

# IEEE P802.3dg IEC 61000-4-4 Interference Model

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# Background

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- Industrial EMC requirements include tolerating periodic bursts of impulse interference
- Widely referenced test standard IEC 61000-4-4:2012 specifies requirements for capacitive injection of periodic burst interference
  - **Interference source pulses are ~50 ns duration @ 50% amplitude**
- Several sources describe the problem and the test
- FEC is repeatedly proposed as a potential compensation technique

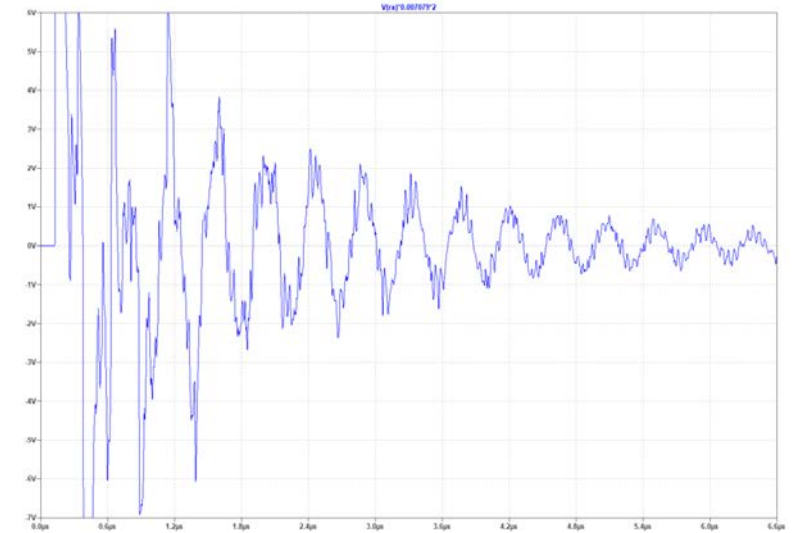
# Background (3da)

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- [https://www.ieee802.org/3/SPMD/public/jan20/Koczwar Zimmerman\\_3SPMD\\_01\\_0120.pdf](https://www.ieee802.org/3/SPMD/public/jan20/Koczwar Zimmerman_3SPMD_01_0120.pdf)
- Describes the burst transient problem
- Proposes FEC as a potential compensation technique
- Suggests that interference period is longer than the pulse time, but offers no further explanation
  - **“50ns pulses generally cause errors in bursts of 5 to 6 bits [480 ns]”**

# Background (3dg)

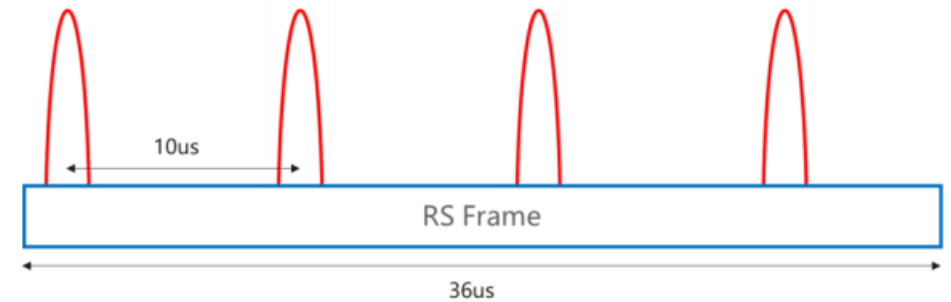
- [https://www.ieee802.org/3/dg/public/May\\_2022/beruto\\_3dg\\_01\\_20220711\\_noise\\_env.pdf](https://www.ieee802.org/3/dg/public/May_2022/beruto_3dg_01_20220711_noise_env.pdf)
- Details IEC 61000-4-4 test (with Spice models)
  - Note error: burst duration @ 100 kHz is 0.75 ms
- Suggests that interference period is longer than the pulse time due to ringing - but offers no model



# Background (3dg)

- [https://www.ieee802.org/3/dg/public/May\\_2022/mu\\_3dg\\_01\\_03162023.pdf](https://www.ieee802.org/3/dg/public/May_2022/mu_3dg_01_03162023.pdf)
- Refers to burst transient problem
- Proposes FEC as a potential compensation technique
- Ignores damped oscillation in response to transient pulses

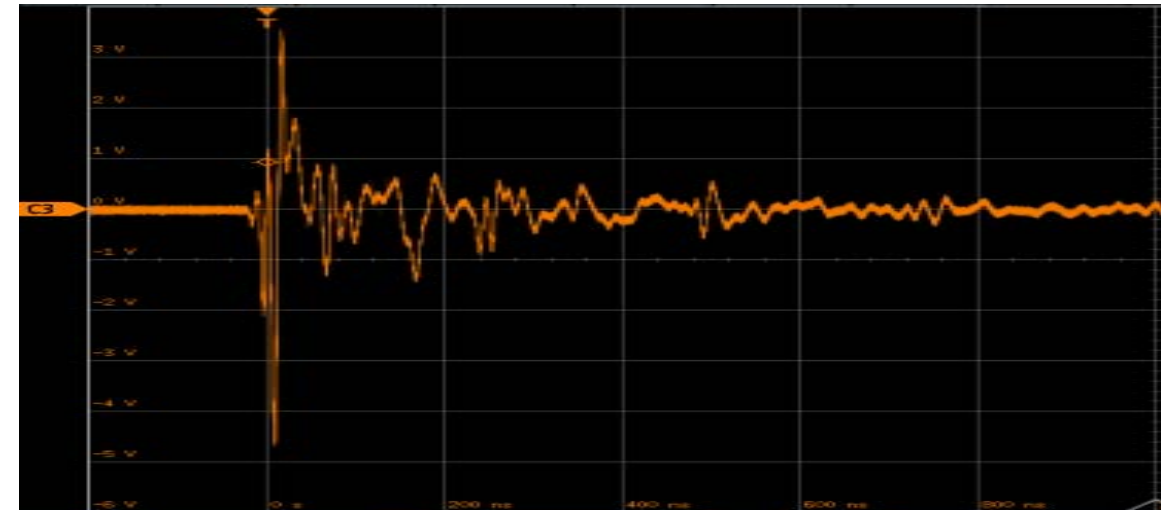
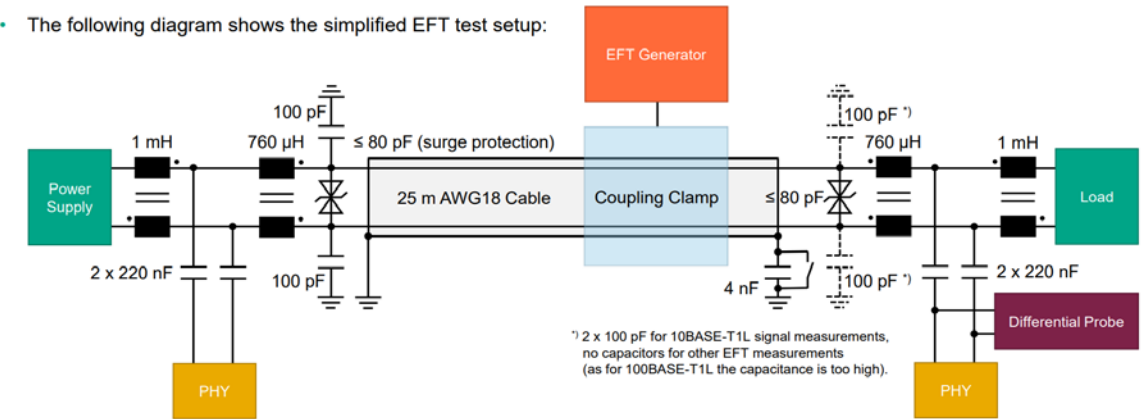
According to IEC61000-4-4 impulse noise model:  
duration = 50ns, burst rate = 100kHz (10  $\mu$ s).



# Background (3dg)

- [https://www.ieee802.org/3/dg/public/May\\_2022/graber\\_3dg\\_01a\\_05172023.pdf](https://www.ieee802.org/3/dg/public/May_2022/graber_3dg_01a_05172023.pdf)
- Measures response to single 1.1 kV EFT pulse in a 10BASE-T1L system
- Shows pulse response is damped oscillation 500-600 ns
- Examines measurement error
- Speculates larger effect on 100BASE-T1L

• The following diagram shows the simplified EFT test setup:



# Purpose

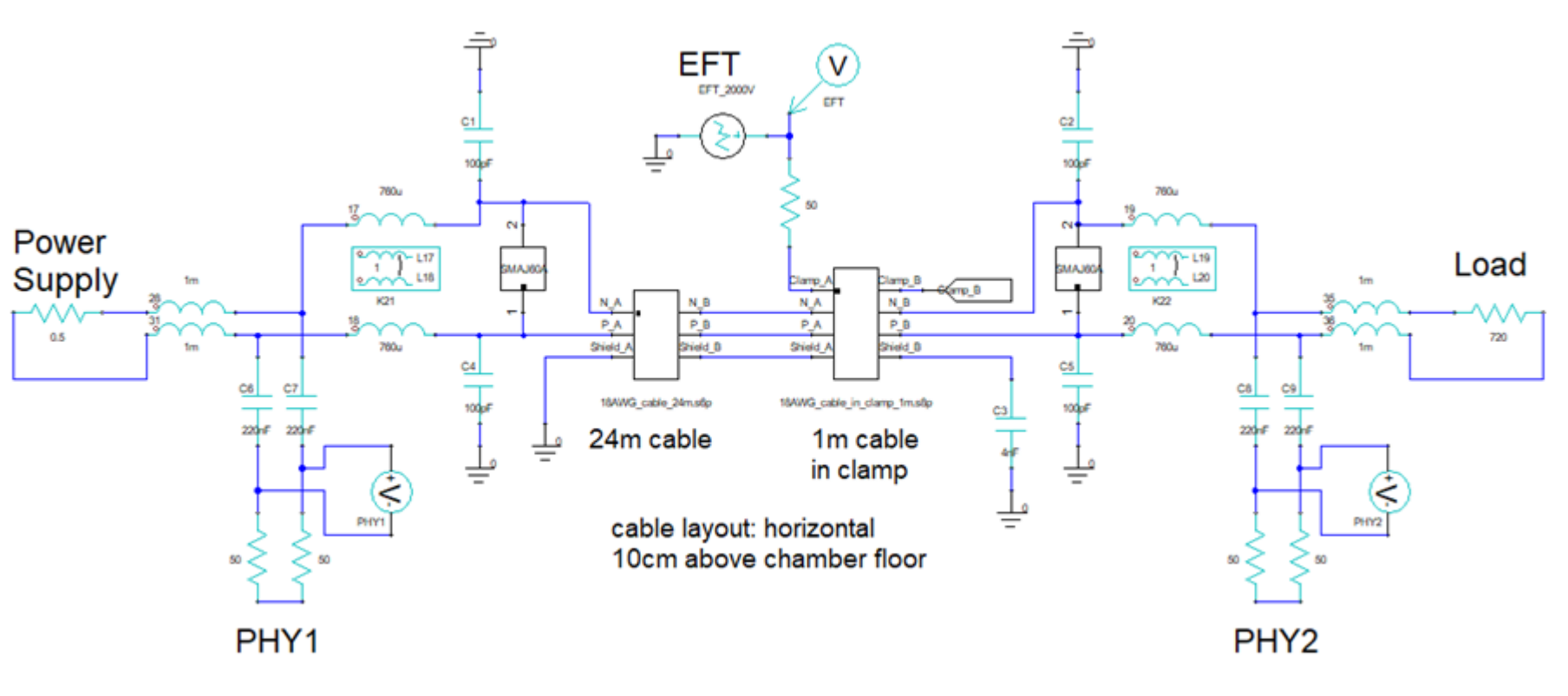
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- IEEE P802.3dg may include an FEC method
- Introduce a model-based approach where various parameters can be quickly altered
- Provide first simulation results that illustrate the expected interference response in a differential communication pair
  - Inform any FEC efforts
  - Provide CSV format as input to PHY models

# Ansys Simulation Model

Follows advised model from:

[https://www.ieee802.org/3/dg/public/May\\_2022/graber\\_3dg\\_01a\\_05172023.pdf](https://www.ieee802.org/3/dg/public/May_2022/graber_3dg_01a_05172023.pdf)

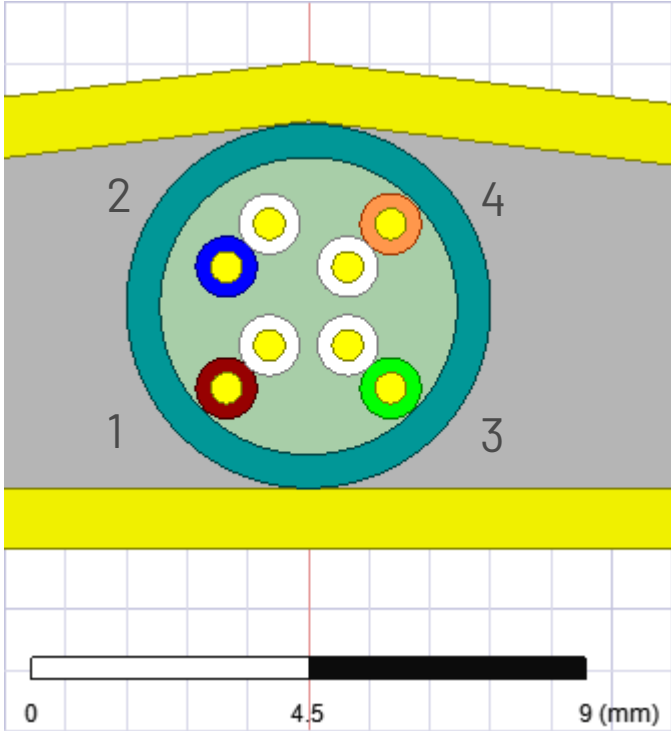
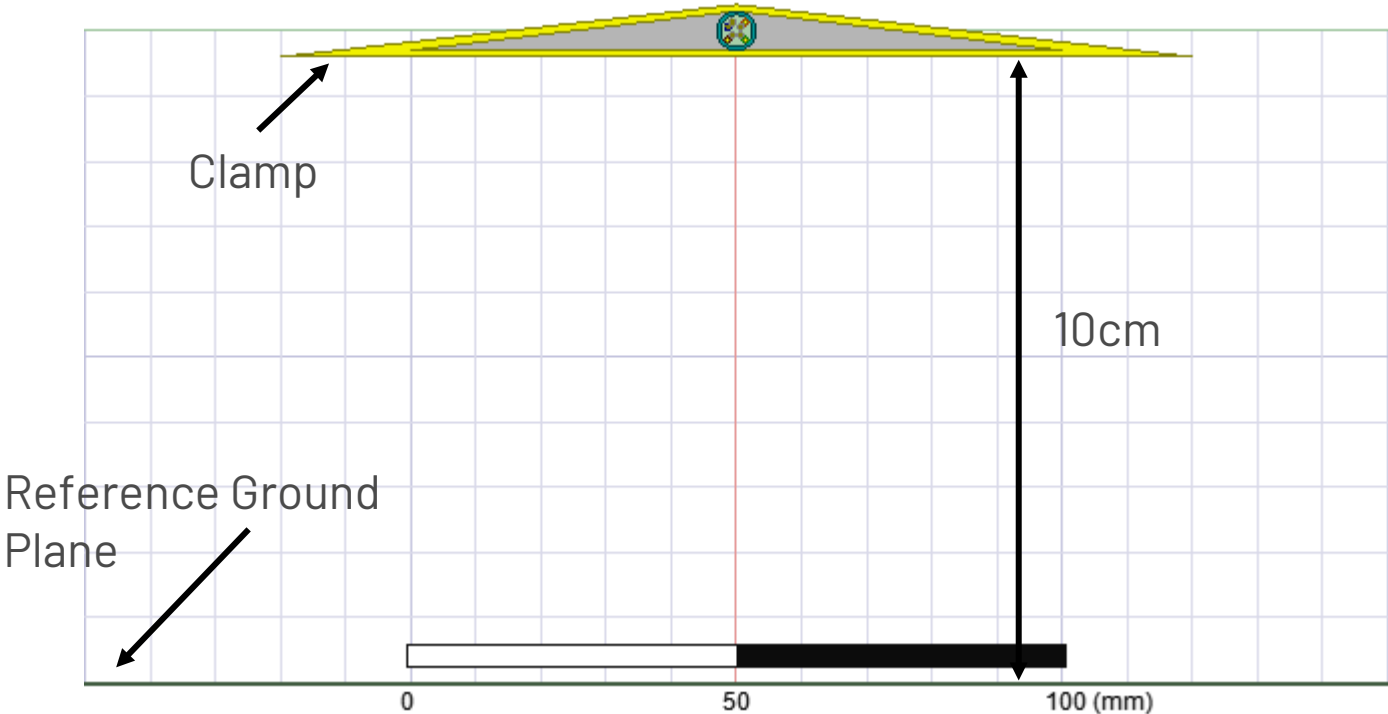


- EFT generator
- Clamp
- Shielded cable
- Cable terminations
- Surge protection
- PHY/coupler model
- Power supply and load model
- Reference ground



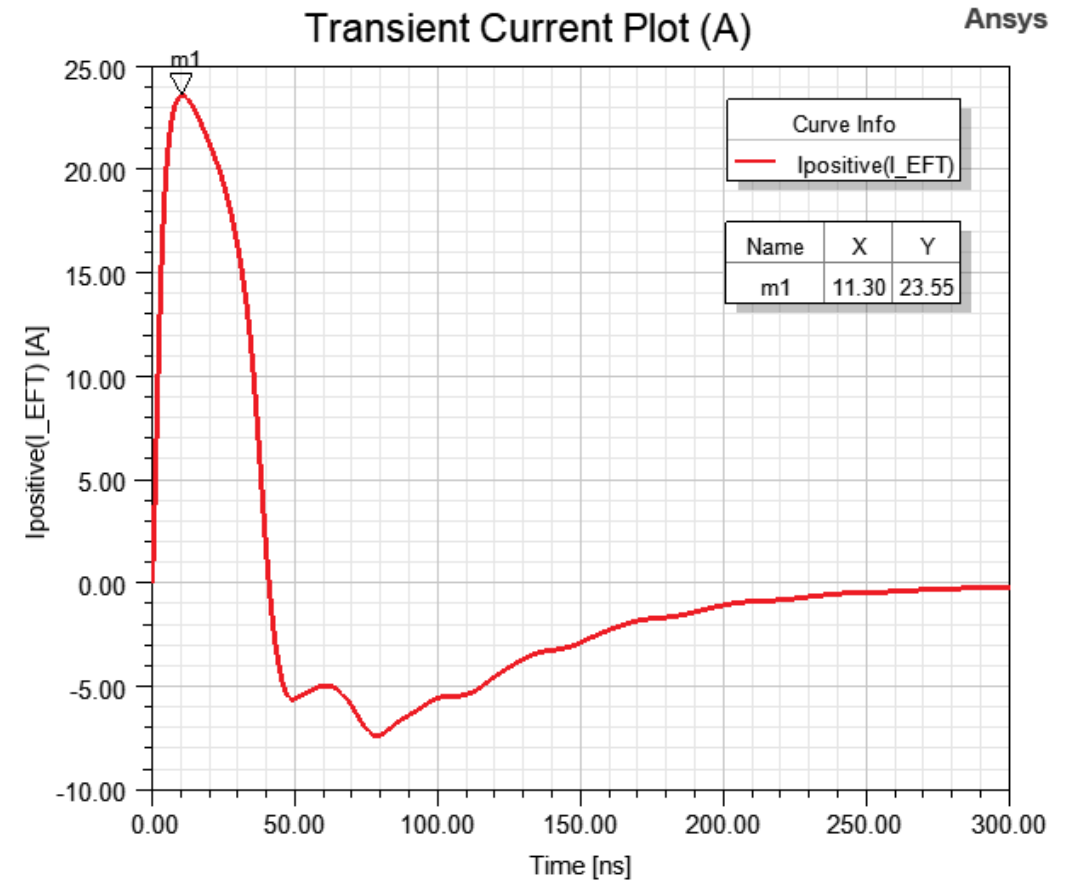
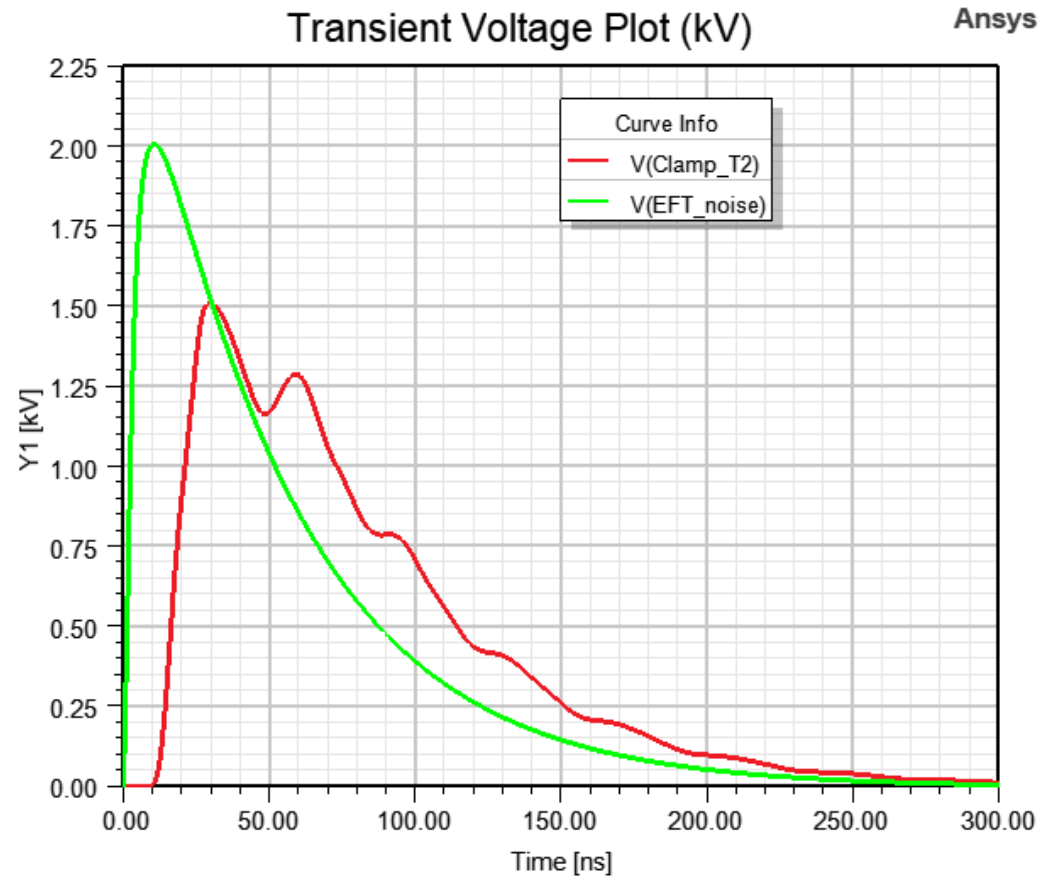
# Illustration - Model of Cable inside Capacitive Clamp

Note: Simulation uses single pair shielded cable

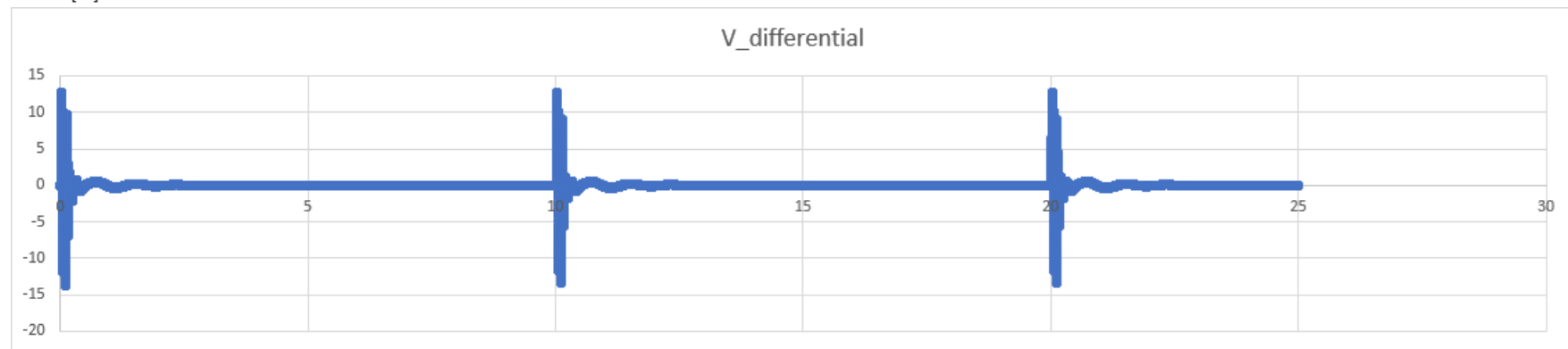
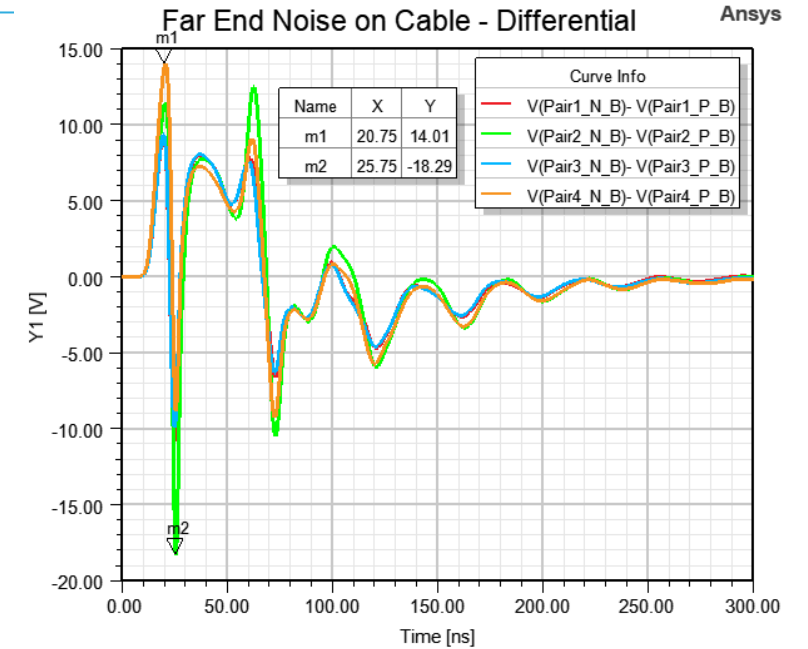
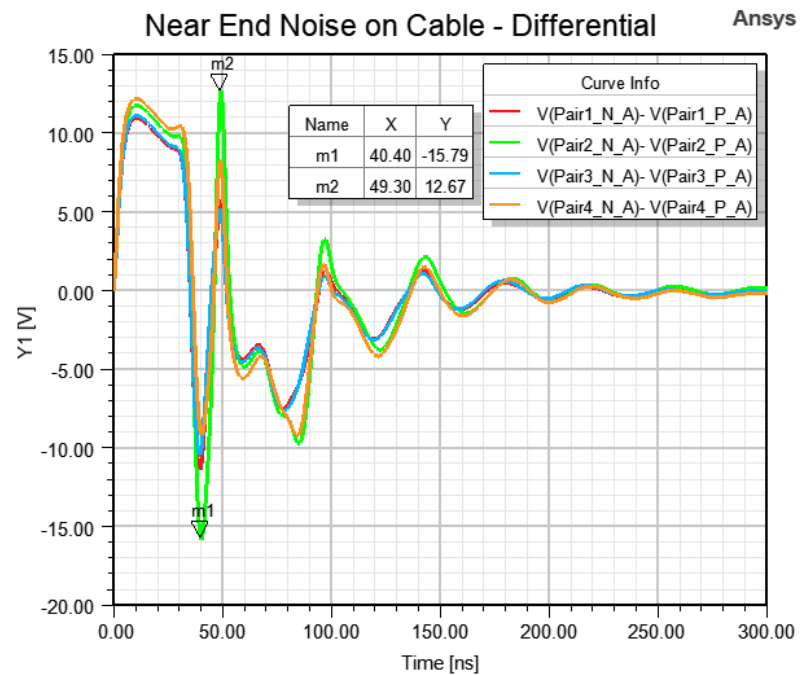


Pairs include twist

# Illustration - Transient Stimulus Waveforms



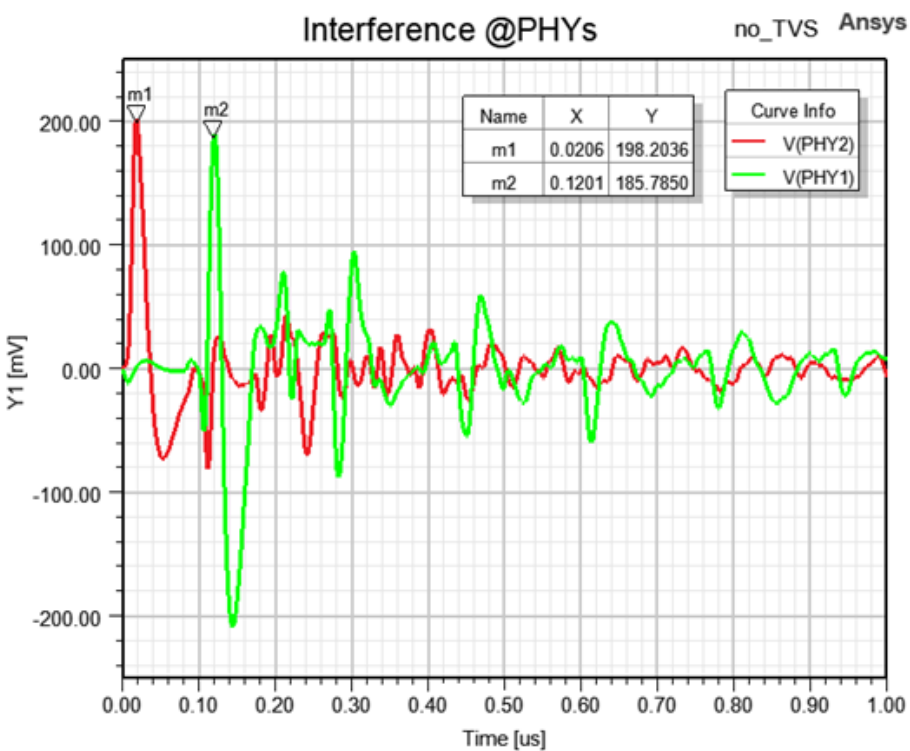
# Illustration - Transient Response Waveforms



# Simulation Output

	A	B	C
1	Time [us]	V(PHY2) [mV]	V(PHY1) [mV]
2	0	0	0
3	2.00066488931869e-07	2.74437170048155e-08	-2.24E-09
4	4.00132977863739e-07	8.22009058670918e-08	-6.75E-09
5	8.00265955727477e-07	2.46084887229731e-07	-2.04E-08
6	1.20039893359122e-06	5.18198680560862e-07	-4.35E-08
7	1.83389528452829e-06	1.16767507977654e-06	-1.00E-07
8	2.46739163546537e-06	2.08197972194116e-06	-1.82E-07
9	3.24357184717895e-06	3.55735996617056e-06	-3.17E-07
10	4.26259982932297e-06	6.07677617812991e-06	-5.57E-07

- Excel output can be CSV
- Time versus:
  - Differential voltage per line
  - Common mode voltage per line
- Other outputs are possible



What is useful to others in the group?

# Conclusions

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- IEC 61000-4-4 burst transient interference can be modeled
  - 100 kHz pulse rate is considered more typical of real environment
- An Ansys simulation shows the interference pulse (50 ns) induces a damped transient response of longer duration (~300 ns)
  - Reasoning: CM termination is not matched and is difficult to match as the CM impedance is variable – both due to test imperfections and in the real world. Interference signal bounces between cable ends.

# Limitations

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- The model needs refinement
  - To better match the real circuit and the measured results
  - To match 100BASE-T1L

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# QUESTIONS?