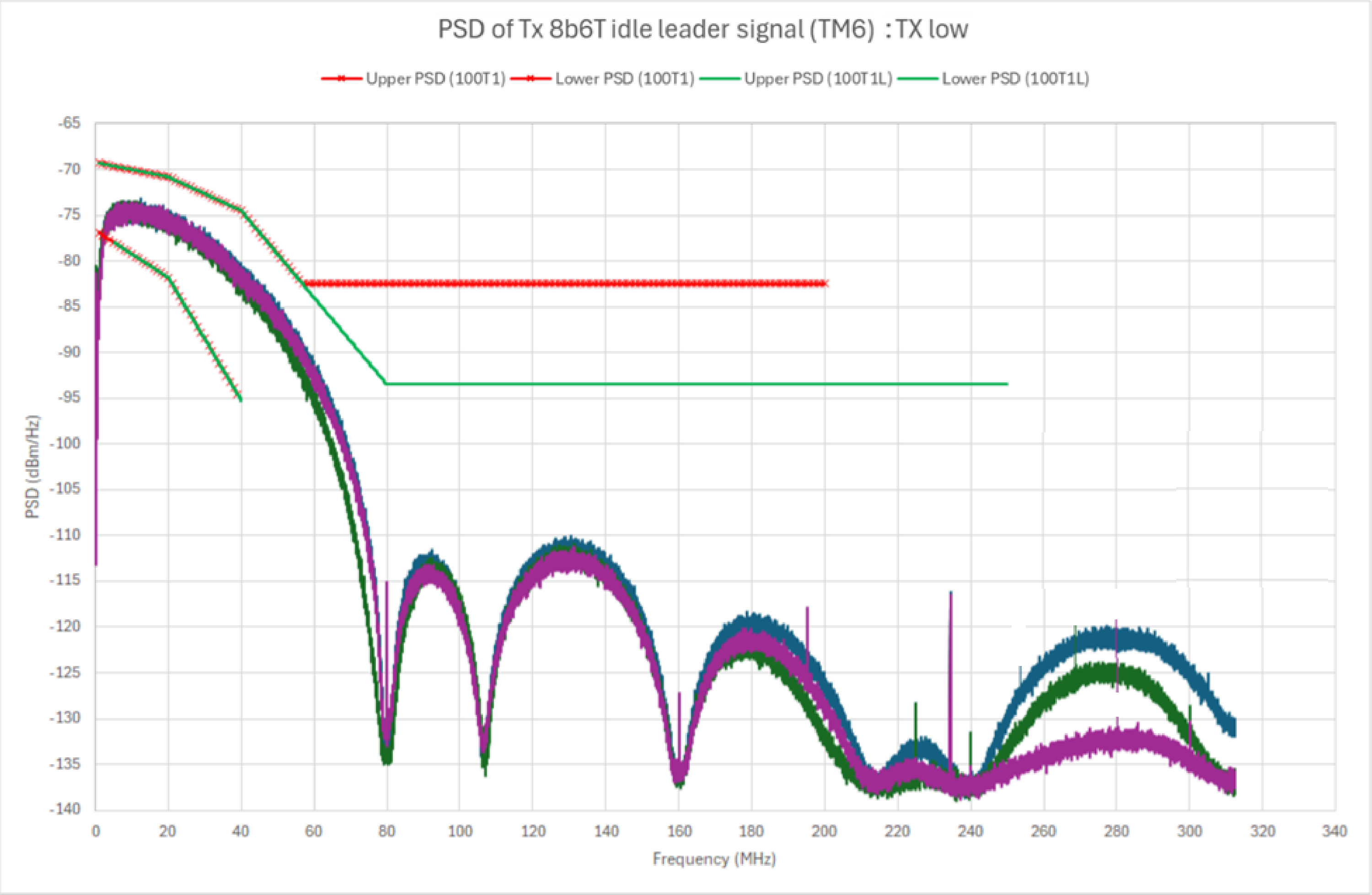


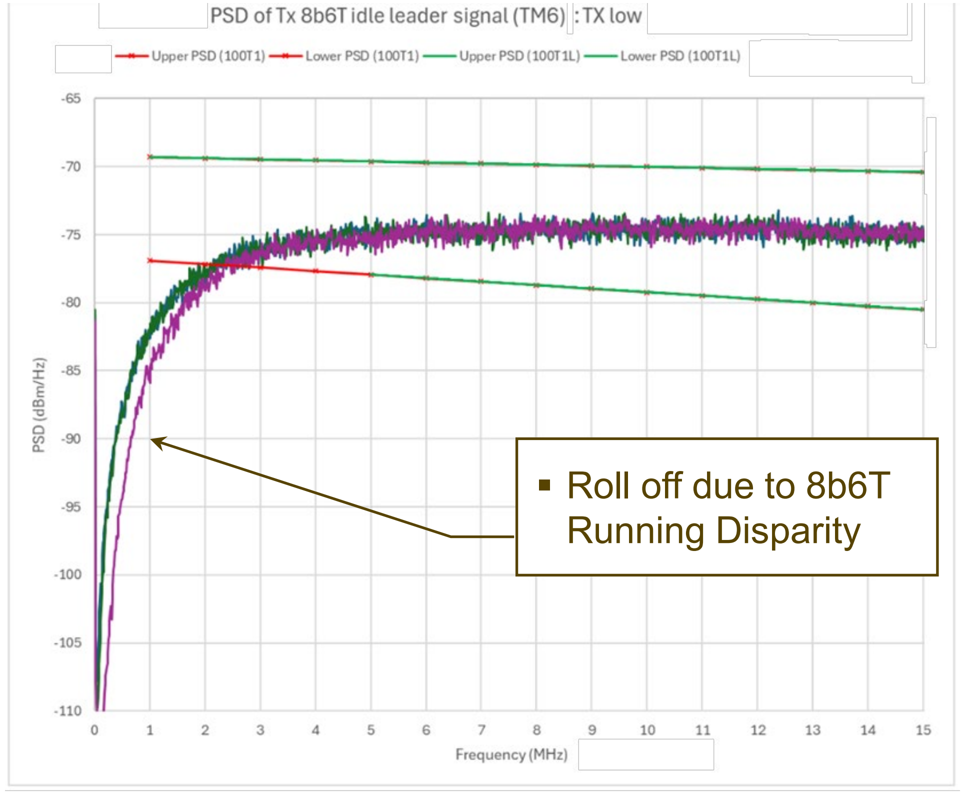
- Continue upper limit line down to 80 MHz and then flat at -87.5 dBm/Hz

- Extend out to 250 MHz

PSD of 100BASE-T1L Idle Test Pattern

► The following is a plot of the PSD of a 1.0V 100BASE-T1L Idle test pattern





MDI Return Loss

MDI Return Loss

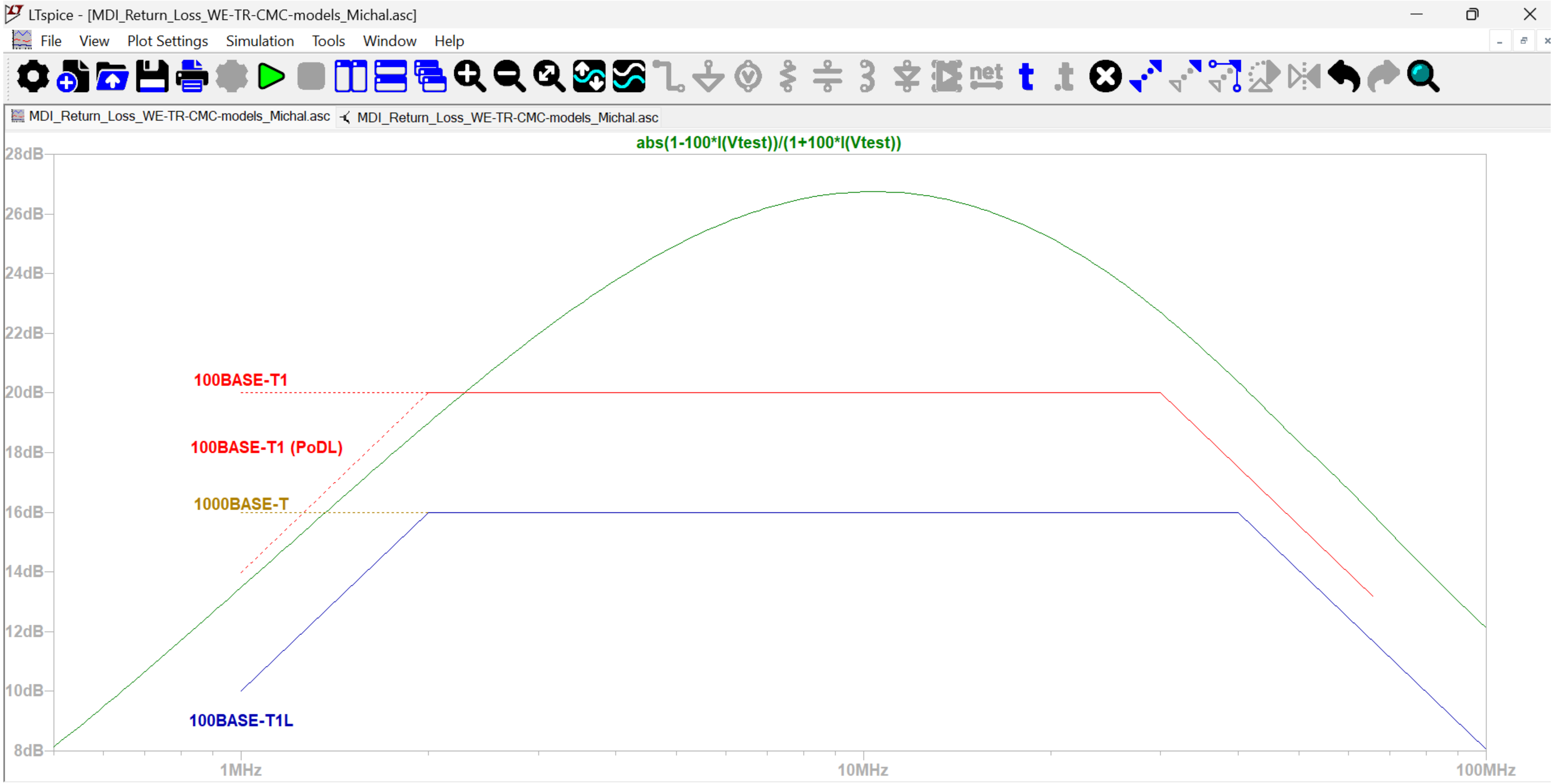
- Return Loss limits were adopted at the 802.3dg interim call in June

- We simulated with the transmit and receive external components including a 350 μH transformer and 470 μH CMC
  - And we included power coupling inductors (40 μH differential)
  - The simulation incorporates the effects of some parasitics
  - More details in this presentation

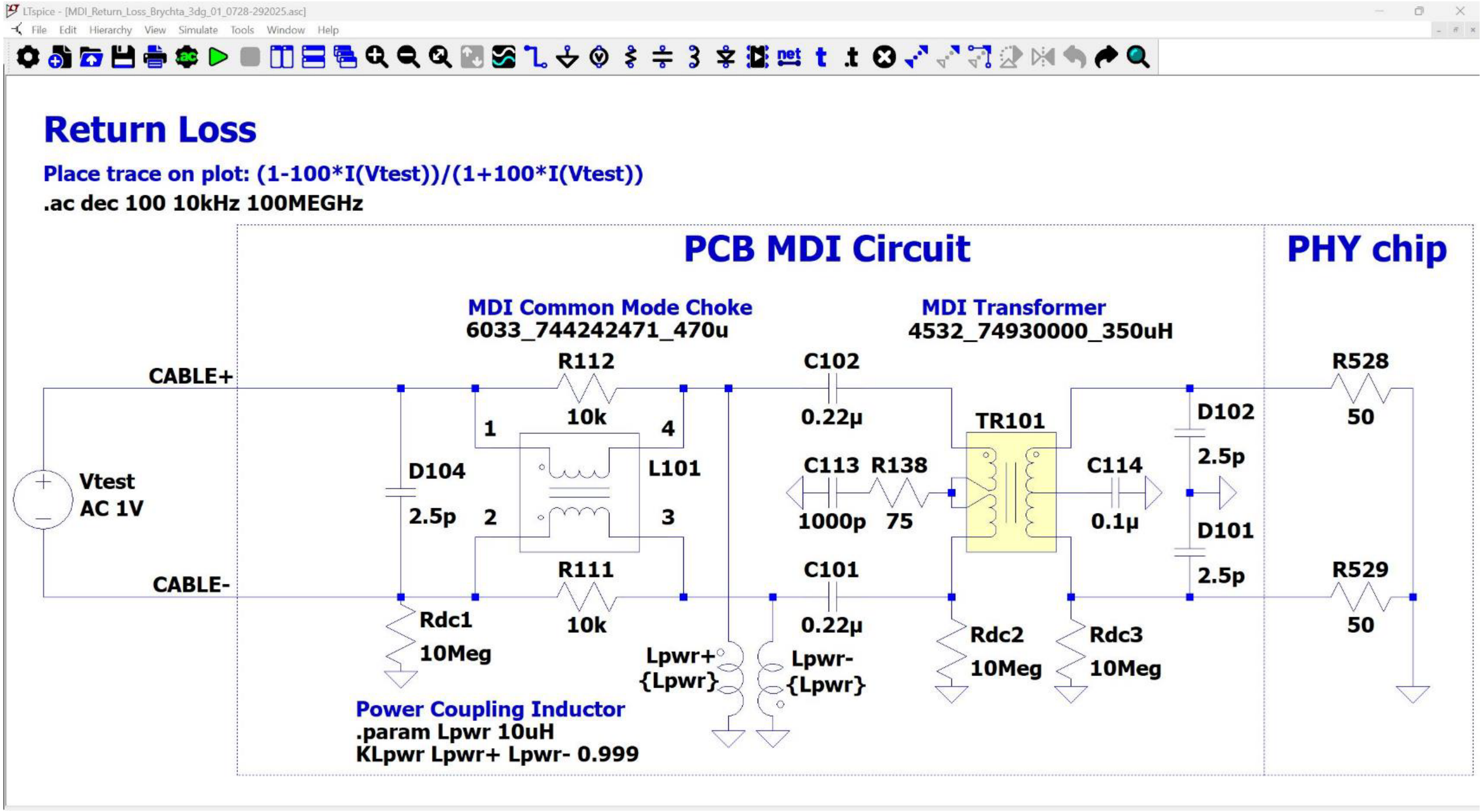
- We have measured return loss with external components
  - Details in this presentation

- Lower power coupling inductor values may be considered for PoDL
  - At present, we do not have a separate Return Loss equation for the case where a Clause 104 PI is encompassed within the MDI
  - Further work is required to decide if this is needed

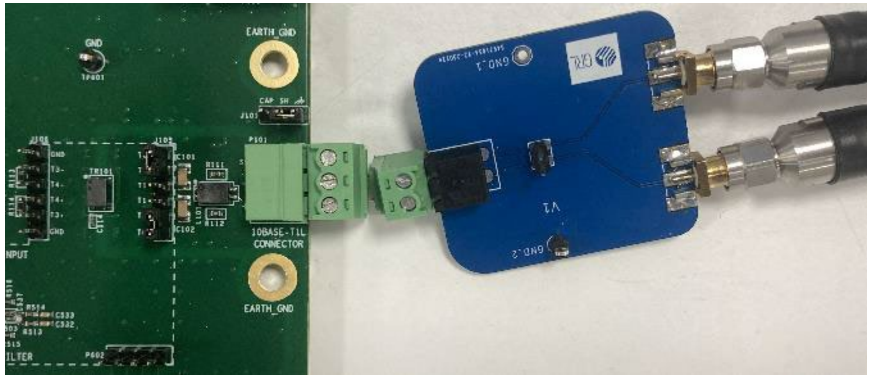
MDI Return Loss – LT Spice Simulation

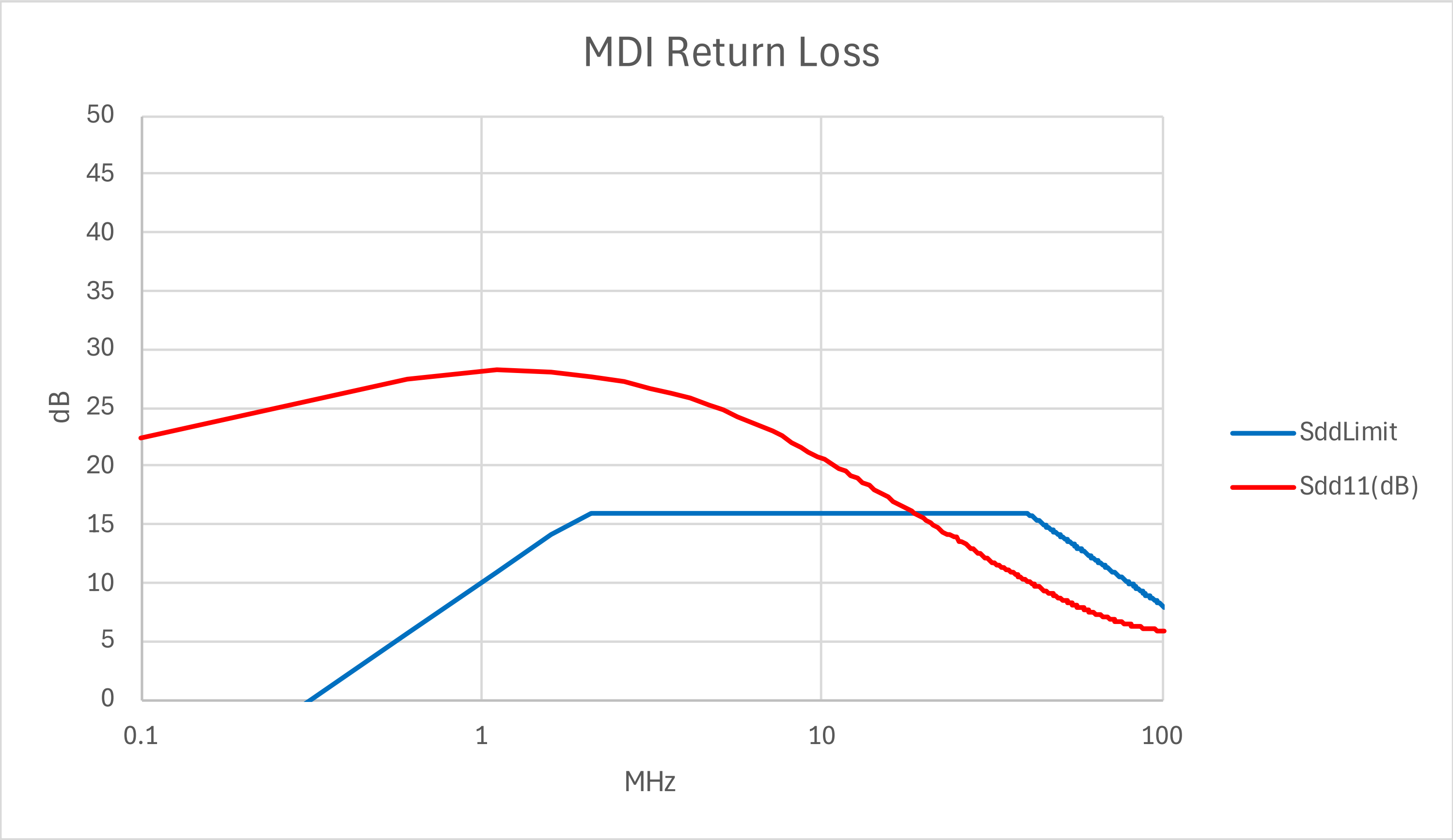


MDI Return Loss – LT Spice Simulation



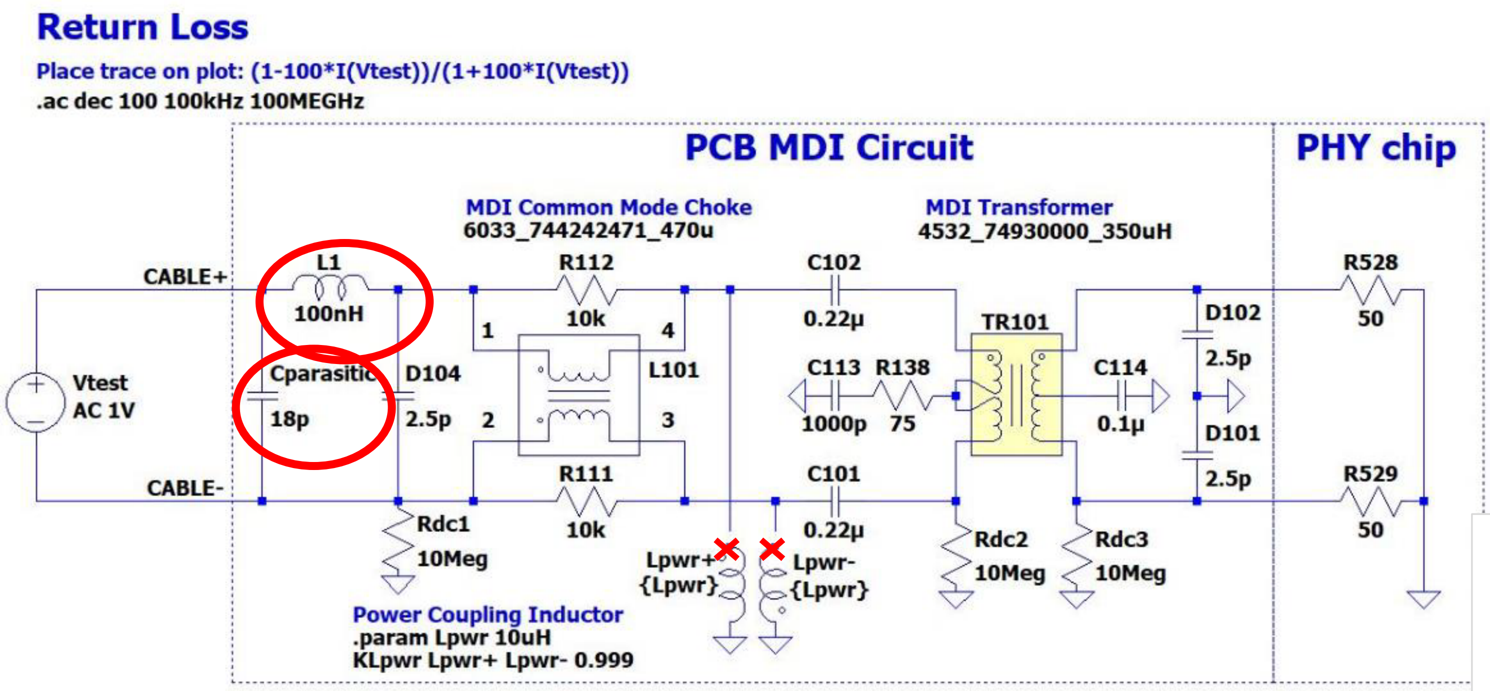
MDI Return Loss – Measurement 1 – No Power Coupling

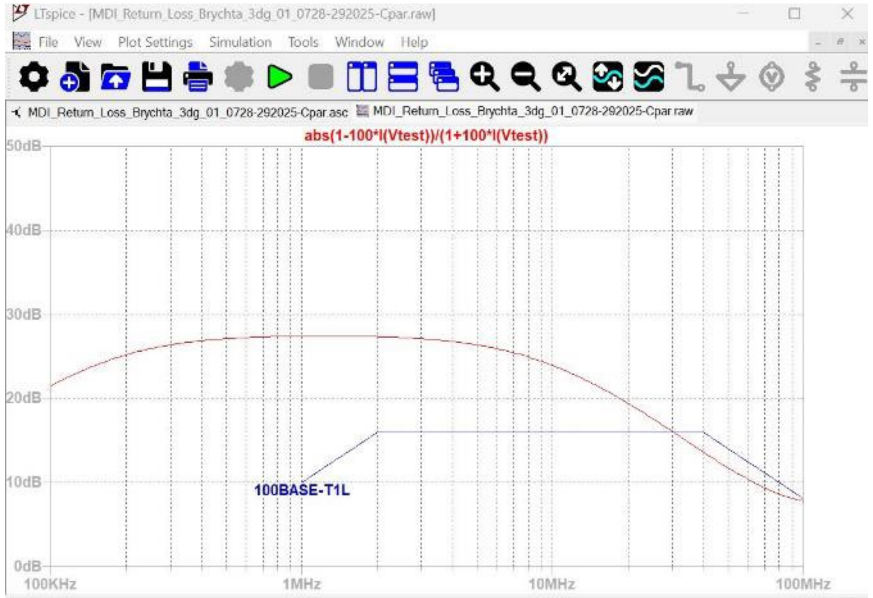


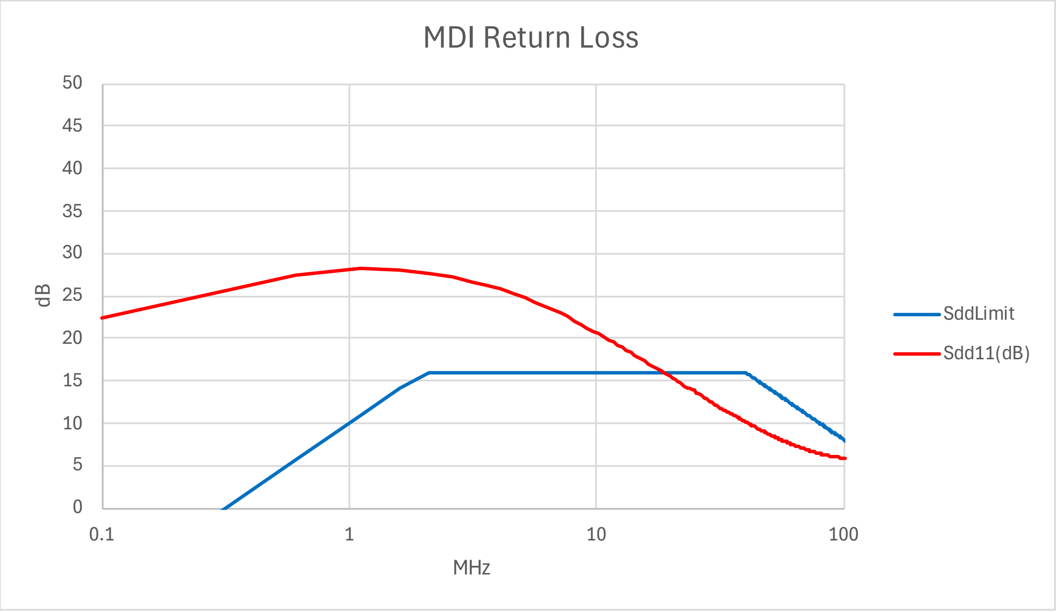


MDI Return Loss – Measurement 1 - Investigation

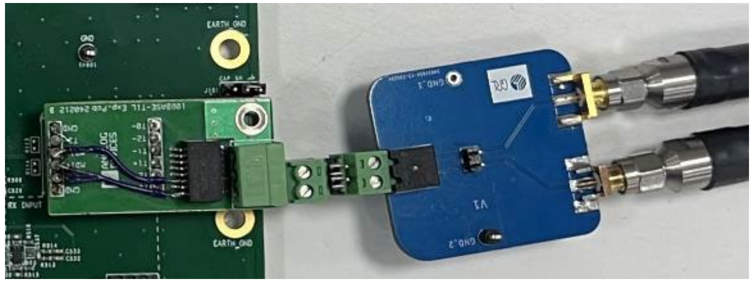
ANALOG DEVICES

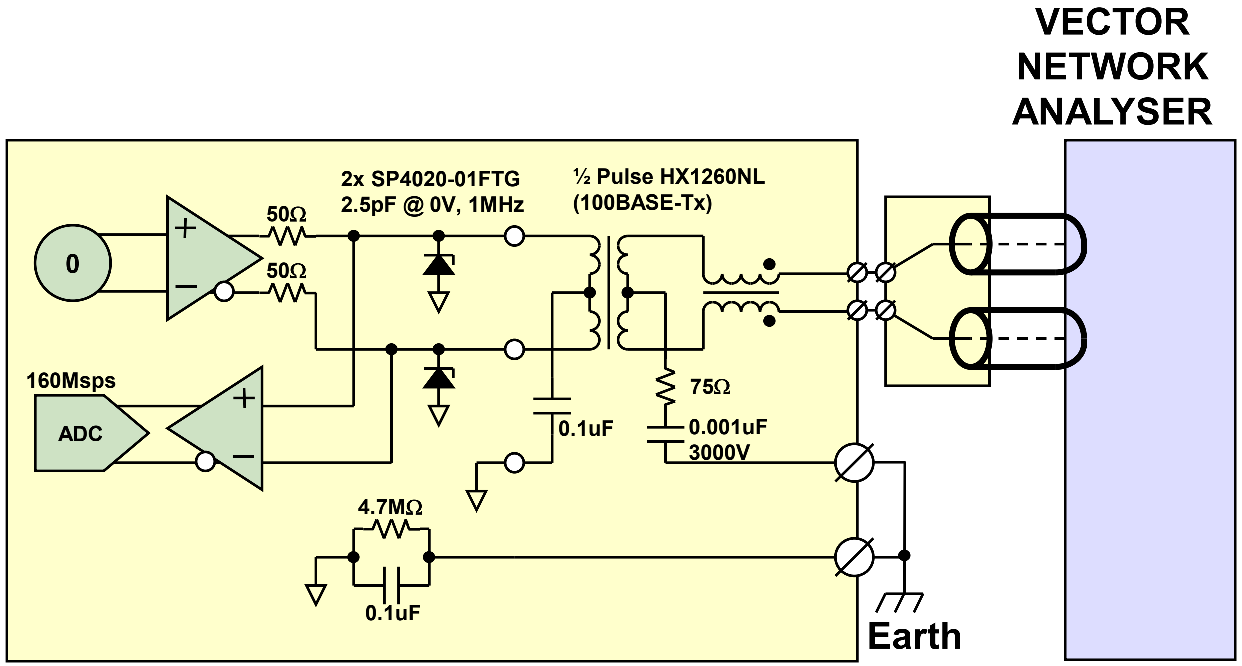


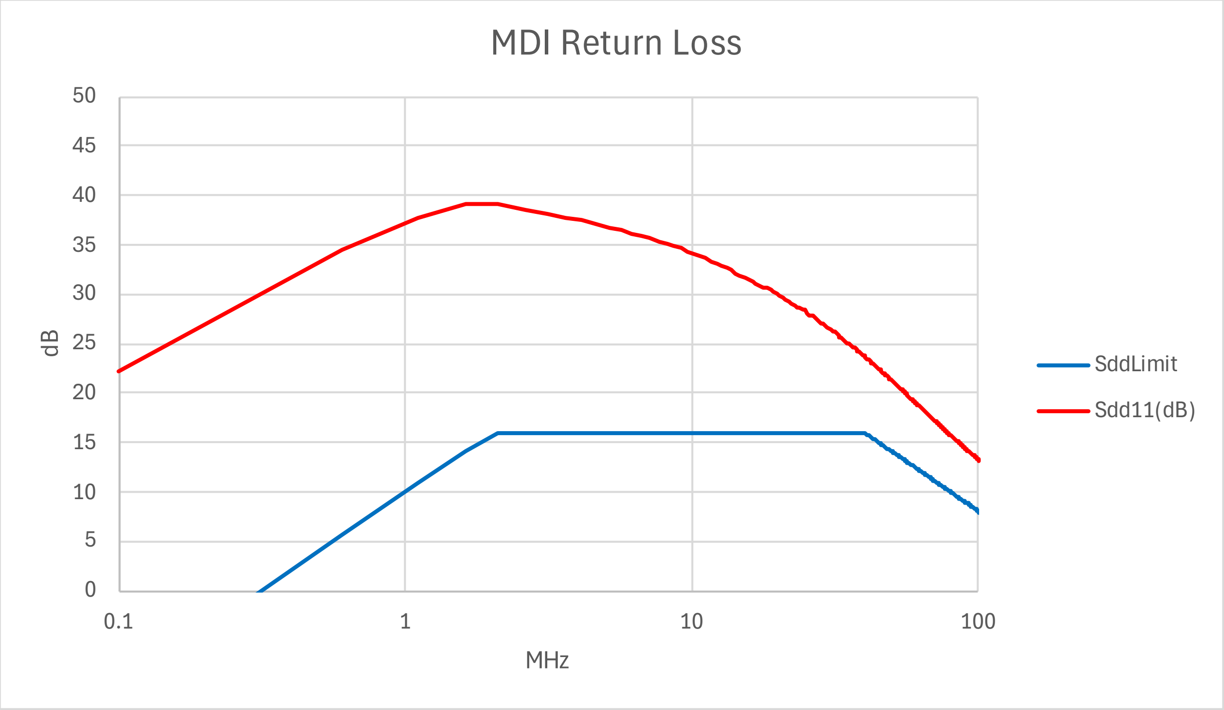




MDI Return Loss – Measurement 2 – no power coupling

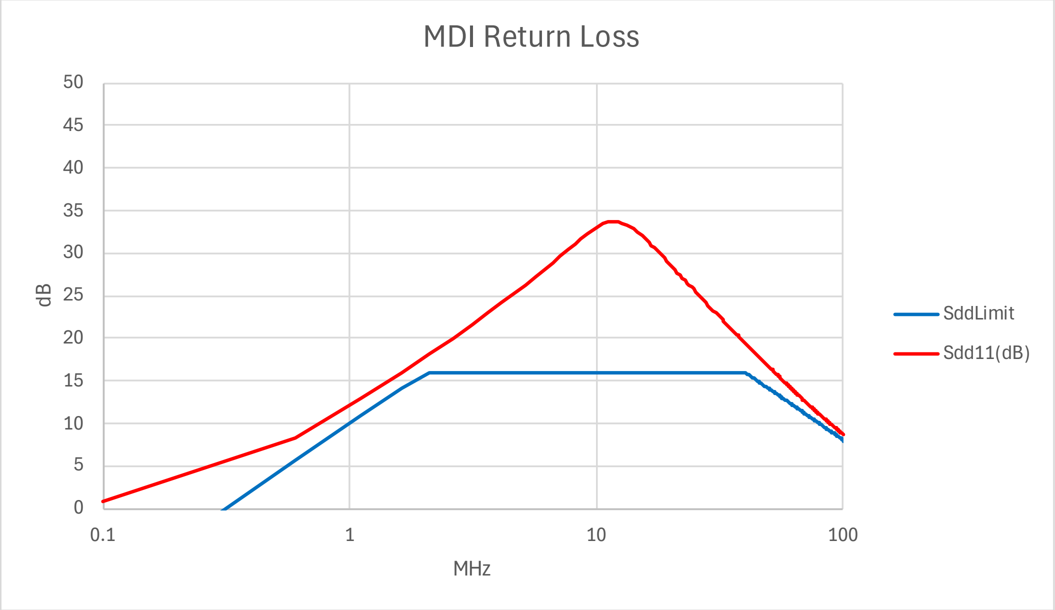




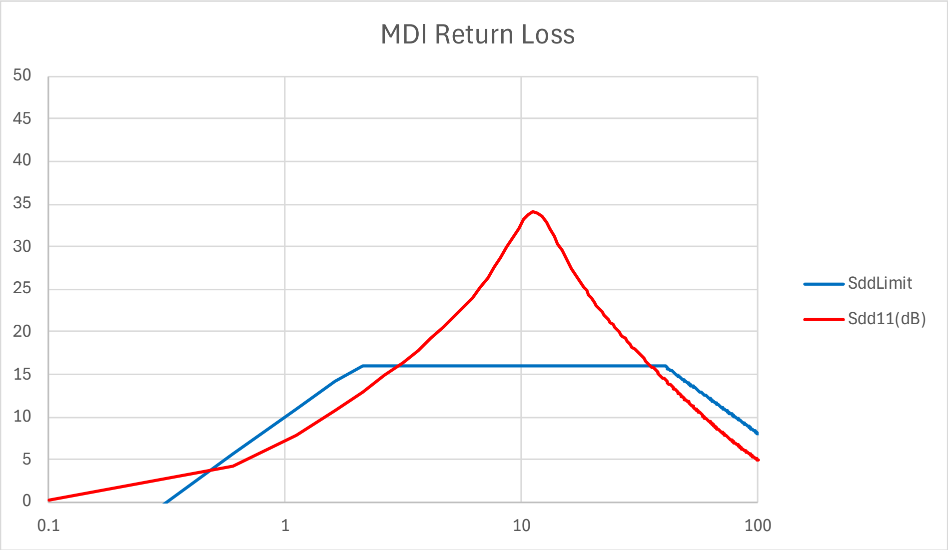


MDI Return Loss – Measurement 2 – with Power Coupling

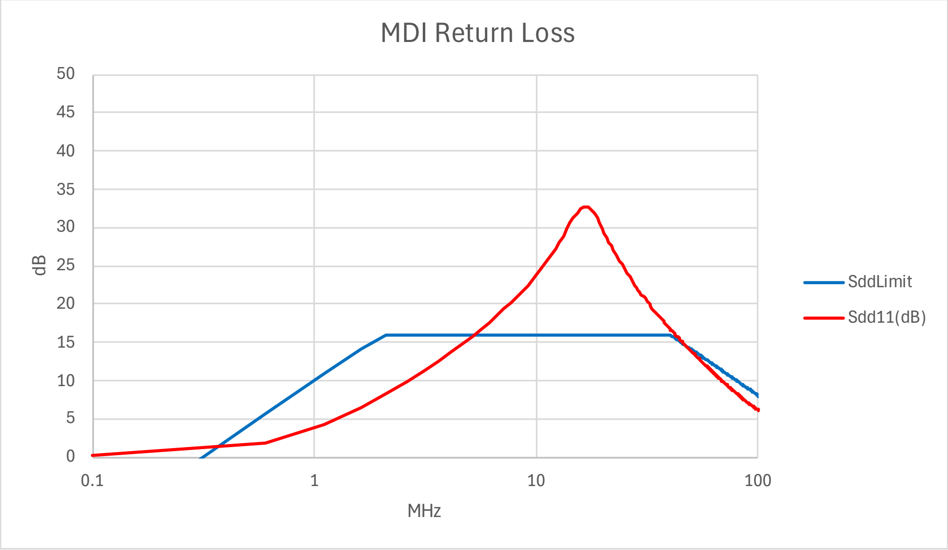
40uH differential (2x 10uH coupled)



18.8uH differential (2x 4.7uH coupled)

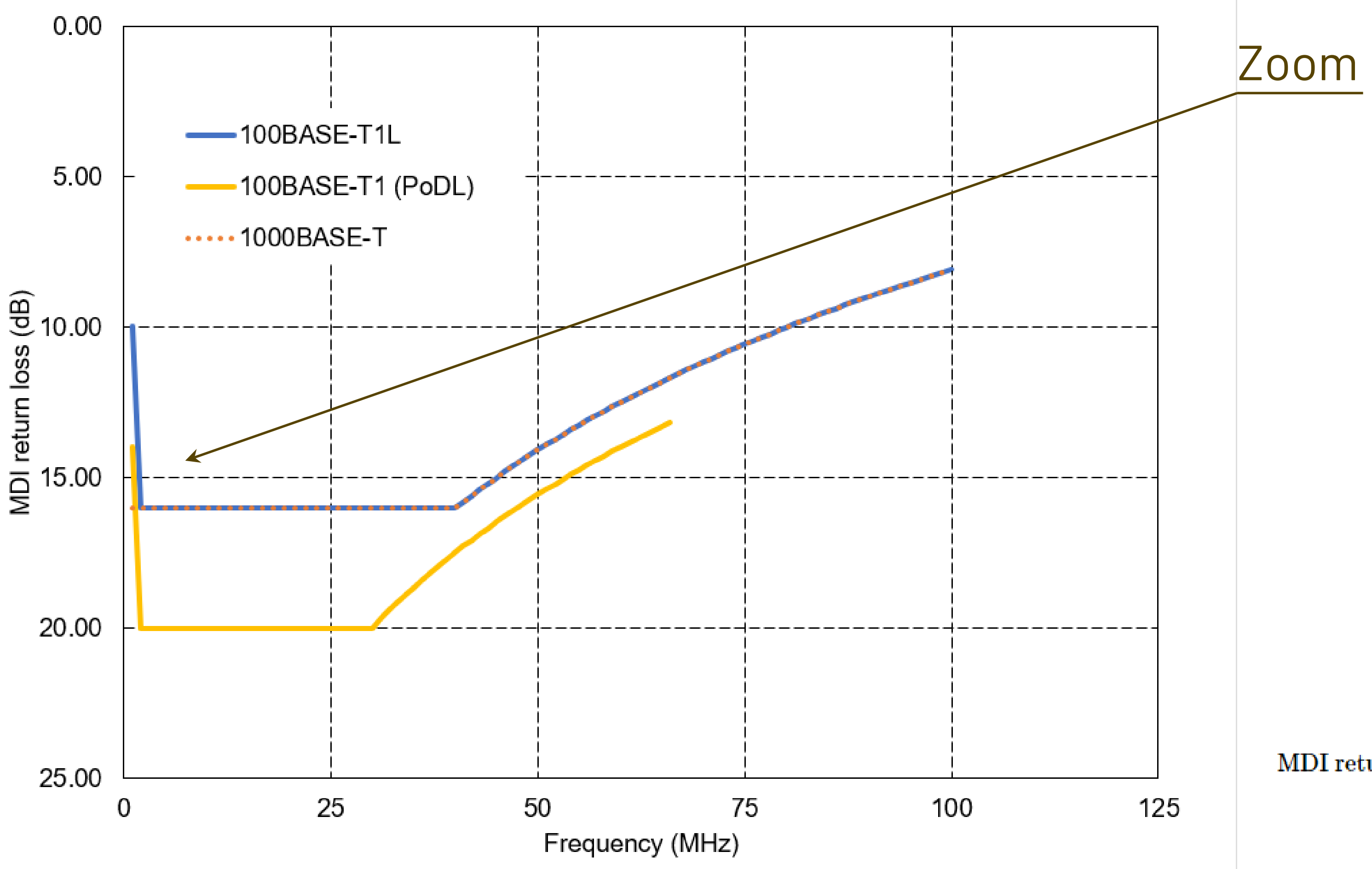


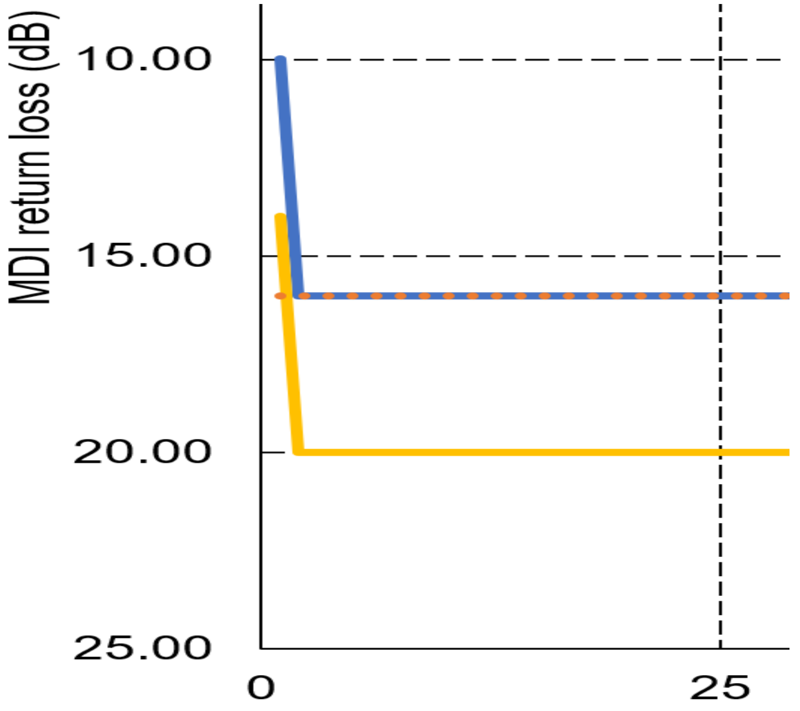
9.6uH differential (2x 2.4uH coupled)



MDI Return Loss Comparison with Previous Standards

► Proposed mask for the MDI Return Loss compared with previous standards





$$\text{MDI return loss } (f) \geq \begin{cases} 16 - 20log_{10}\left(\frac{2}{f}\right) & \text{dB for 1 MHz } \leq f < 2 \text{ MHz} \\ 16 & \text{dB for 2 MHz } \leq f < 40 \text{ MHz} \\ 10 - 20log_{10}\left(\frac{f}{80}\right) & \text{dB for 40 MHz } \leq f < 100 \text{ MHz} \end{cases}$$

Droop

Droop

- ▶ Simulation

- ▶ Measurement

- ▶ Lower power coupling inductor values may be considered for PoDL
  - We do have separate Droop limits
  - At present, we do not have a separate Return Loss equation for the case where a Clause 104 PI is encompassed within the MDI
  - Further work is required to decide if this is needed

Droop – LT Spice Simulation

Droop

Measured at system MDI terminated by 100ohm resisstor

Measure V1 at 3 symbols (37.5ns) and V2 at 8 symbols (100ns) after 0 crossing (Find 3rd rising edge to see waveform more settled)

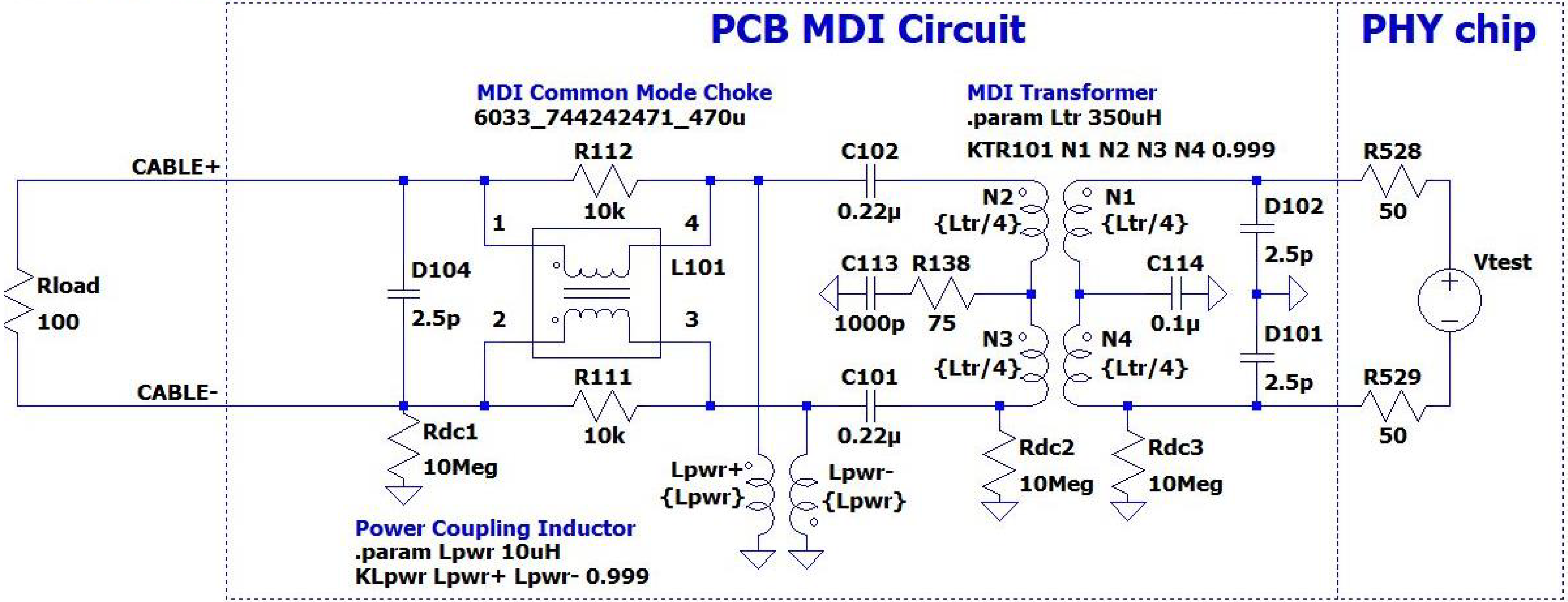
Calculate Droop = (V1-V2)/V1*100%

Press <CTRL> + <L> and scroll down in text to see .meas results

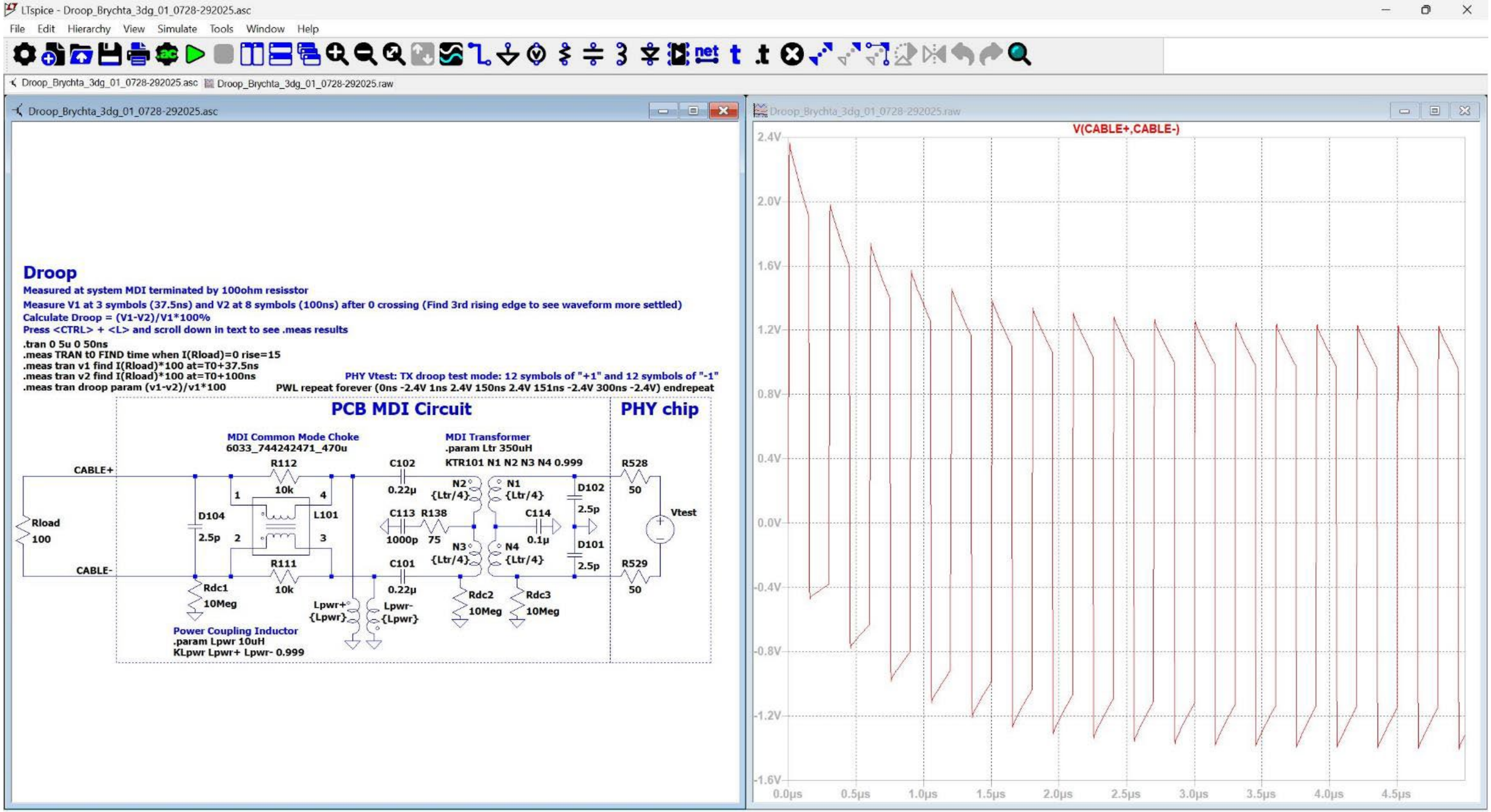
```
.tran 0 5u 0 50ns
.meas TRAN t0 FIND time when I(Rload)=0 rise=15
.meas tran v1 find I(Rload)*100 at=T0+37.5ns
.meas tran v2 find I(Rload)*100 at=T0+100ns
.meas tran droop param (v1-v2)/v1*100
```

PHY Vtest: TX droop test mode: 12 symbols of "+1" and 12 symbols of "-1"

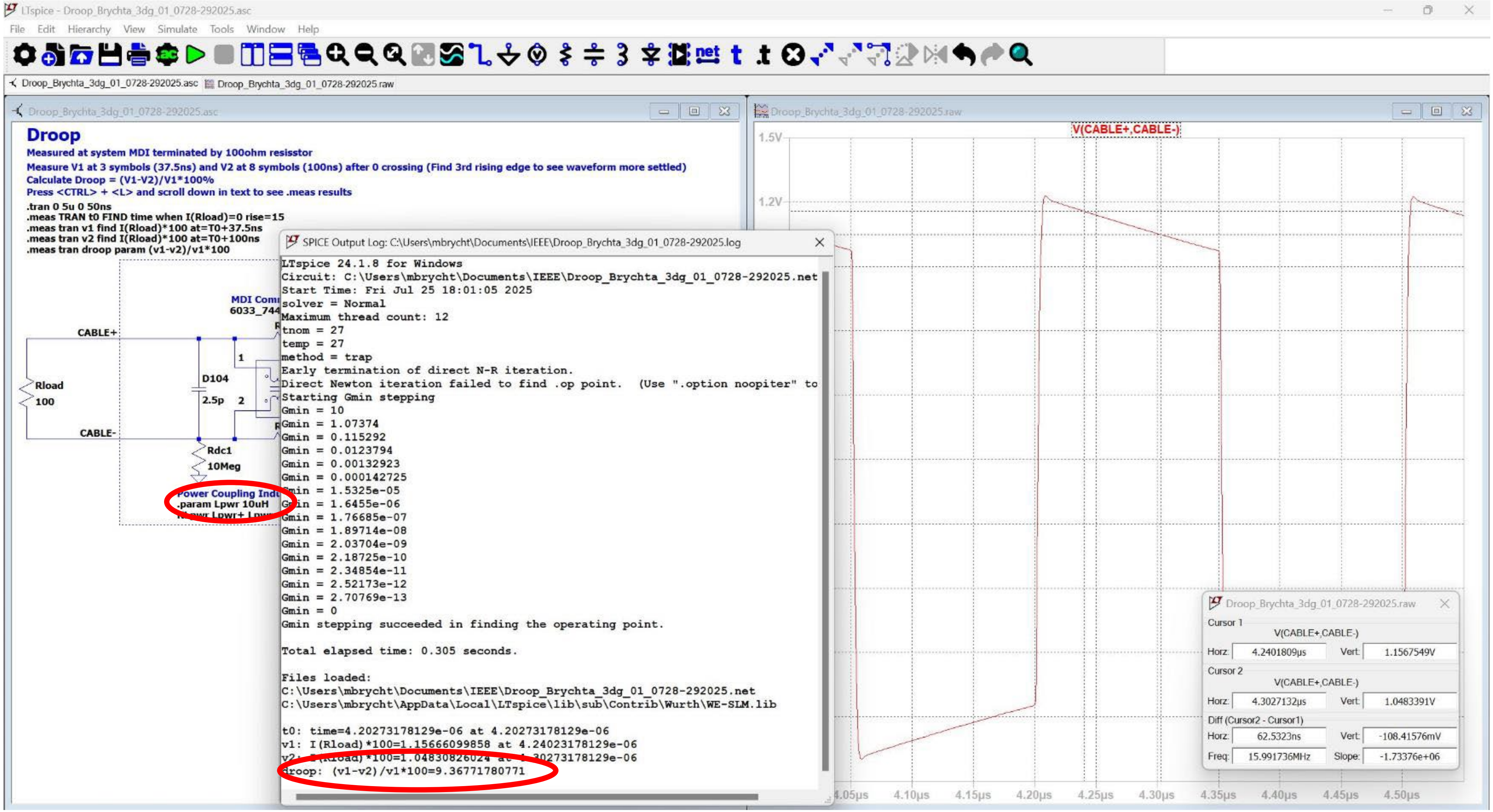
PWL repeat forever (0ns -2.4V 1ns 2.4V 150ns 2.4V 151ns -2.4V 300ns -2.4V) endrepeat



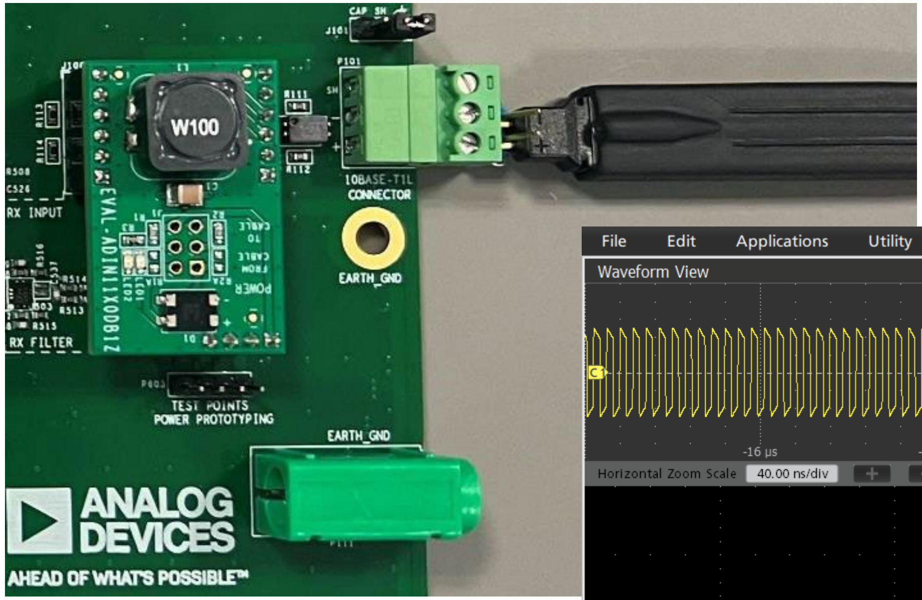
Droop – LT Spice Simulation

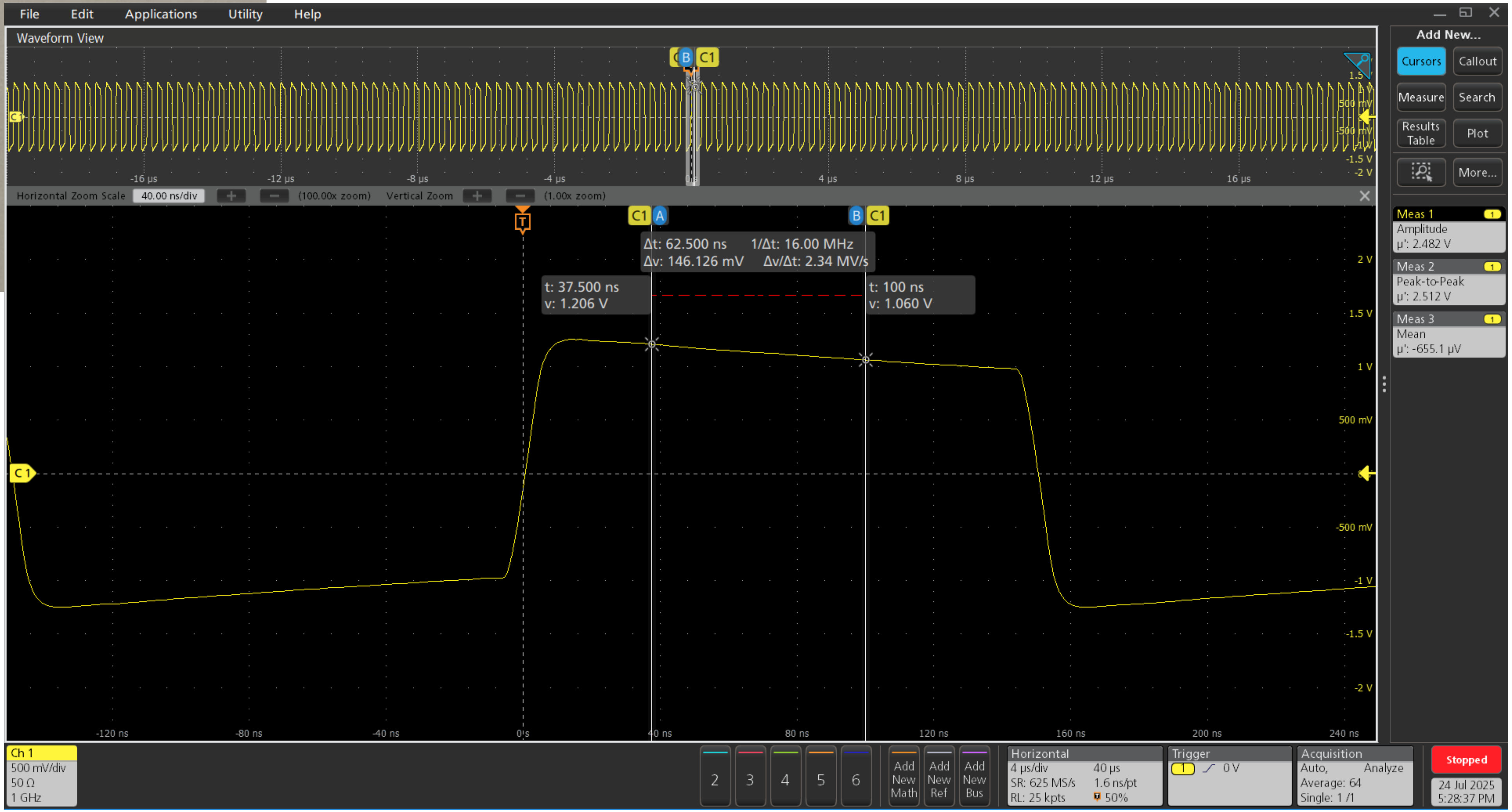


Droop – LT Spice Simulation



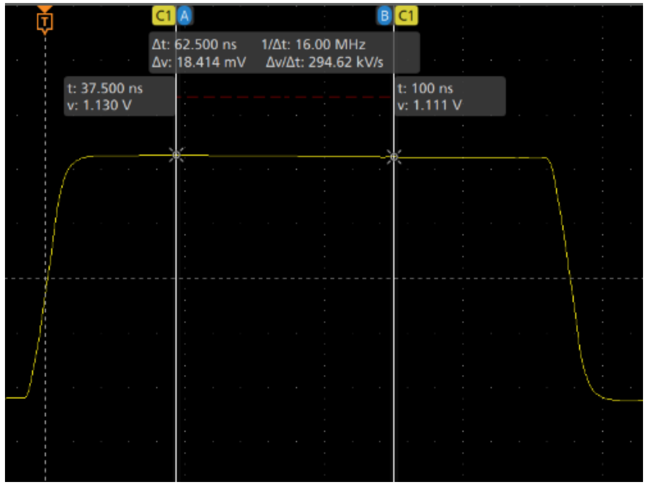
Droop – Measurement





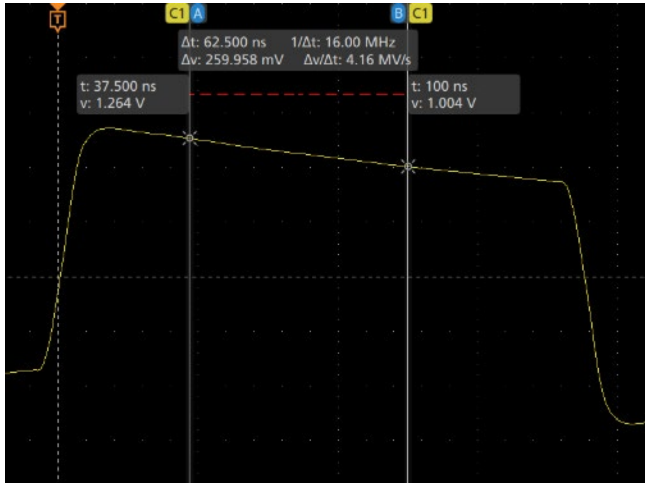
Droop – Measurement

No Power Coupling



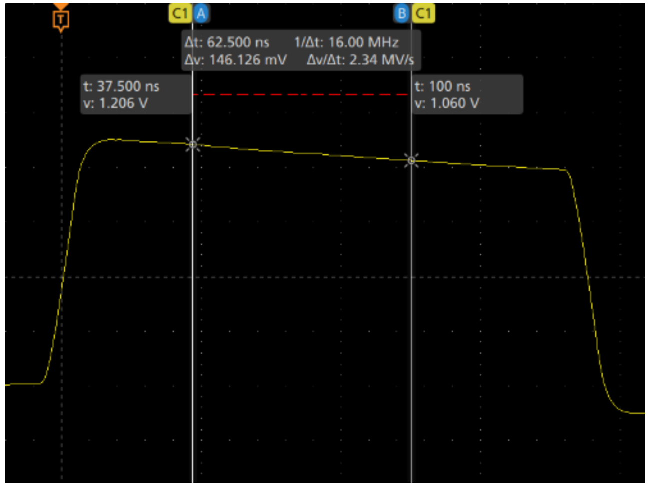
Droop 1.7%

18.8uH differential (2x 4.7uH coupled)



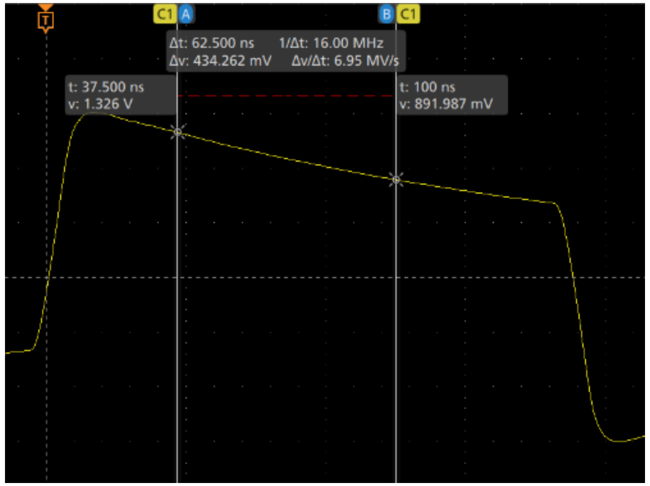
Droop 21%

40uH differential (2x 10uH coupled)



Droop 13%

9.6uH differential (2x 2.4uH coupled)



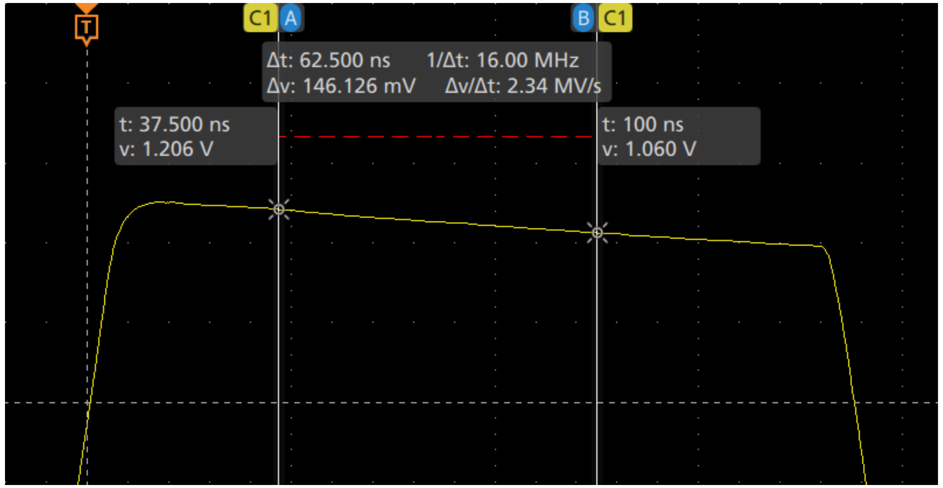
Droop 33%

Droop – Measurement Method Note

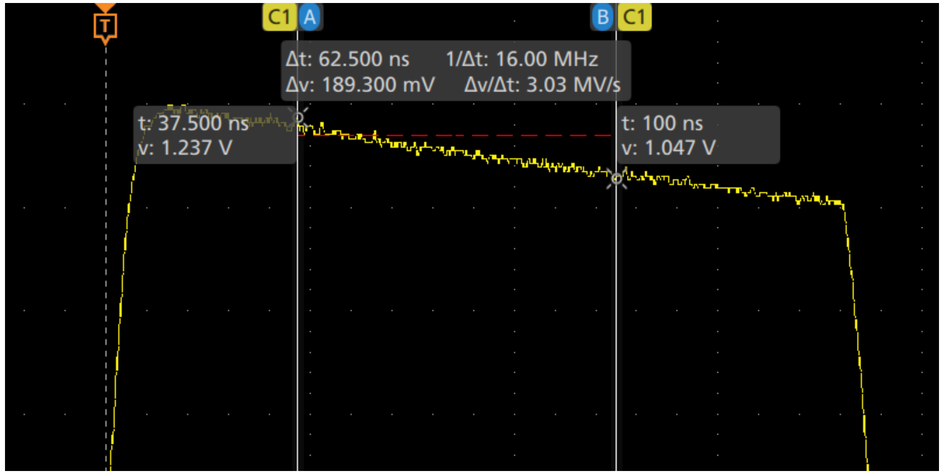
- Using oscilloscope averaging
  - Measurement results in this presentation used average of 64
  - Eliminates effect of random system noise
  - Otherwise the noise may significantly affect the result

Reading	V1	V2	Droop
1	1.213	1.057	12.86068
2	1.211	1.045	13.70768
3	1.212	1.07	11.71617
4	1.208	1.074	11.09272
5	1.198	1.071	10.601
6	1.195	1.071	10.37657
7	1.206	1.082	10.28192
8	1.224	1.048	14.37908
9	1.199	1.082	9.758132
10	1.237	1.047	15.35974

Oscilloscope Capture – Averaging 64



Oscilloscope Capture – No Average



Droop - Summary

Differential Inductor	LTSpice Simulation	Measurement 1	Measurement 2
None (only transformer)	1.3%	1.7%	2.2%
40uH	9.4%	13%	12%
18.8uH	17%	21%	20%
9.6uH	29%	33%	32%

… the magnitude of both the positive and negative droop shall be less than 10% measured with respect to an initial value at 37.5 ns after the zero crossing and a final value at 100 ns after the zero crossing.

When a Clause 104 Type G 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 37.5 ns after the zero crossing and a final value at 100 ns after the zero crossing

Thank You.
Questions?