Canova Tech

The Art of Silicon Sculpting

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Comment #478 - MDI electrical specification

IEEE802.3cg TF

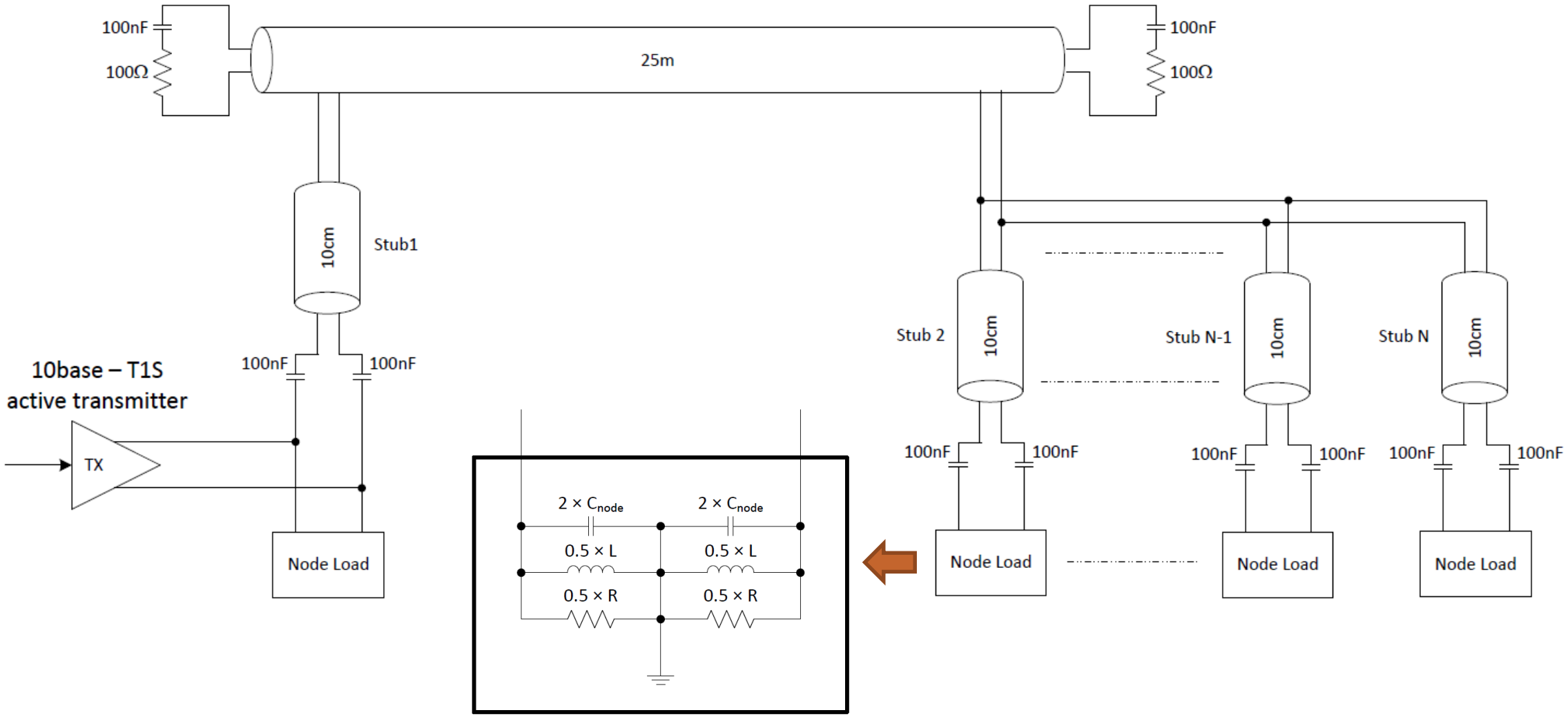
Purpose

- Follow-up on mixing segment node loading
  - http://www.ieee802.org/3/cg/public/Mar2018/brandt_cg_01a_0318.pdf
- Proposed resolution to comment #478
  - http://www.ieee802.org/3/cg/comments/802.3cg_draft1p2_Received_Comment%20ID.pdf
- Investigate the loading effect on the eye opening for different node count
- Propose a max total capacitance load across all nodes and a max node capacitance load

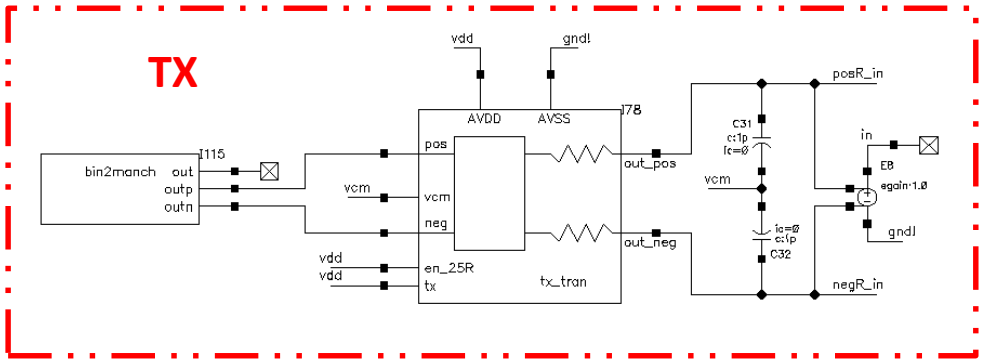
Modeling

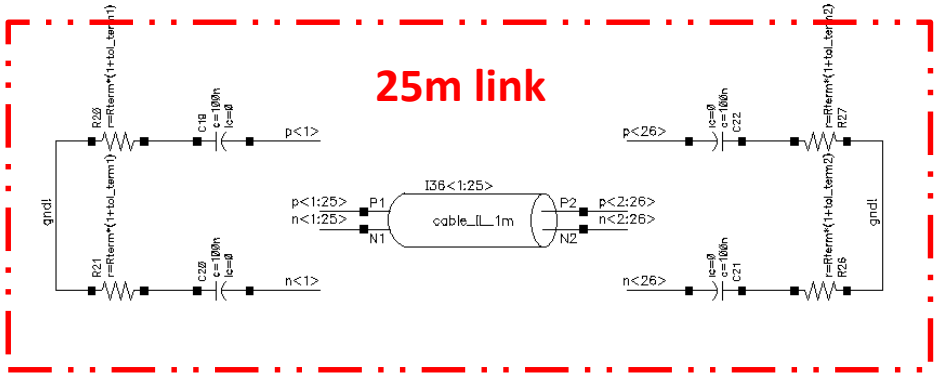
- 25m total mixing segment
- 8 to 40 nodes
- Using lumped configuration since it represents the worst case (in particular for the differential node capacitance value)
- Eye opening have been investigated versus differential node resistance, inductance and capacitance values.
- RLC from http://www.ieee802.org/3/cg/public/Mar2018/brandt_cg_01a_0318.pdf and comment #478
  - $R > 5K\Omega$
  - $440uH < L < 1mH$
  - $C < 4.5pF$
- **Node capacitance has been determined simulating a large number of nodes (40)**
- **We expect to afford an higher capacitance limit for a lower number of nodes**

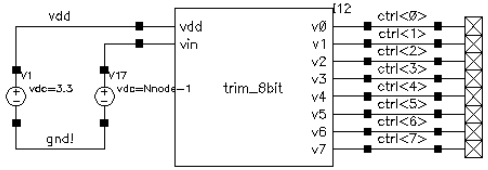
Modeling (concept diagram)

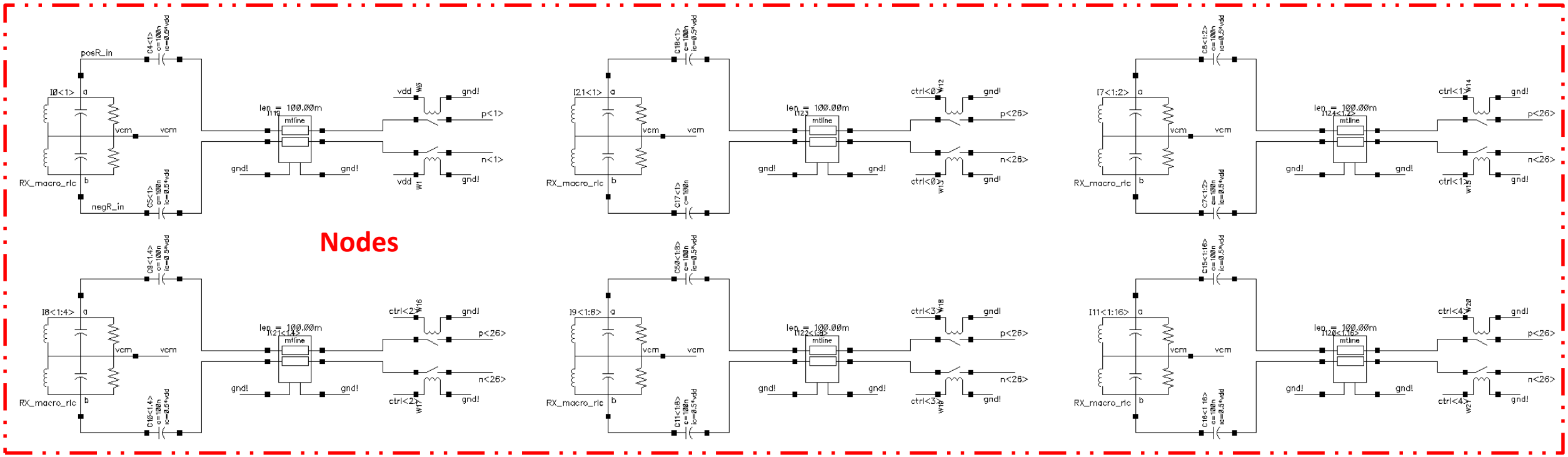


Modeling (schematic)

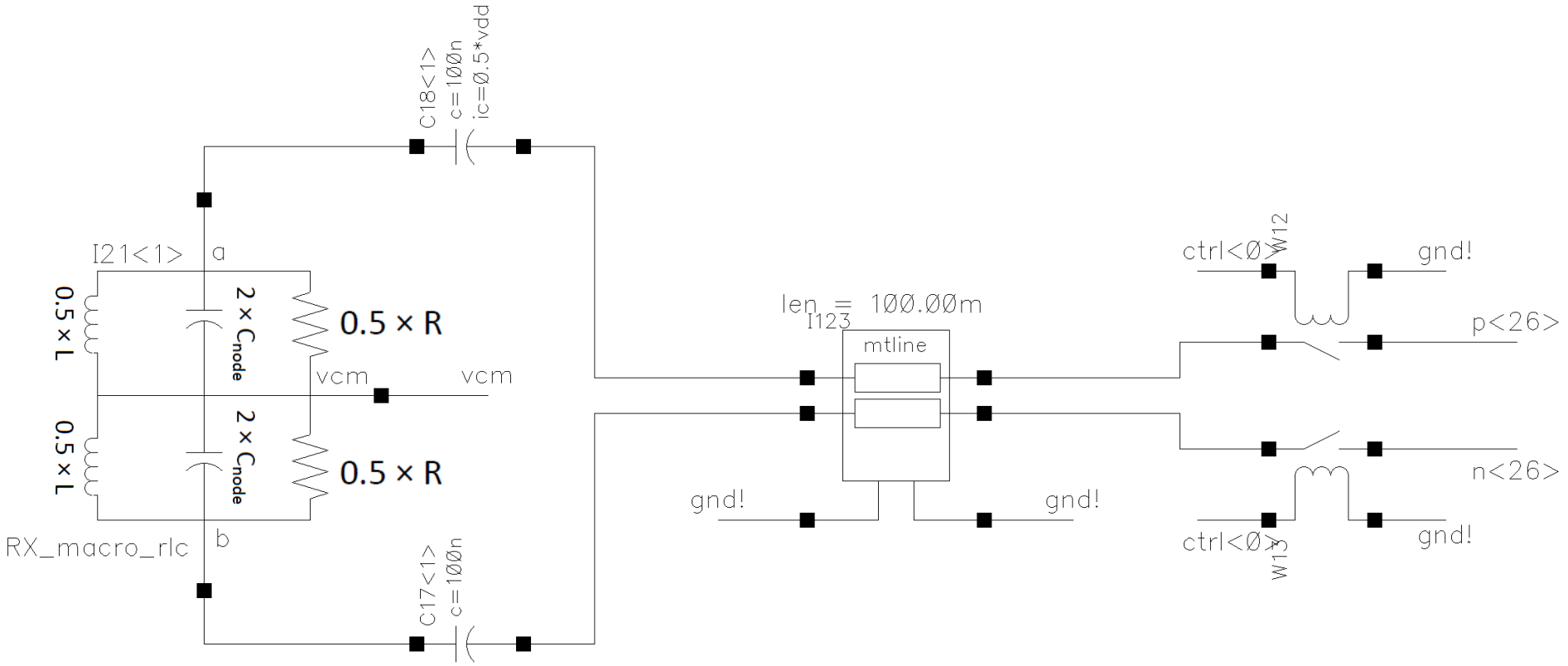






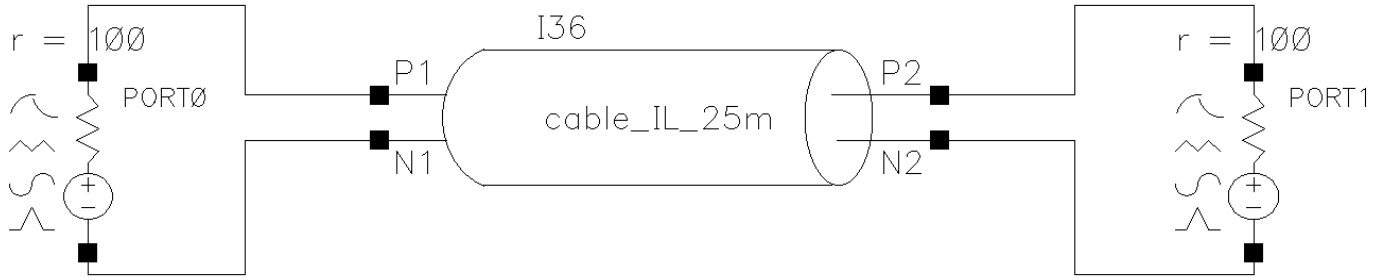


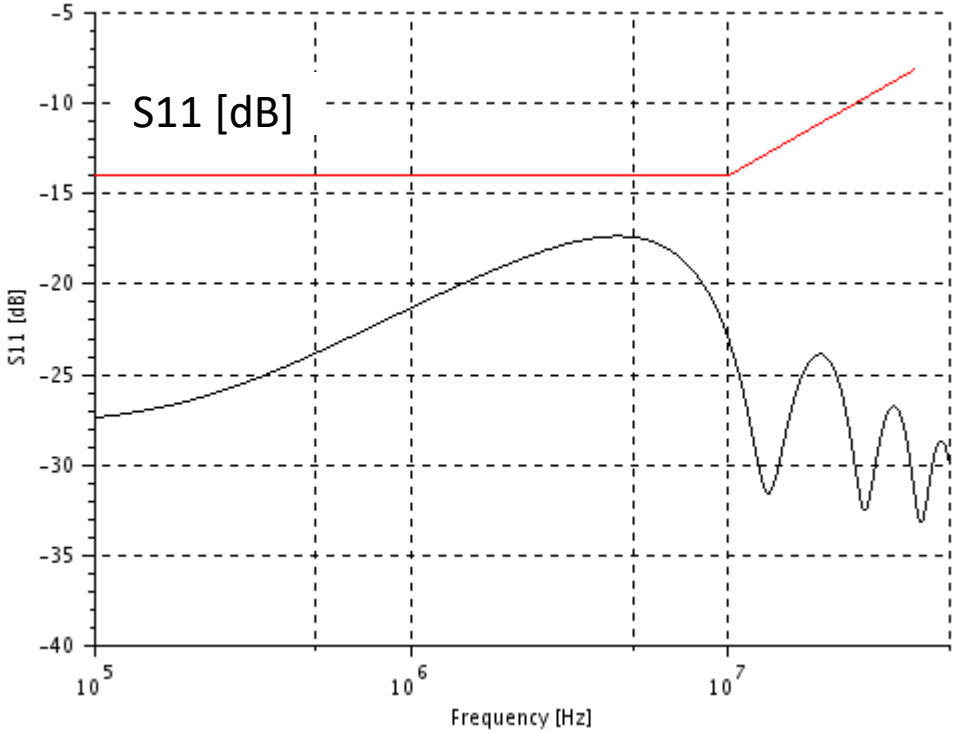
Modeling (schematic)

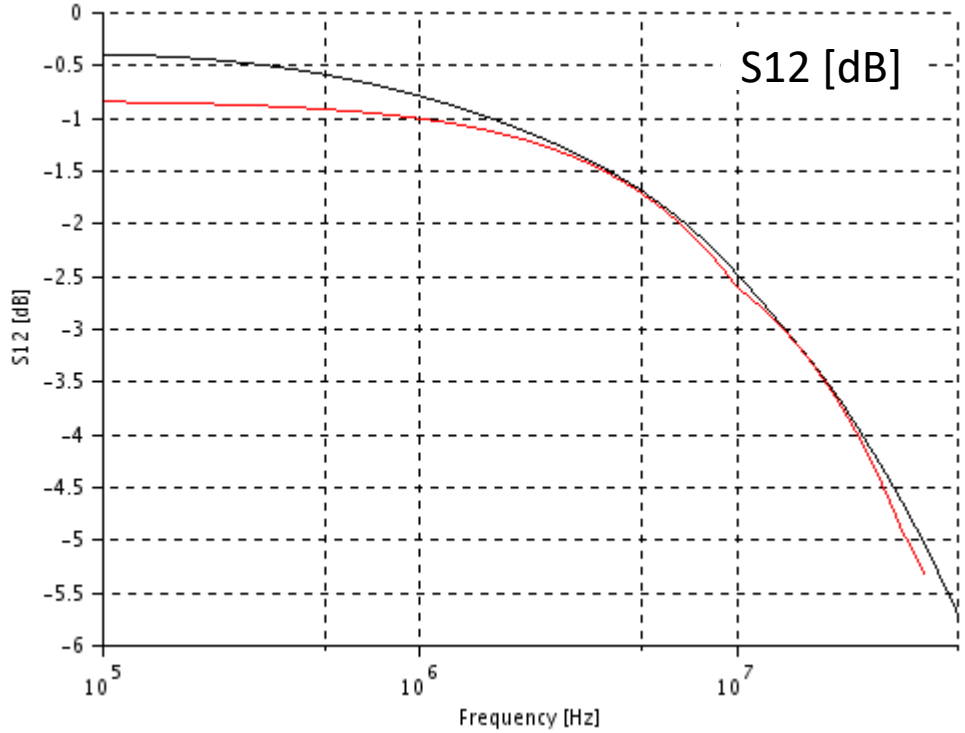


Modeling: 25m lossy transmission line S11 and S12

- Red: limit
- Black: model



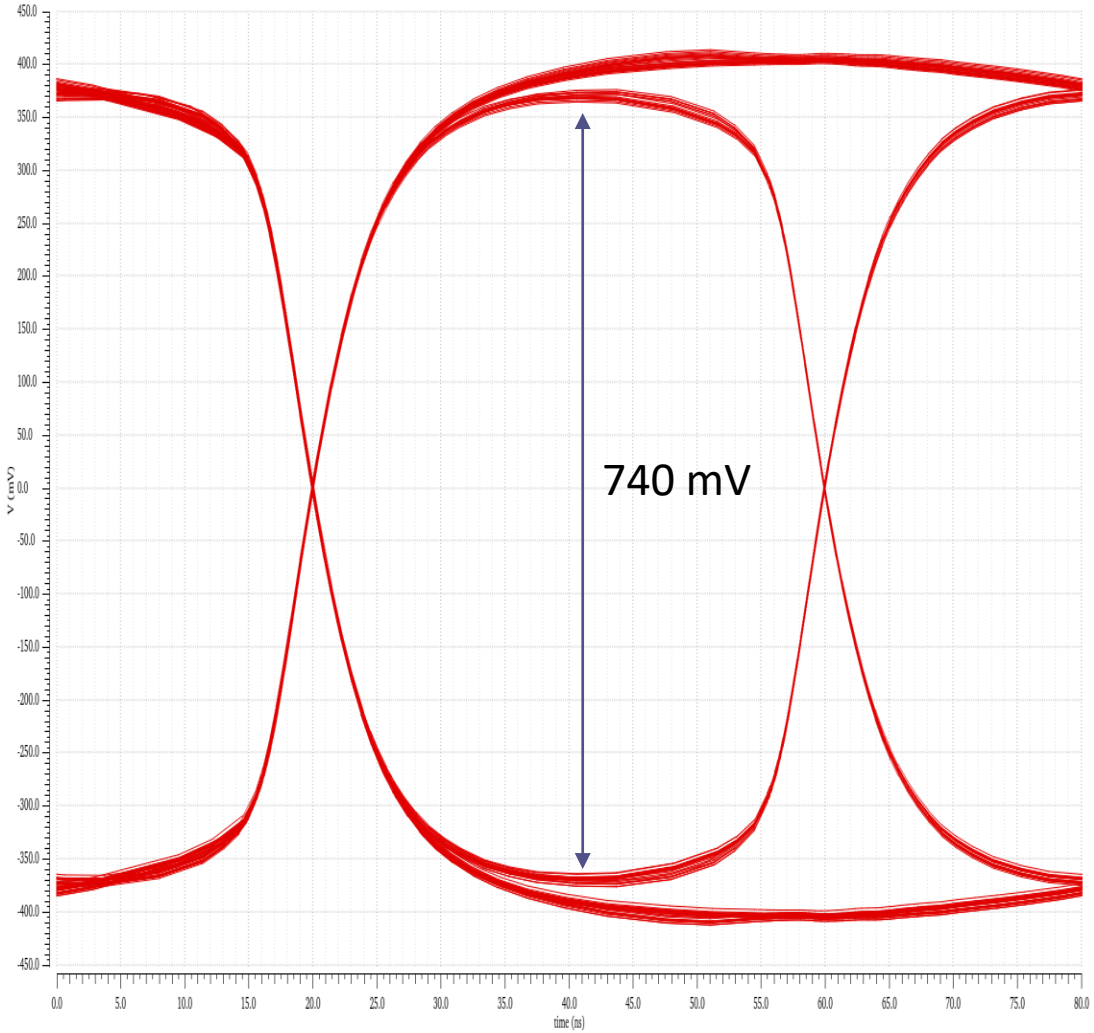




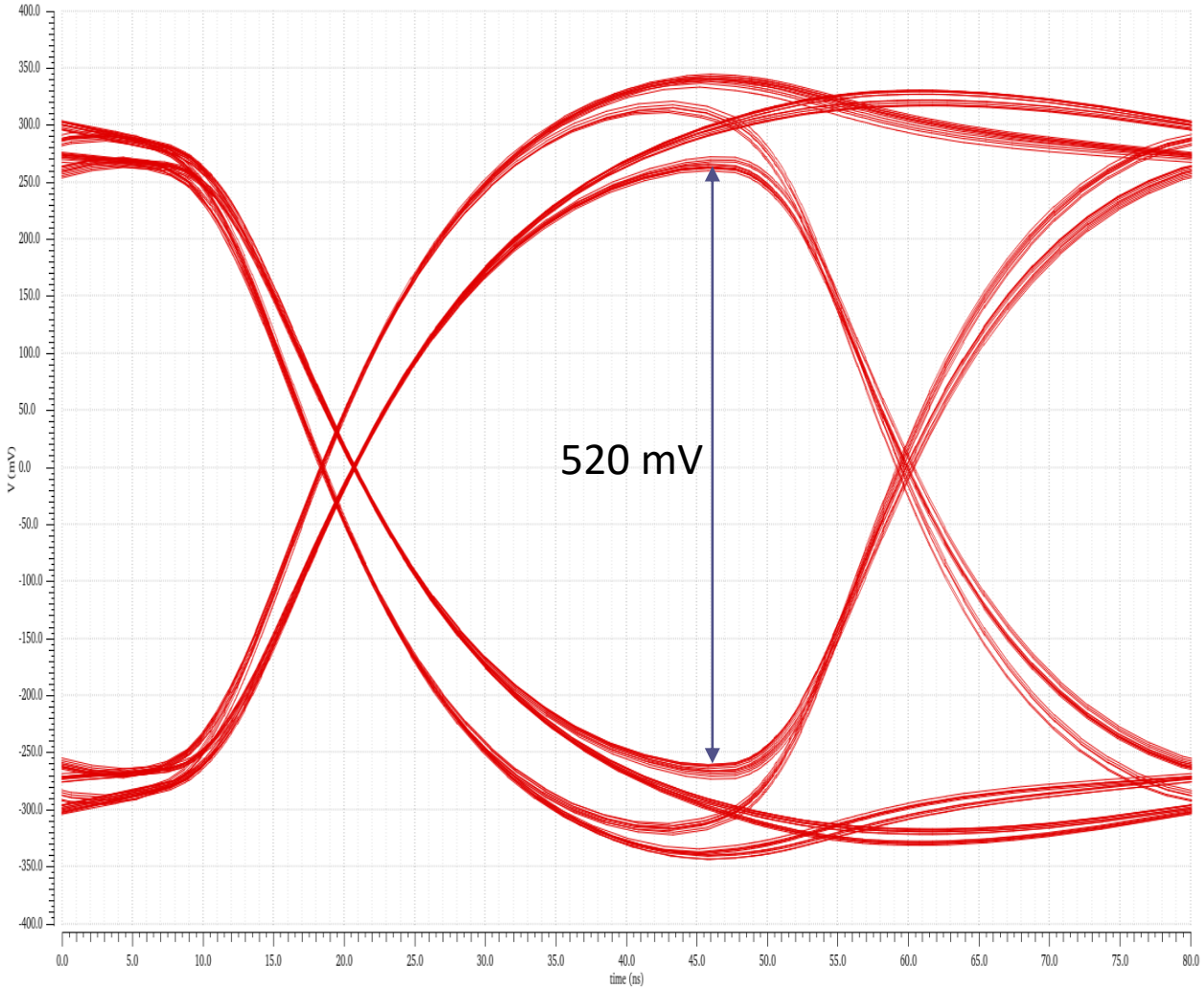
Modeling

- Preliminary results show only a weak dependence of the eye on the differential resistance and inductance versus the number of nodes, but there is a strong dependence on the differential capacitance.
- Several runs have been then performed with the following configuration.
  - Differential node resistance set to 10KΩ
  - Differential node inductance set to 440μH
  - Differential node capacitance sweep between 2pF to 30pF
  - Variable number of nodes between 8 and 40
  - Eye opening versus number of nodes and differential node capacitance evaluated

Eye diagrams

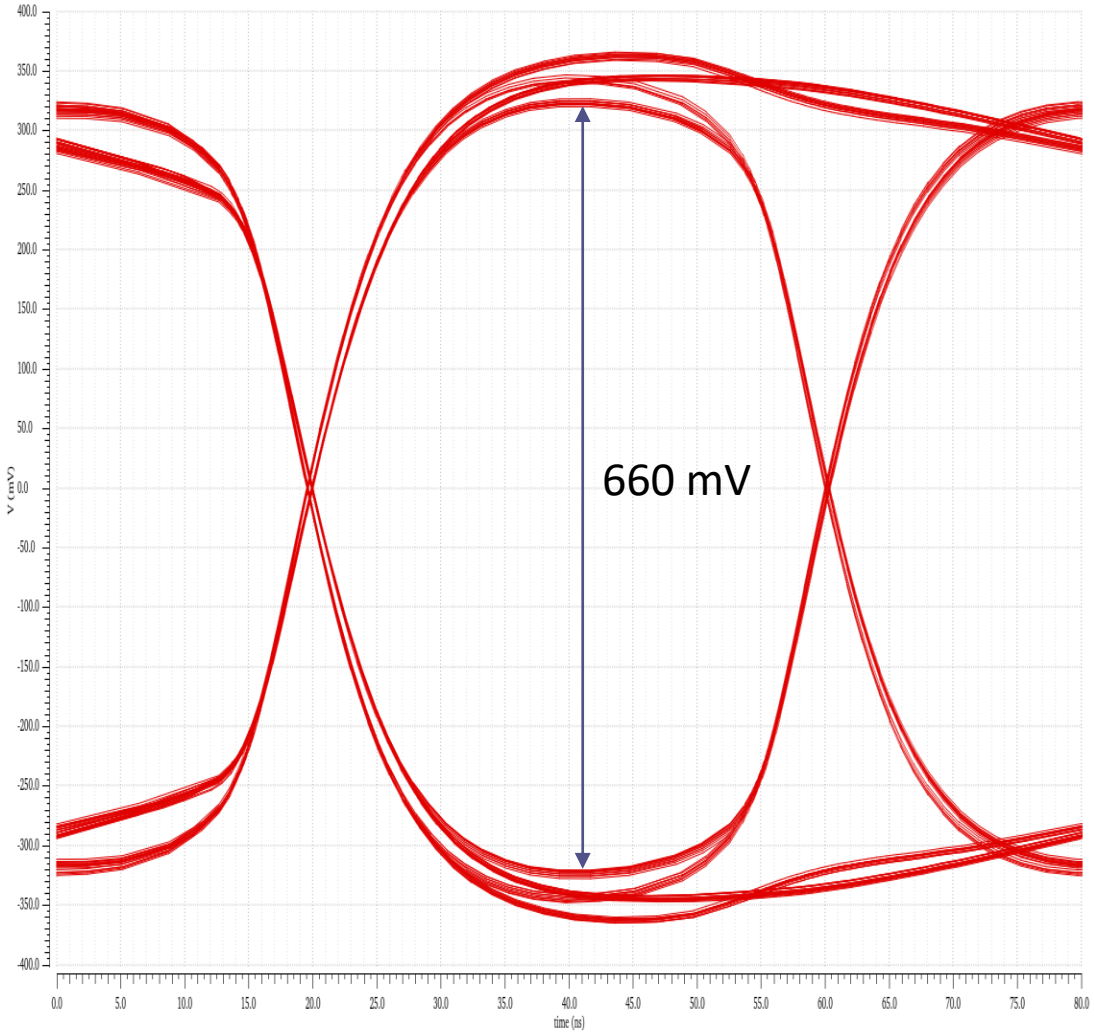


NODES = 8 C_{node} = 2pF

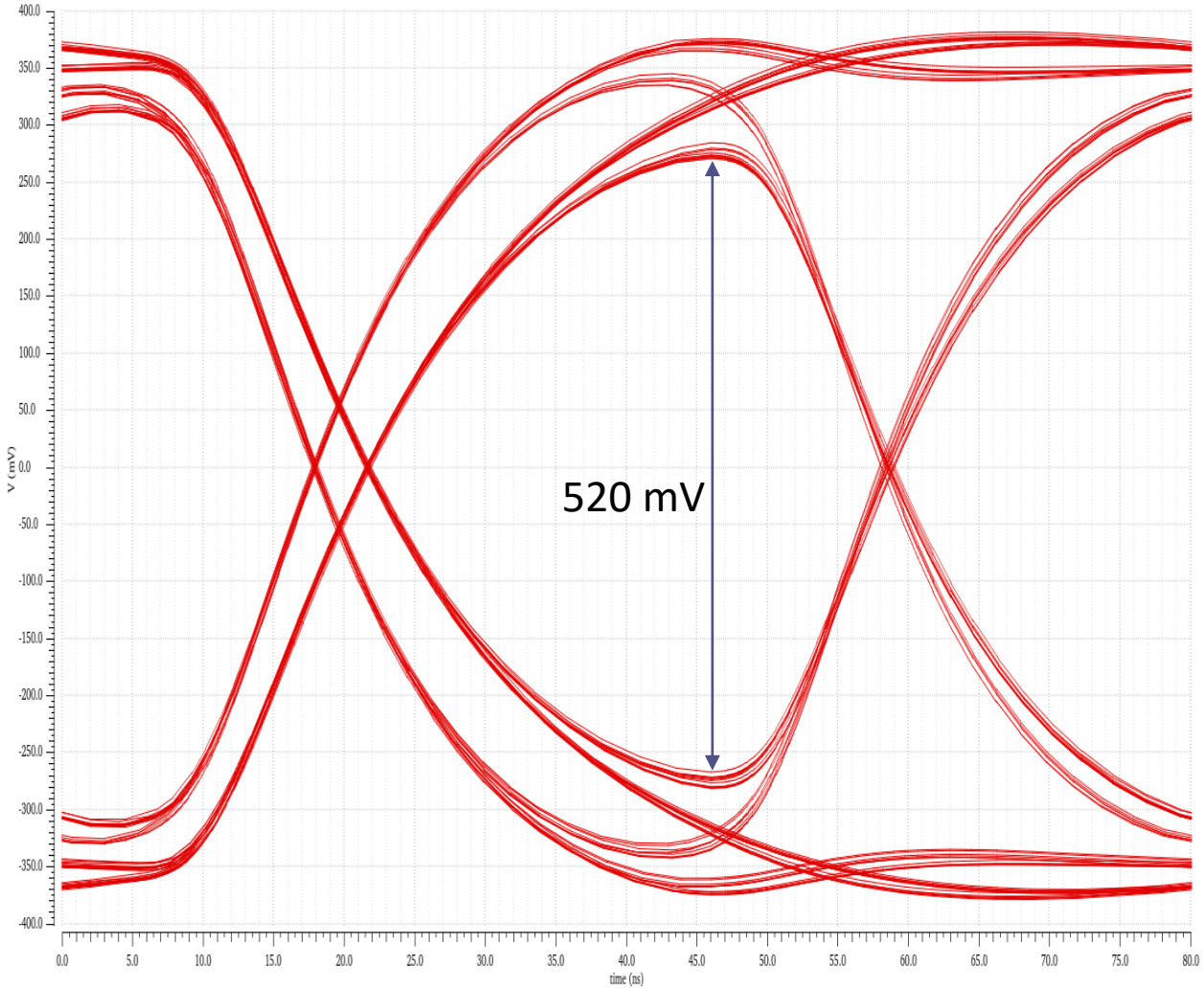


NODES = 8 C_{node} = 28pF

Eye diagrams

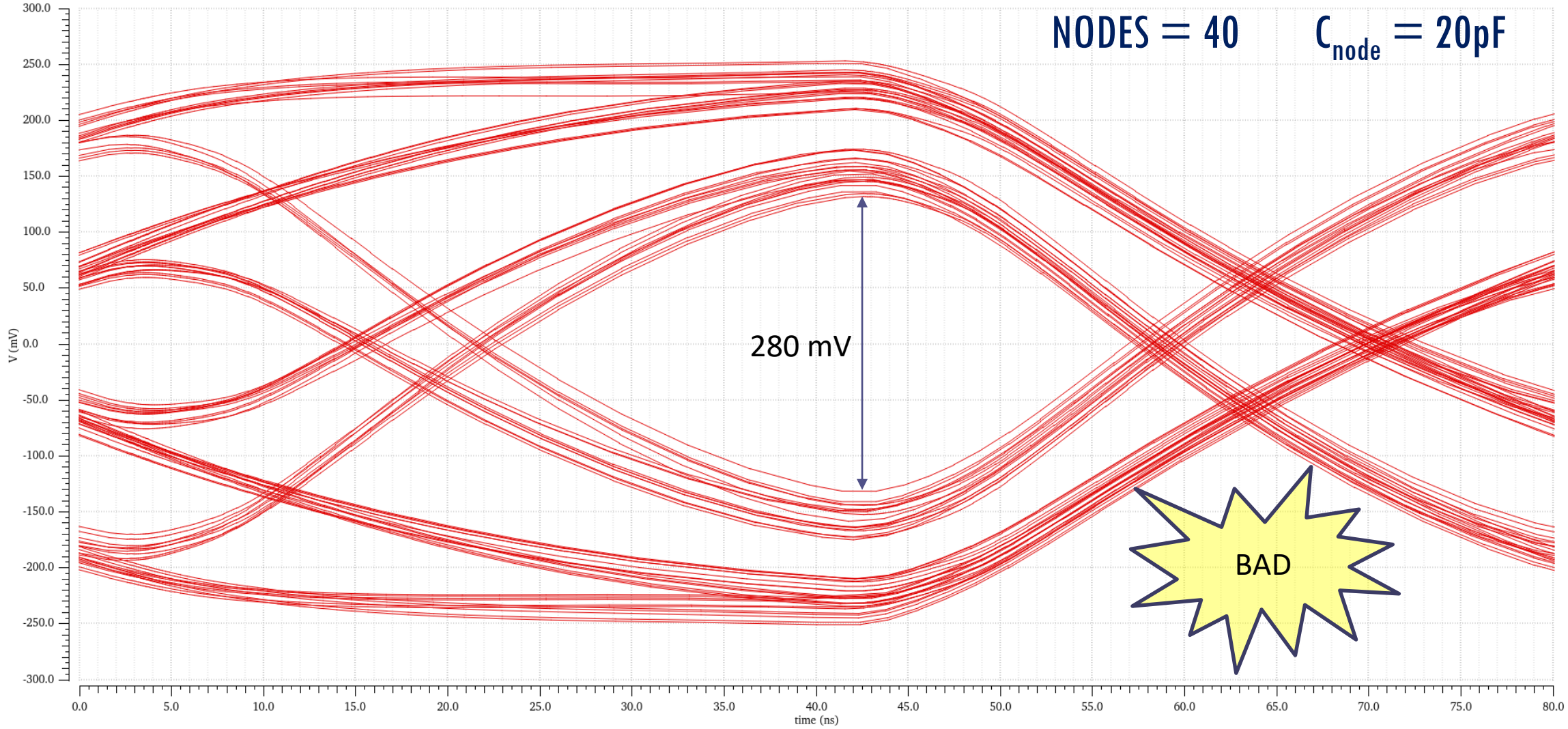


NODES = 40 C_{node} = 2pF

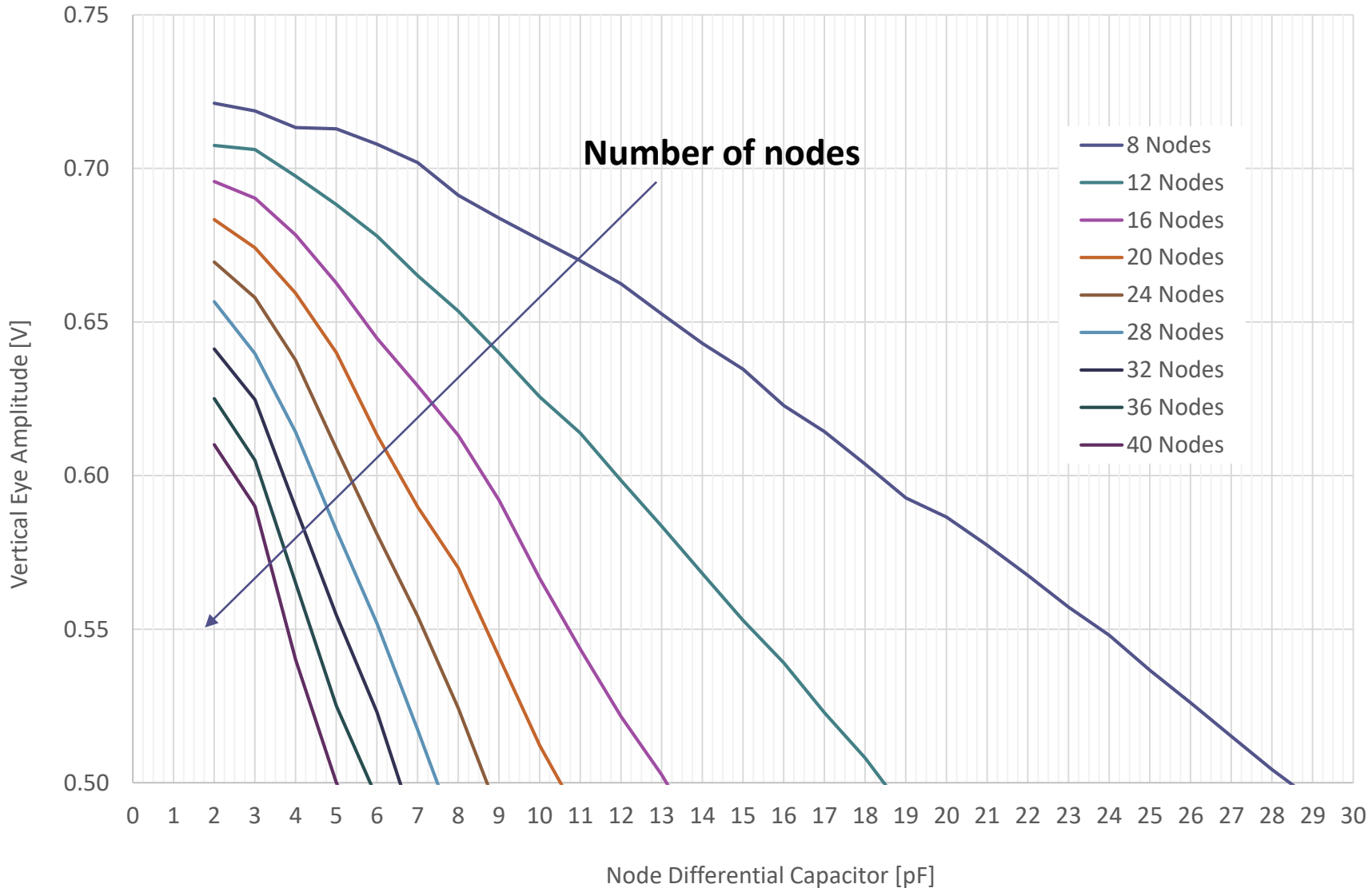


NODES = 40 C_{node} = 5pF

Eye diagrams

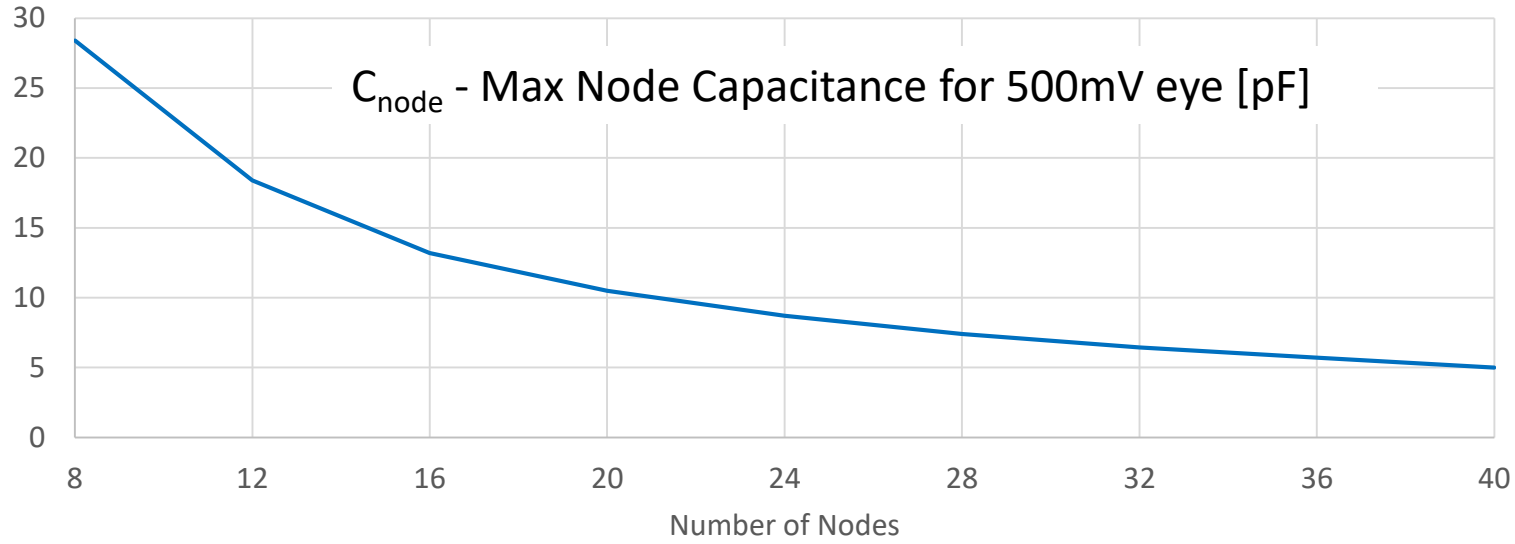


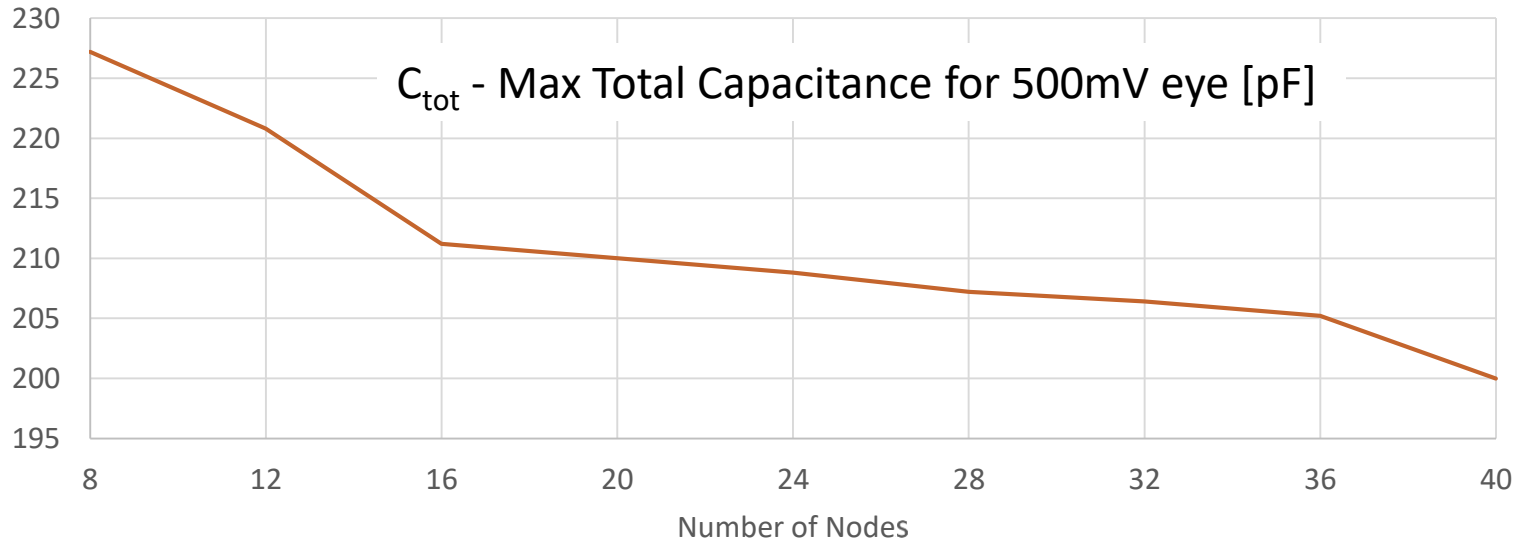
RX Eye Amplitude vs. Node Differential Capacitor and Number of nodes



- From this data the maximum capacitance for each node C_{node} and the total capacitance across all nodes C_{tot} can be extrapolated
- Assuming 500mV RX eye opening

Node and total capacitance vs number of nodes





Per node cap and total cap vs number of nodes

- 180pF limit for the total capacitance can be considered a reasonable value (margin included)
- For a 40 nodes network tot cap limit would give 180pF / 40 = 4.5pF per node
- For a 8 nodes network tot cap limit would give 180pF / 8 = 22.5pF per node
- We propose a 15pF per node limit to keep more margin (eye opening) for automotive use cases

Conclusion

- Changing the number of nodes, the total amount of differential capacitance that we can afford to keep a reasonable eye opening changes.
- Maximum total capacitance across all nodes C_{tot} and the maximum capacitance for each node C_{node} can be defined, along with R and L limits, as follows:
  - R > 10 kOhm
  - 440uH < L < 1 mH
  - C_{tot} < 180 pF
  - C_{node} < 15 pF
- MDI minimum parallel impedance can be expressed as follow:

$$|Z| = \frac{1}{\sqrt[2]{\frac{1}{R^2} + \left(\frac{1}{2\pi \cdot f \cdot L} - 2\pi \cdot f \cdot C_{node}\right)^2}}$$

  - 0.3 MHz < f < 40 MHz