
Nokia Siemens
Networks

driver schedules: pre-/de-emphasis and frequency/data-rate issues

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DATE , Munich , Germany

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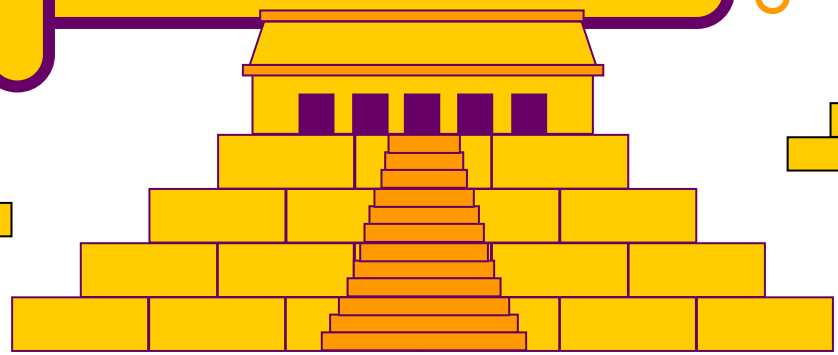
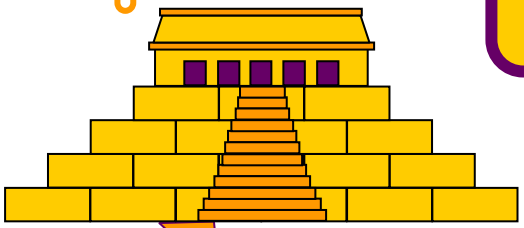
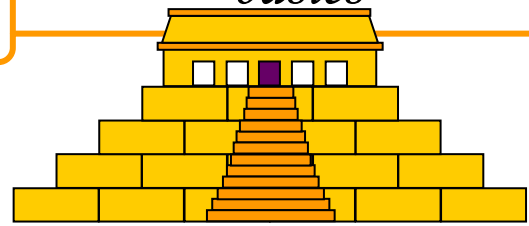
driver schedule: pre-/de-emphasis and frequency/data-rate issues



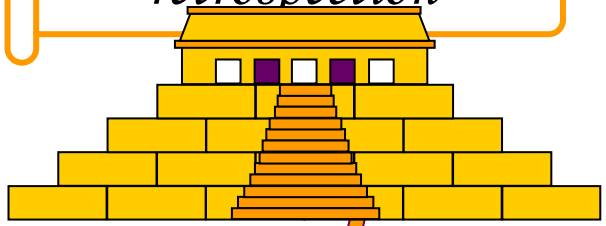
summary



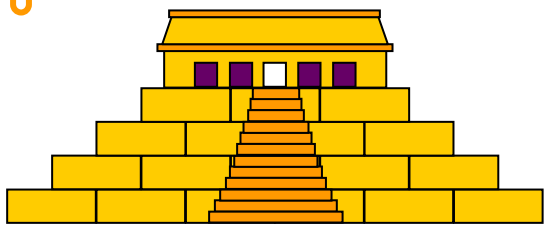
Pre-/De-emphasis basics



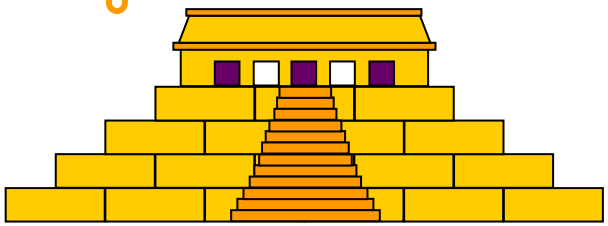
Driver schedule retrospection



Frequency /data rate

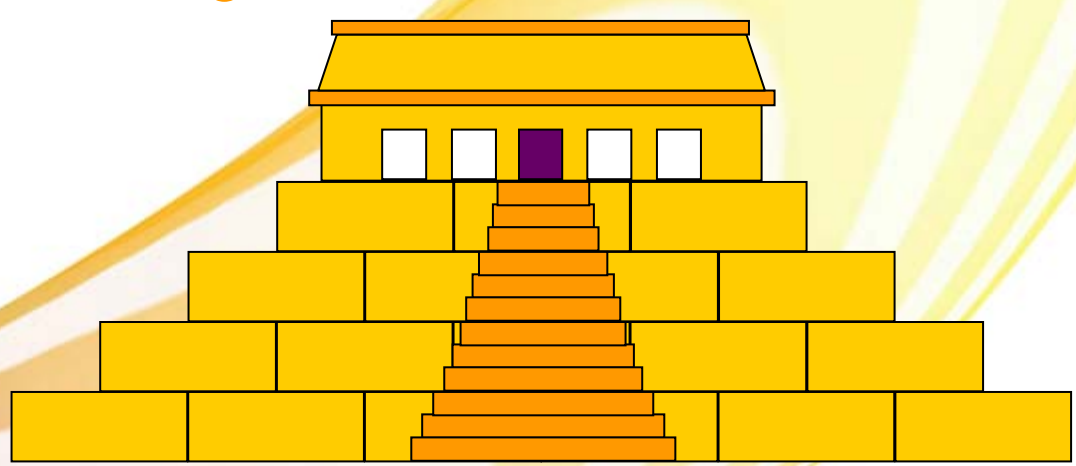


examples

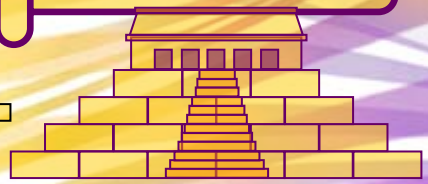


Nokia Siemens Networks

Pre- /De-emphasis basics



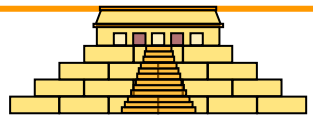
driver schedule: pre-/de-emphasis and frequency/data-rate issues



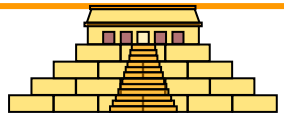
summary

Examples

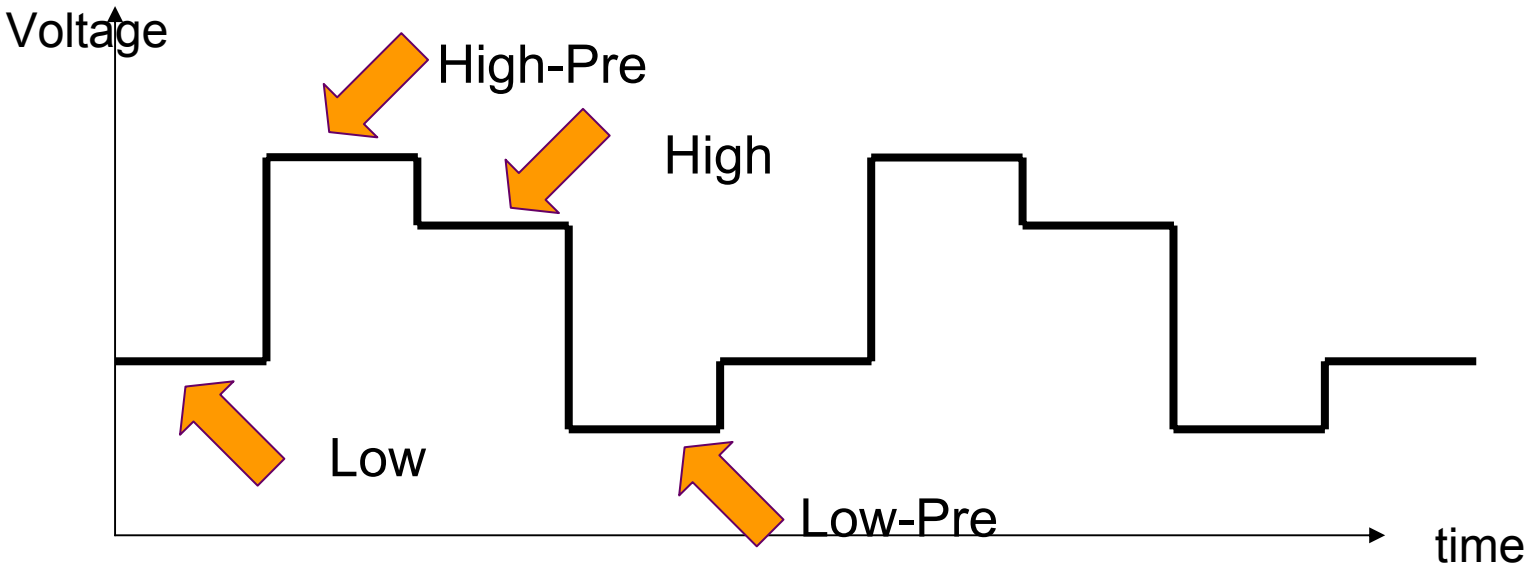
Driver schedule retrospections



Frequency /data rate



pre-emphasis overview



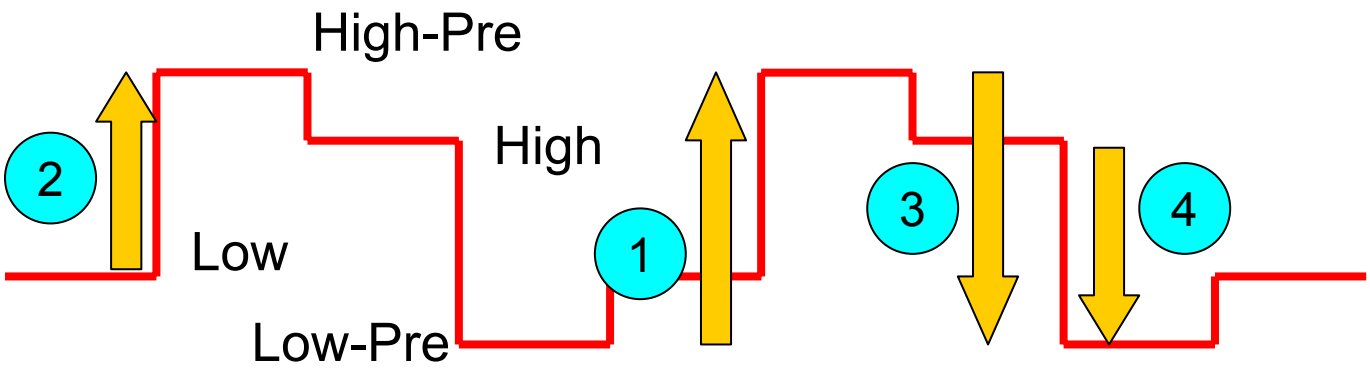
Pre- or DE-emphasis is often realized with current-mode-drivers and you can define 4 states:

(e.g. pre-emphasis)

Low
Low-Pre
High
High-Pre

each bit after a change of the logic state is‚emphasized‘

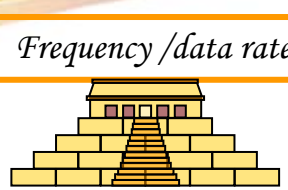
pre-emphasis switching modi



There exist 4 possible switching modi

1. Low-Pre → High-Pre …10→1
2. Low → High Pre …00→1
3. High-Pre → Low-Pre …01→0
4. High → Low-Pre …11→0

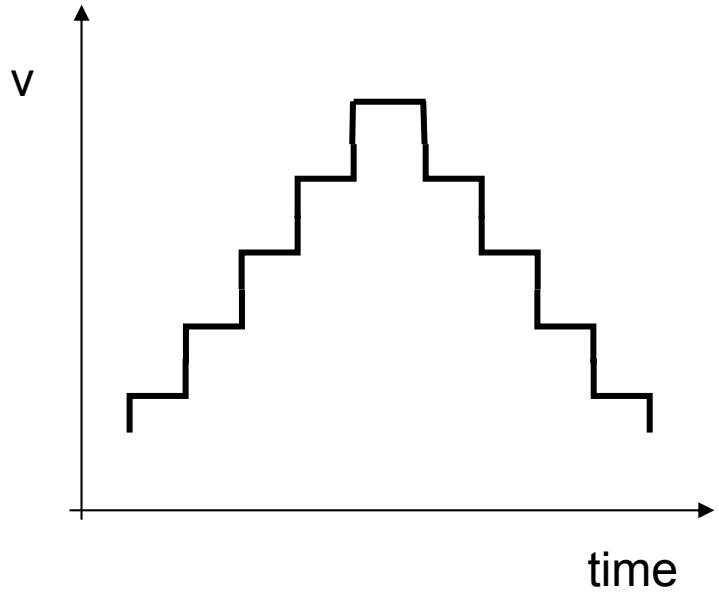
Driver schedule retrospections



driver schedule information

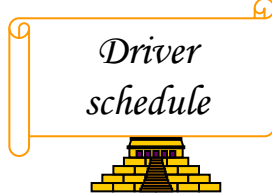
Driver schedule

- IBIS summit presentations
  - Arpad Muranyi
  - Bob Ross
  - Chris Reid
  - Hazem Hegazy
  - Lance Wang
  - .....
- IBIS cookbook 4.0
- IBIS spec 4.2
- ????



Modeled with driver schedule

driver schedule static curves



[Model] 2-Driver-schedule

[Voltage Range] 3.30V 3.1350V 3.4650V

[GND Clamp]

[POWER Clamp]

[Pulldown]

[Pullup]

[Driver Schedule]

MODEL_1	0s	NA	0ns	NA
MODEL_2	0.5ns	NA	0ns	NA

[Model] Model_1

[GND Clamp]

[POWER Clamp]

[Pulldown]

[Pullup]

[Model] Model_2

[GND Clamp]

[POWER Clamp]

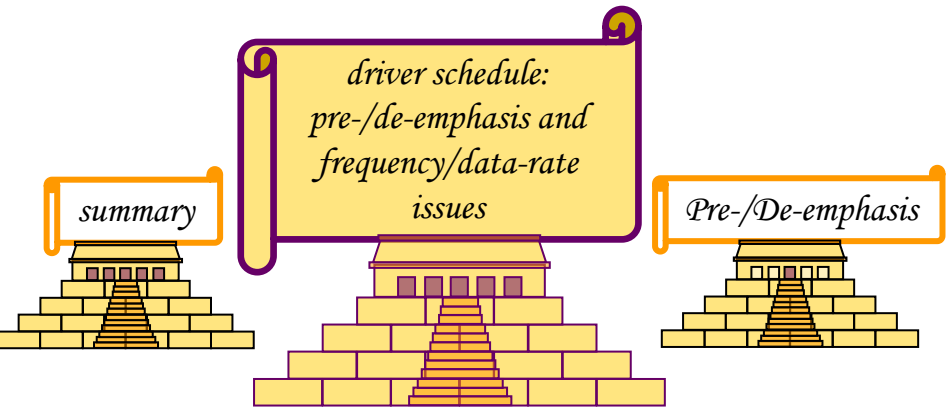
[Pulldown]

[Pullup]

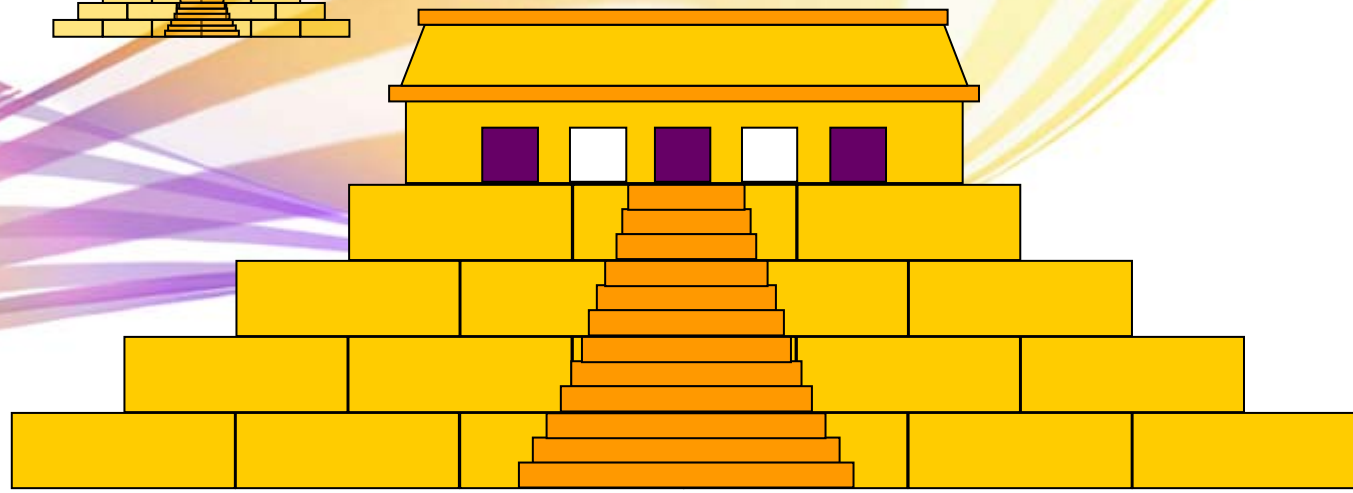
Top level model tables

Driver schedule timing

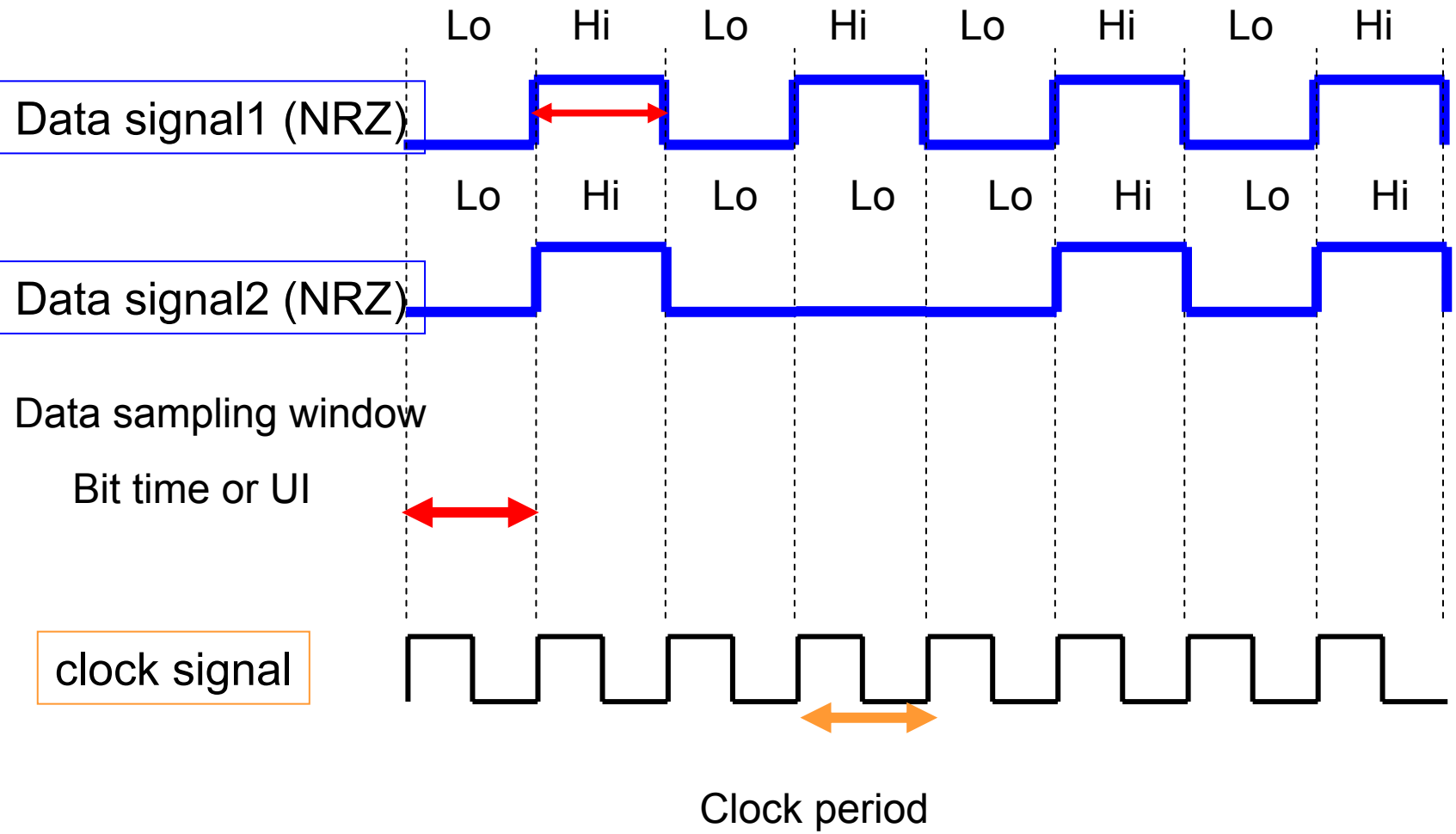
Scheduled model tables



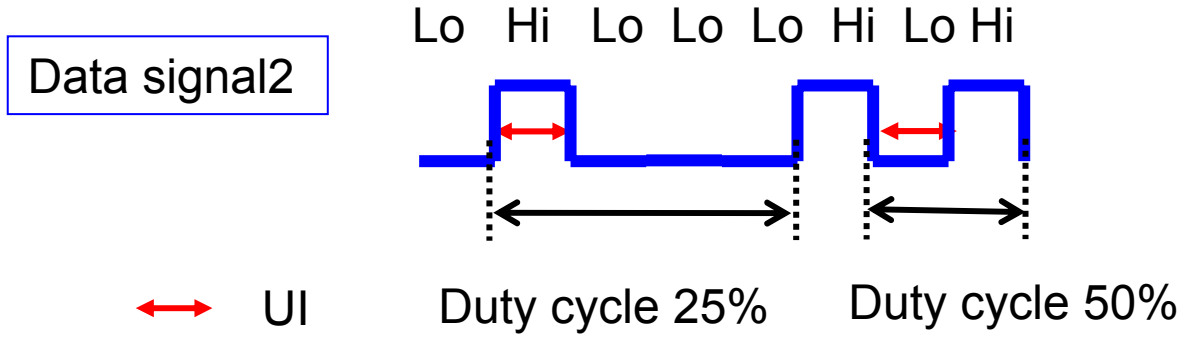
Frequency / data rate



Data signal & clock signal



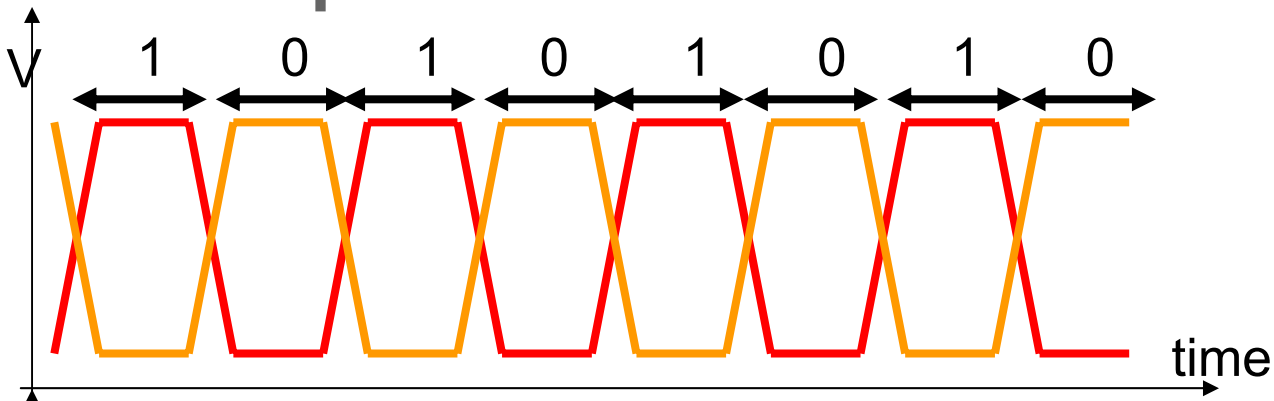
unit intervall and data rate (and frequency)



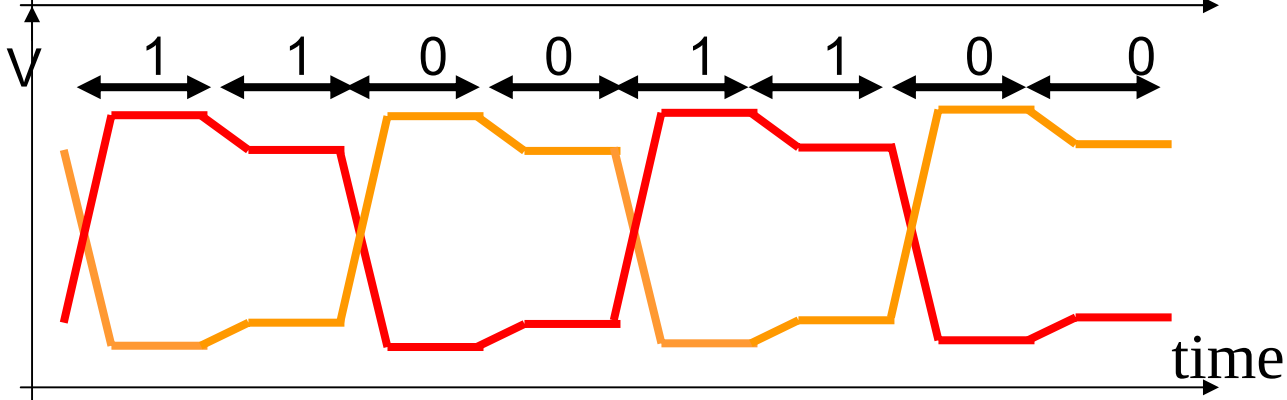
- Correlation
  - Between **U**nit **I**ntervall and Data rate
  - Datarate = 1/ UI
    - e.g.
  - 1.25Gbps = 1 / 800e-12s
  - It takes one UI for one bit to be transmitted
- Assuming a 1010.. Pattern
  - For binary data signals :
    Frequency = data rate /2
  - This is not the clock frequency
  - Eg. : Datarate → Frequency
    5Gbps → 2.5GHz
    1.25Gbps → 625MHz

different patterns

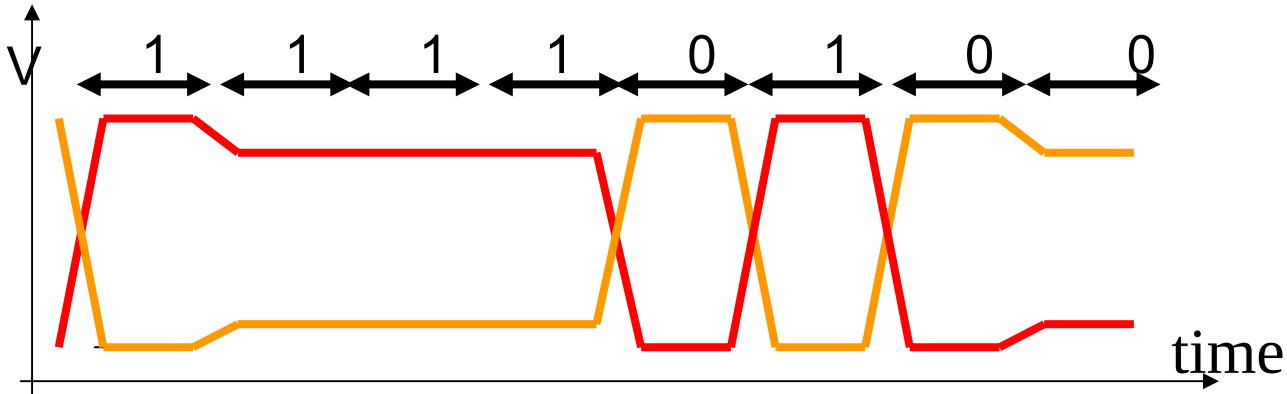
pattern



data pattern
10101010



data pattern
11001100



data pattern
11110100

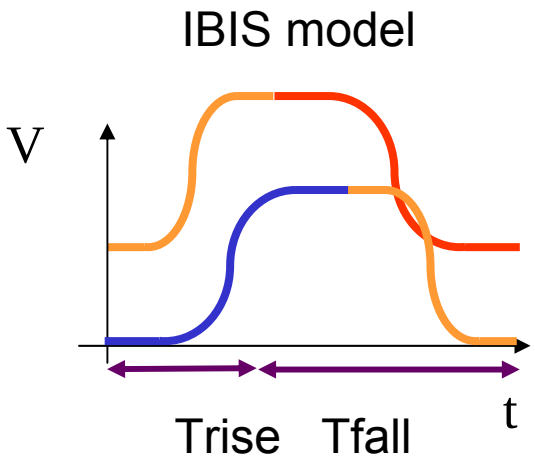
classic IBIS model

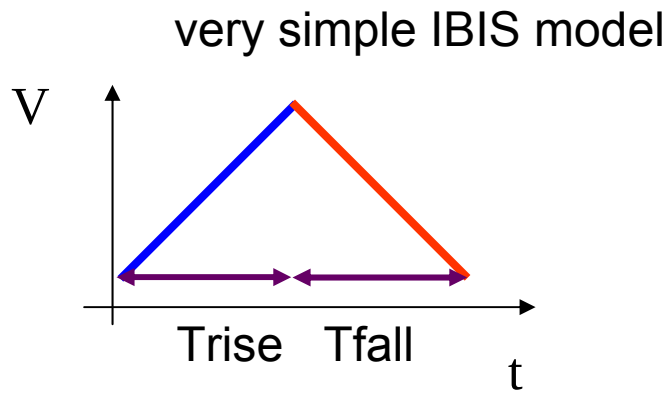
Normaly the rising and falling times of the IBIS model determines the max. frequency where the model can be used

Rule of thumb : Fmax IBIS model = 1/ (trise + tfall)

Eg.: IBIS model with trise 2ns, tfall 2ns

Fmax = 1/ 4ns = 250Mhz

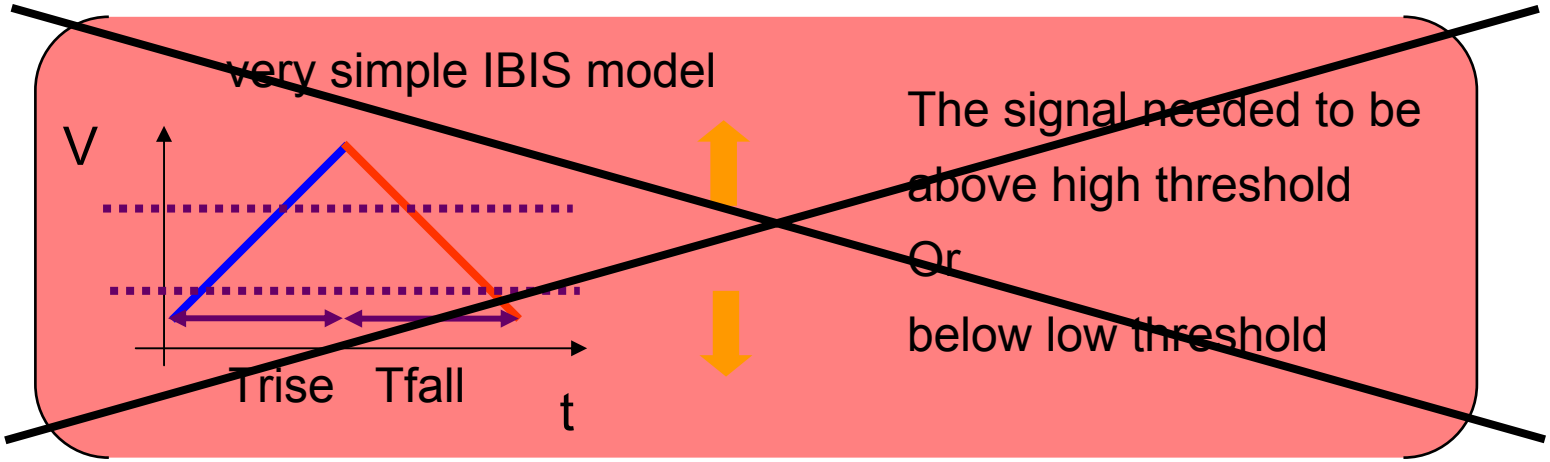




driver schedule for Multi-Gigabit applications

Old rule of thumb : Fmax IBIS model = 1/ (trise + tfall)

This rule is no longer valid



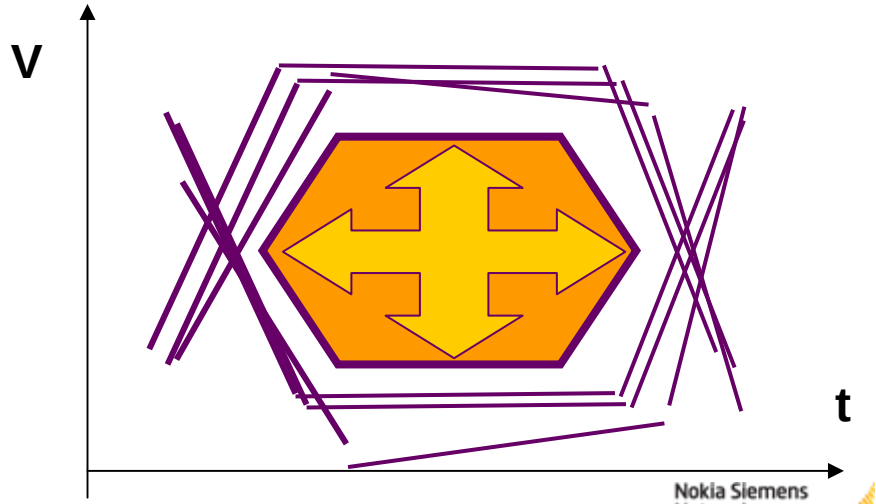
The signal needs to be

long enough above high threshold

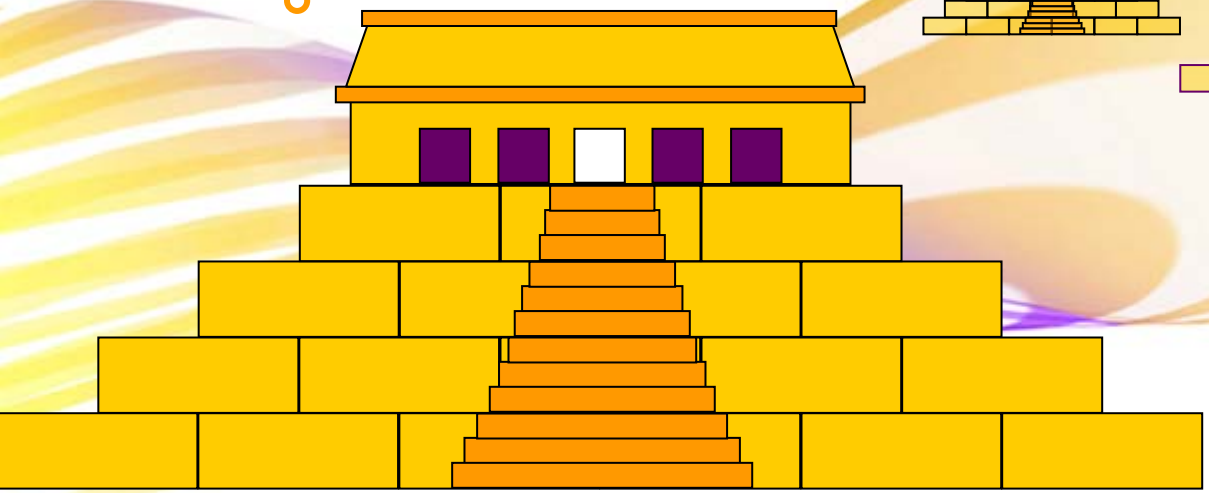
Or

Long enough below low threshold

And this for many times



Examples



summary

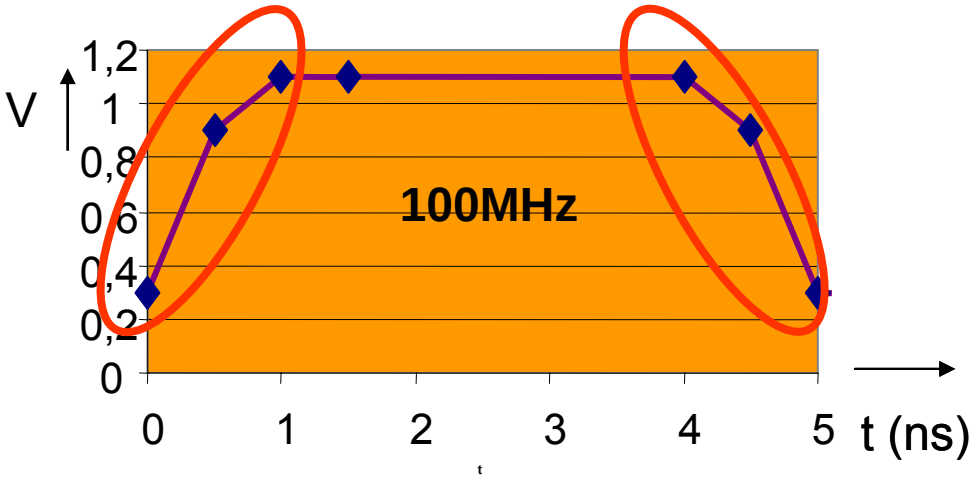
driver schedule: pre-/de-emphasis and frequency/data-rate issues

Pre-/De-emphasis

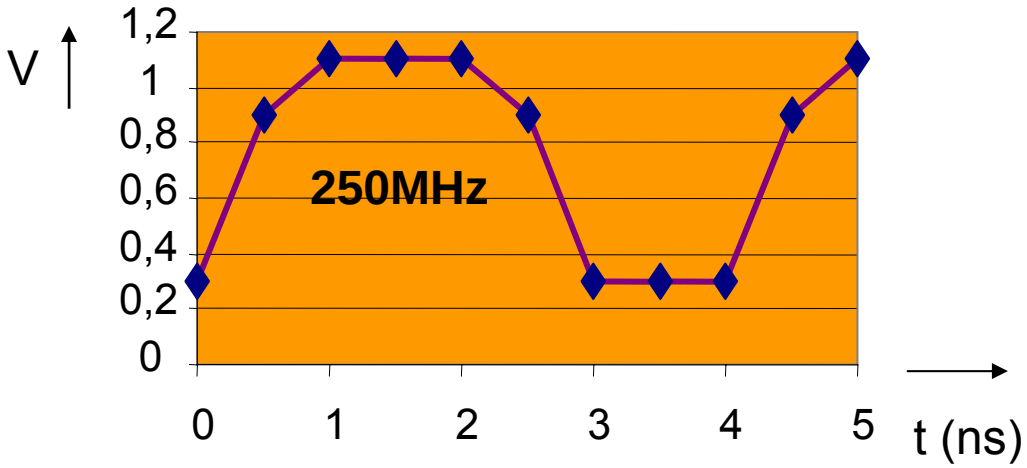
Driver schedule retrospections

Frequency / data rate

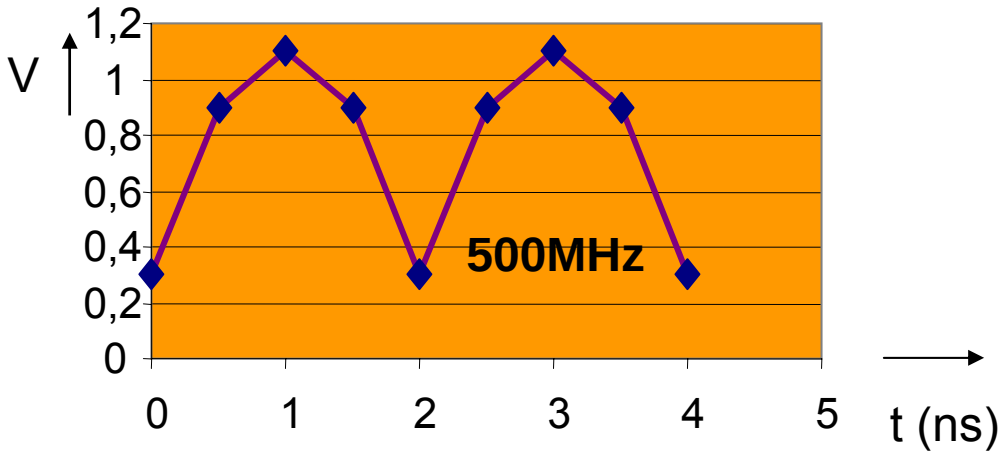
low frequencies pushpull-cmos model

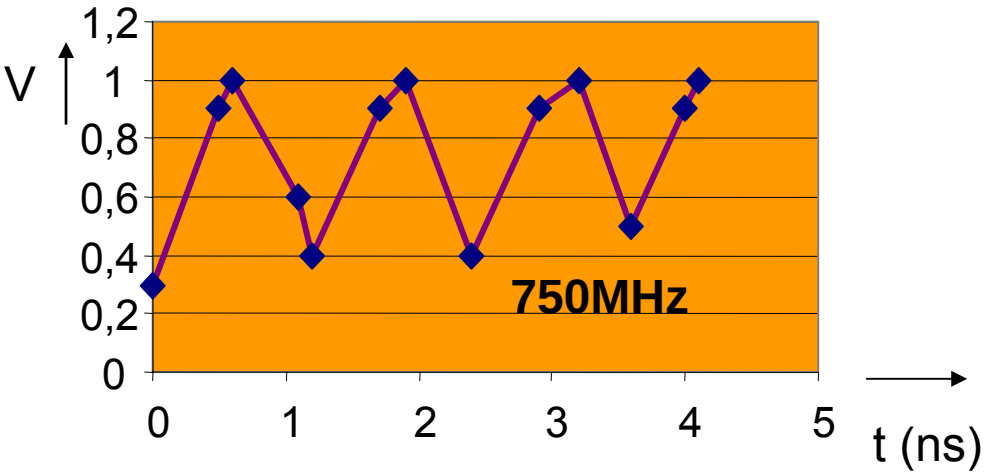


Model has got risetime and falltime of about 1ns
So it could be used up to 500MHz !!??



high frequencies pushpull-cmos model

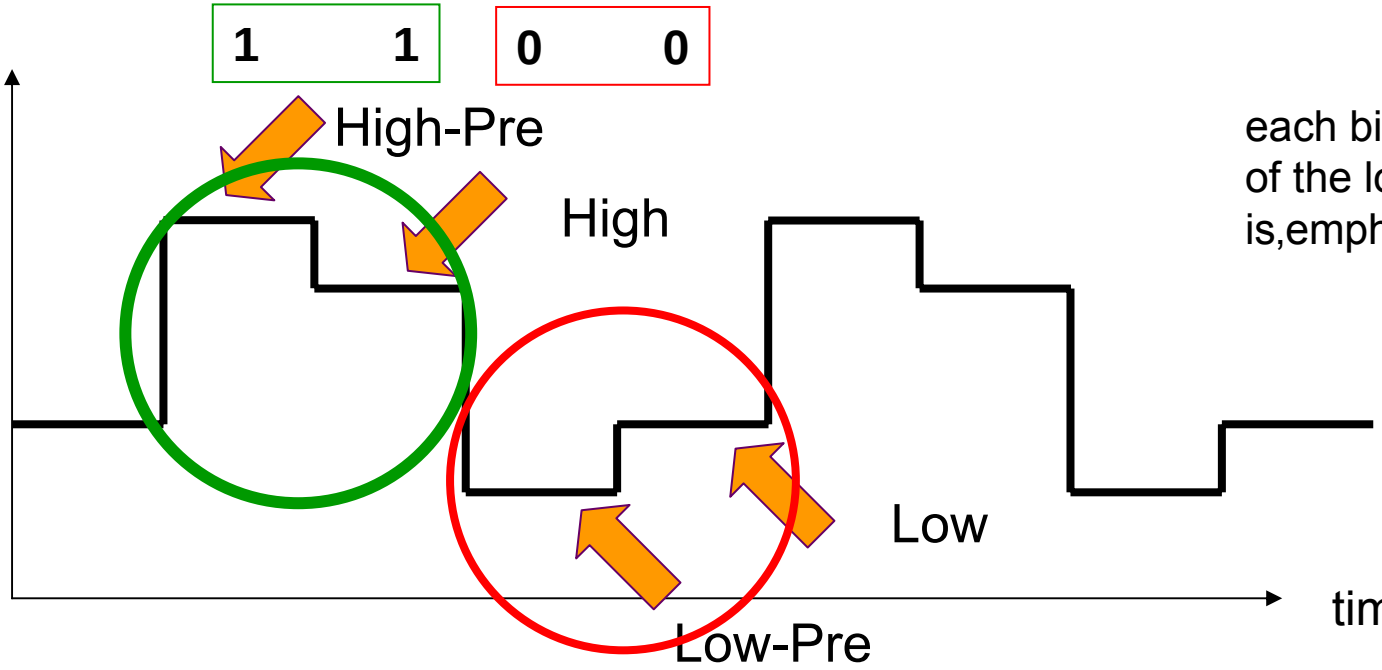




above 500MHz :

The behavior looks suspicious

Signal characteristics for pre-emphasis

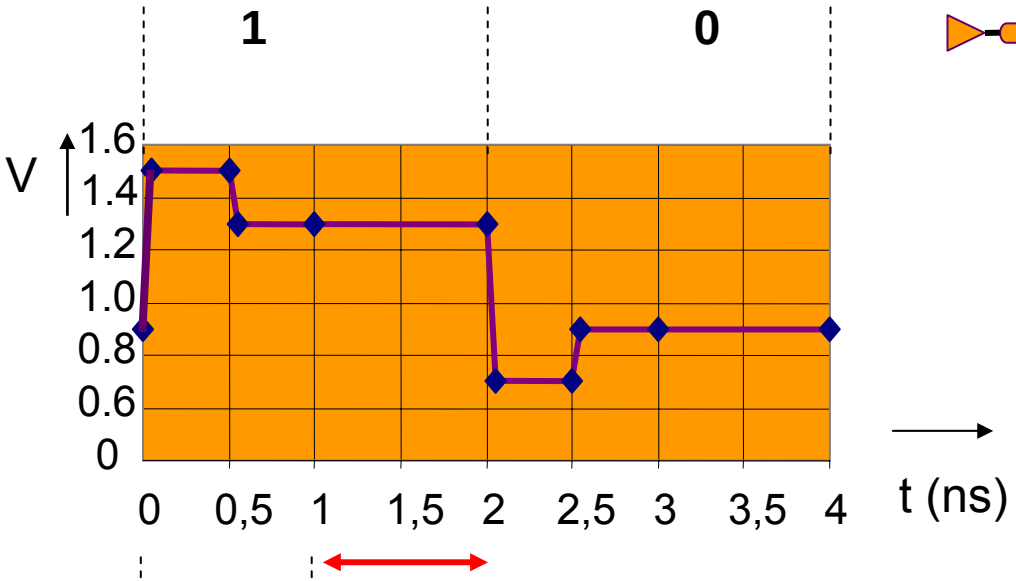


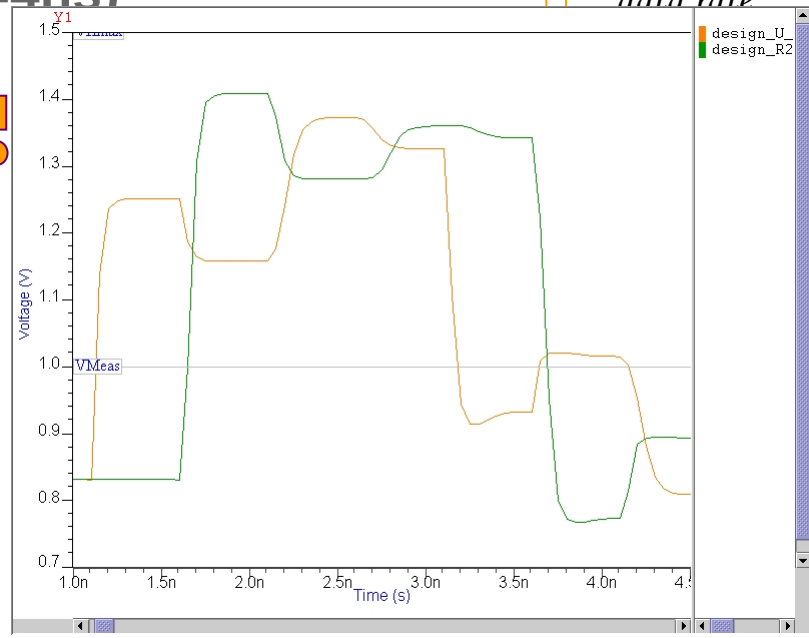
each bit after a change of the logic state is‚emphasized‘

rising egde contains information for datapattern 1 1

falling egde contains information for datapattern 0 0

driver schedule @ 250MHz (tp=4ns)



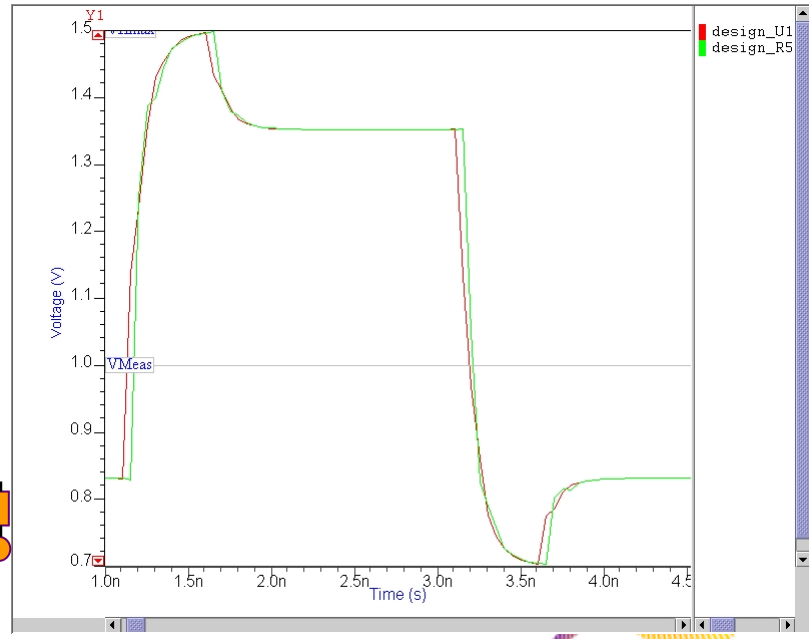


Rising part finished,

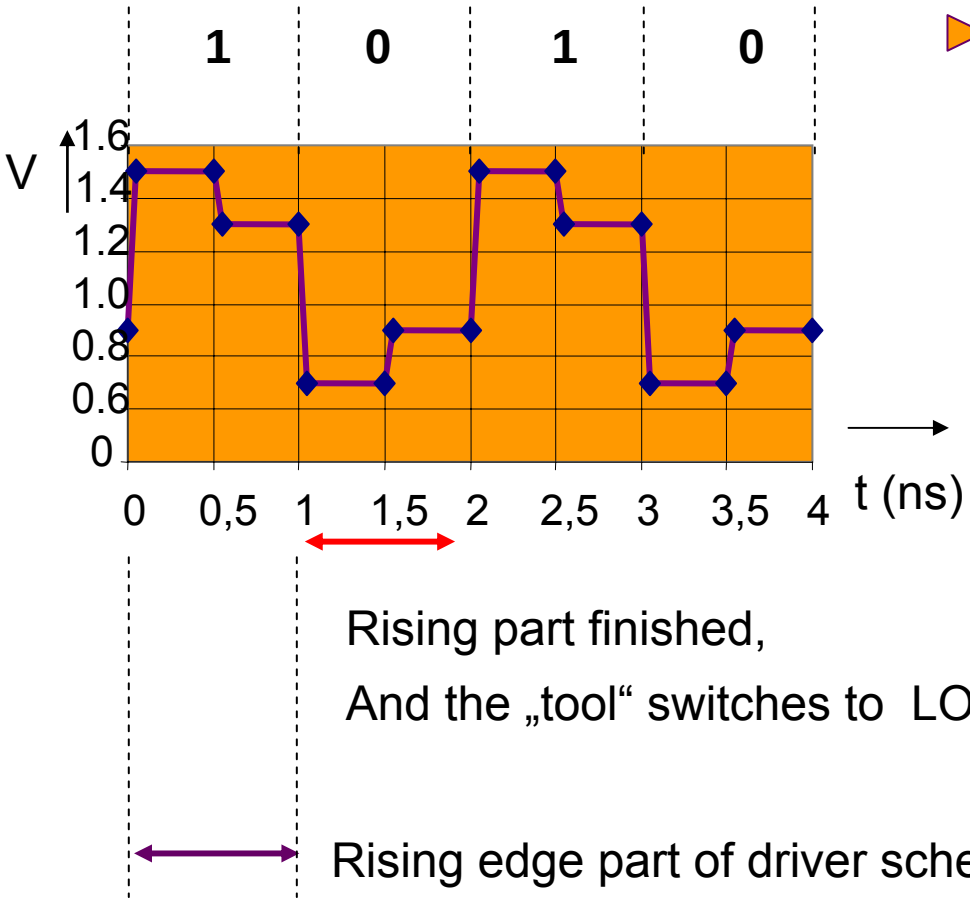
Model stays in this logic HIGH state,

until „tool“ switches to LOW

Rising egde part of driver schedule



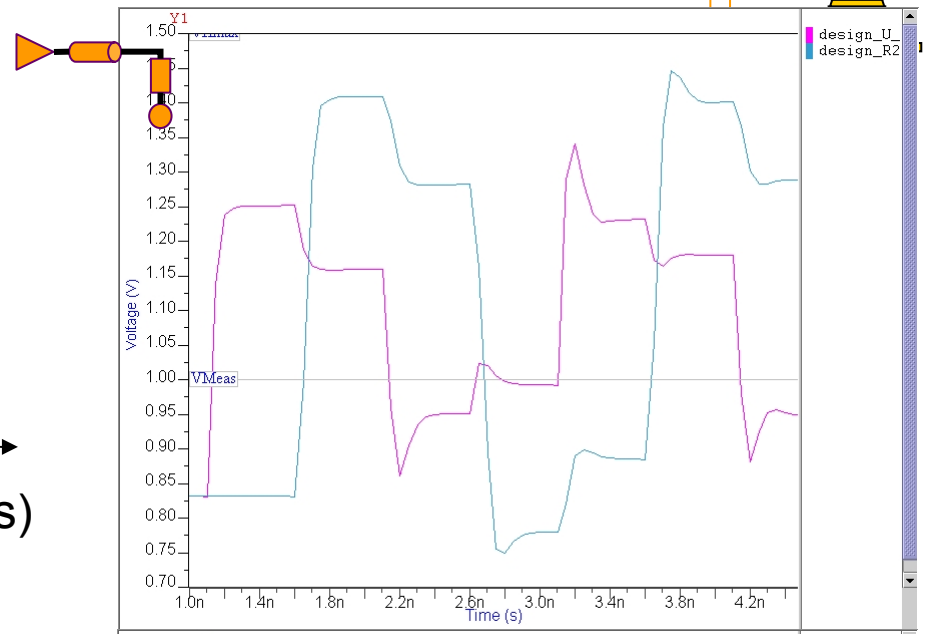
driver schedule @ 500MHz (tp=2ns)

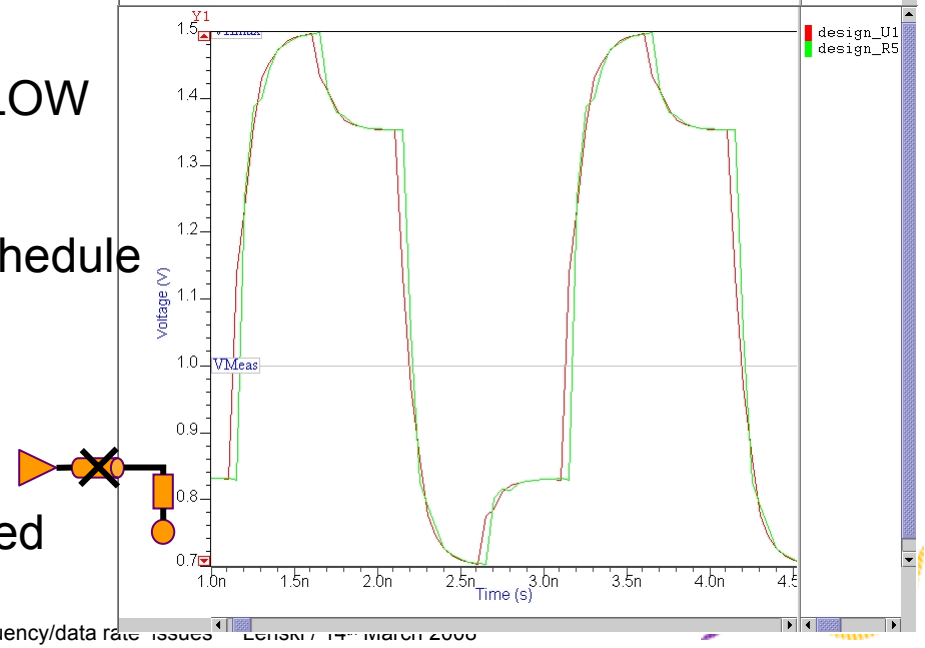


Rising part finished,

And the „tool“ switches to LOW

Rising edge part of driver schedule

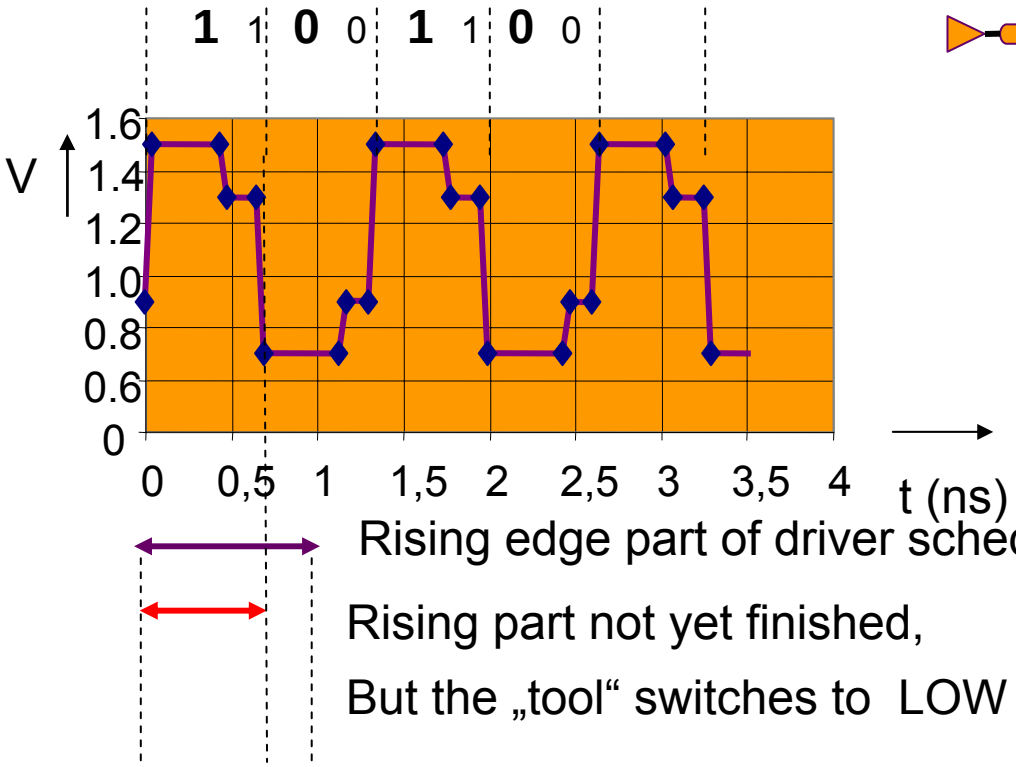




Model shows the pre-emphasis behavior,

because the pattern 11 and 00 can be fulfilled

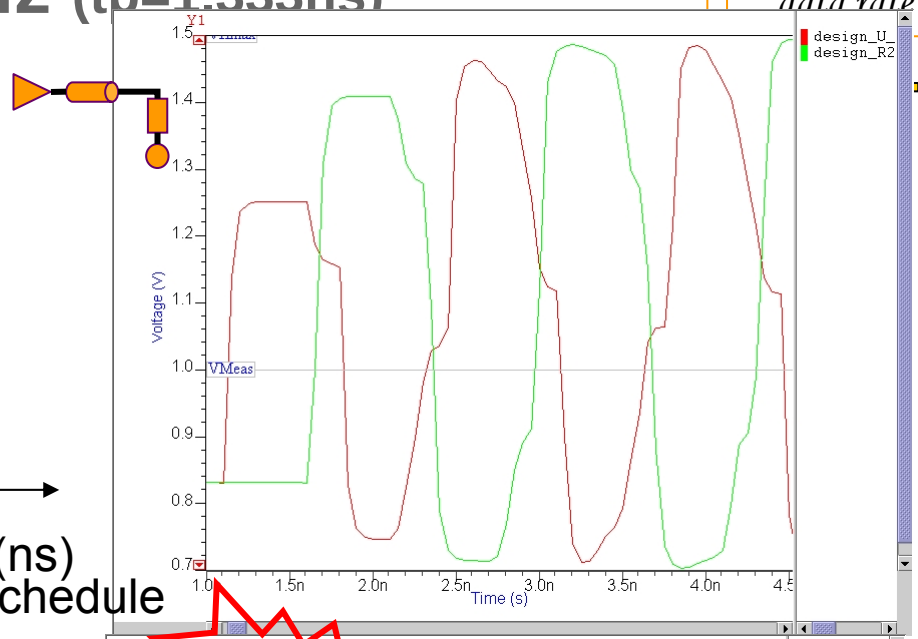
driver schedule @ 750MHz (tp=1.333ns)

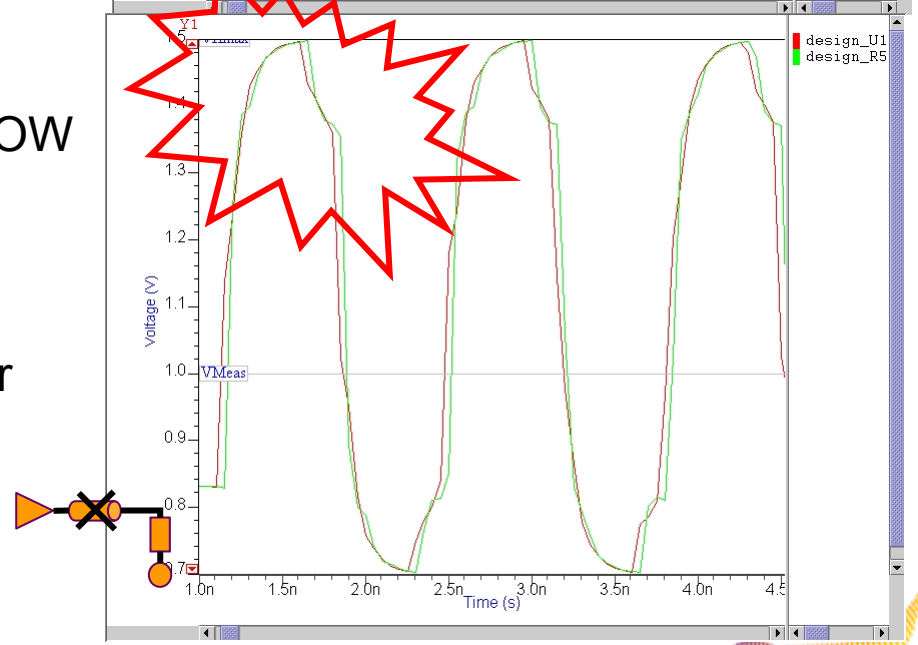


Rising edge part of driver schedule

Rising part not yet finished,

But the „tool“ switches to LOW



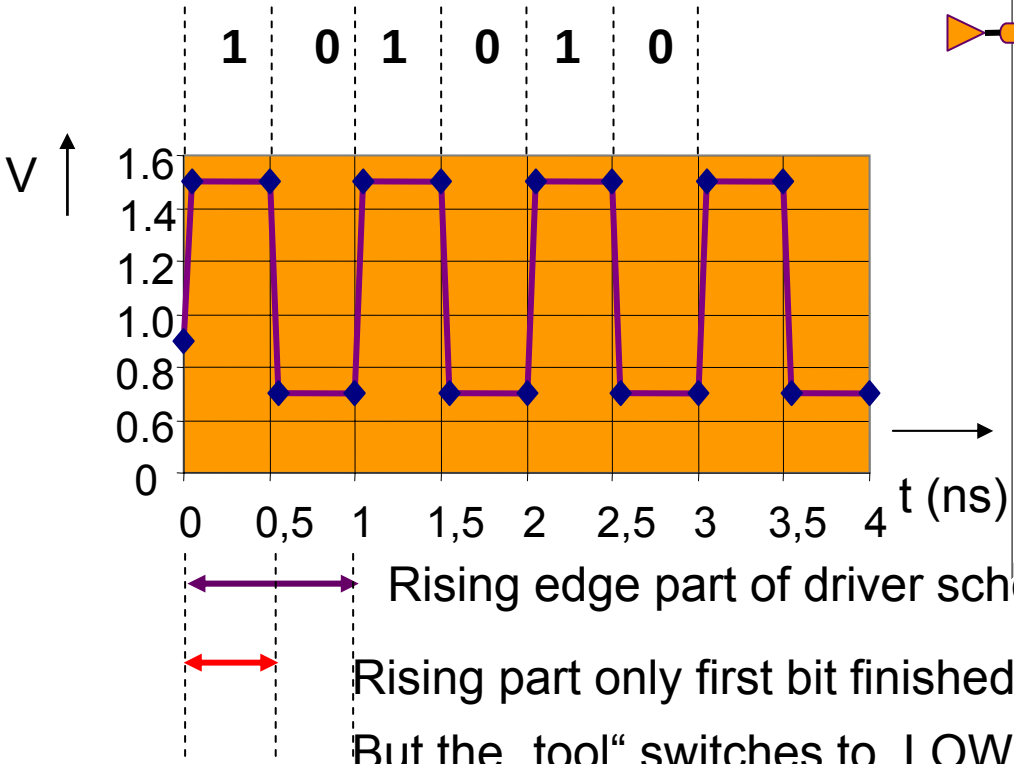


Model shows correct pre-emphasis behavior

for the first bit,

but for the second bit, it is switched off

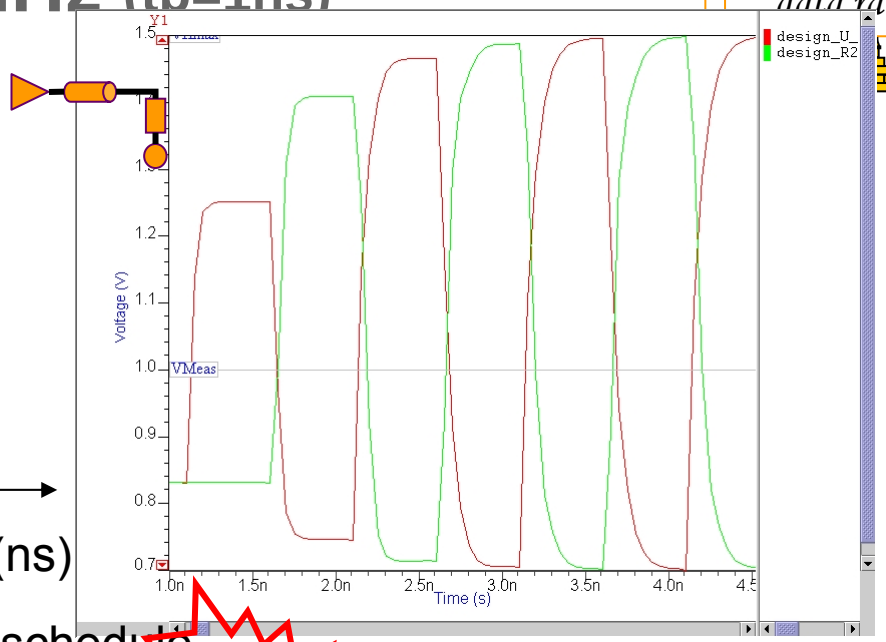
driver schedule @ 1000MHz (tp=1ns)

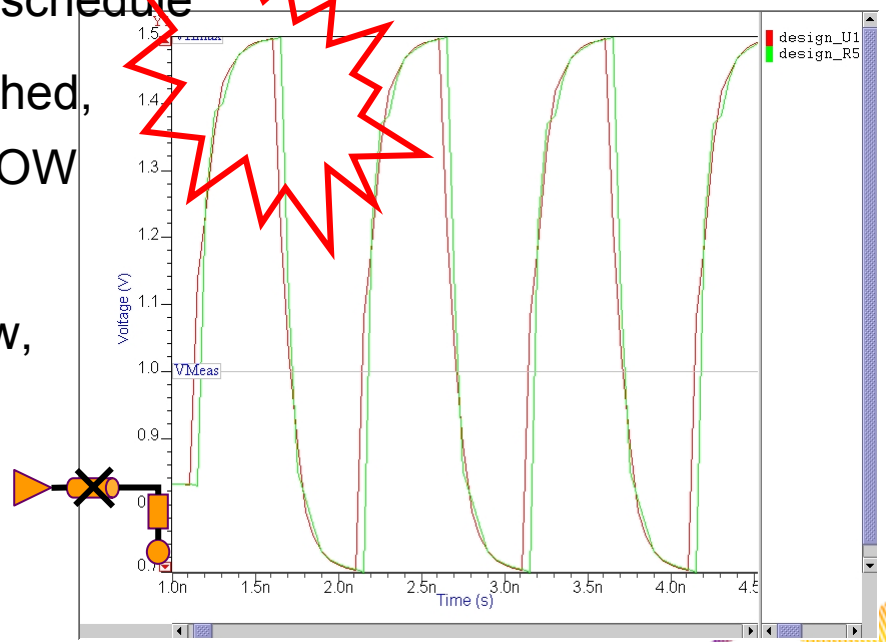


Rising edge part of driver schedule

Rising part only first bit finished,

But the „tool“ switches to LOW





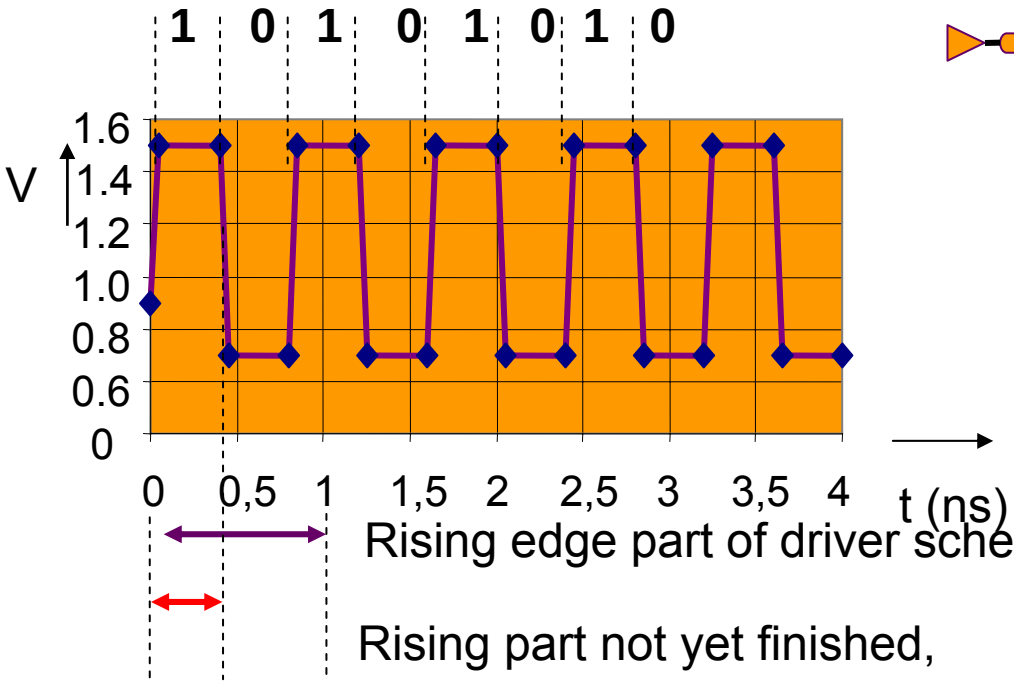
Model shows a switching from High to Low,

but between High-Pre and Low-Pre,

So only the pattern 101010

will be shown correctly

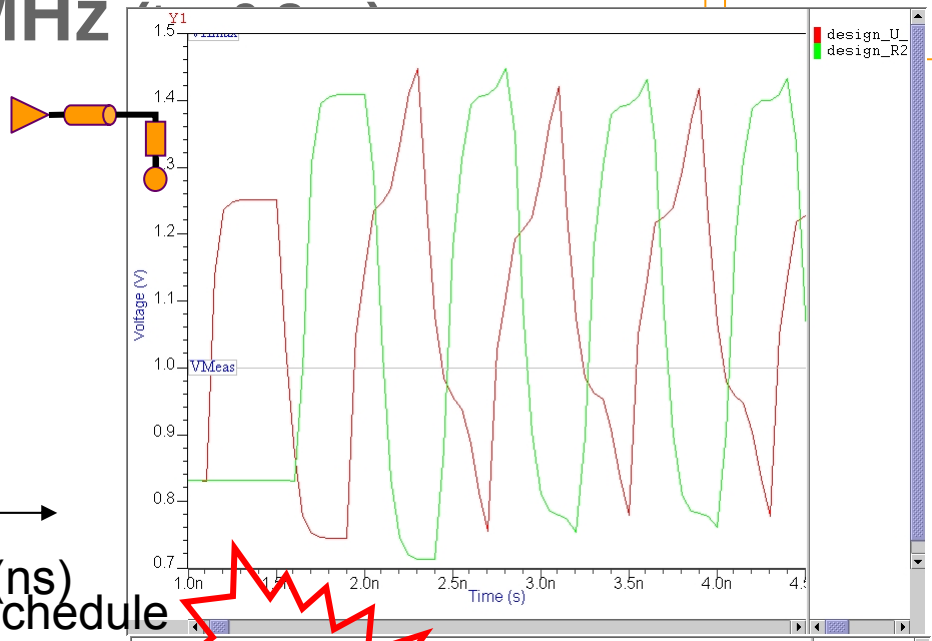
driver schedule @ 1250MHz

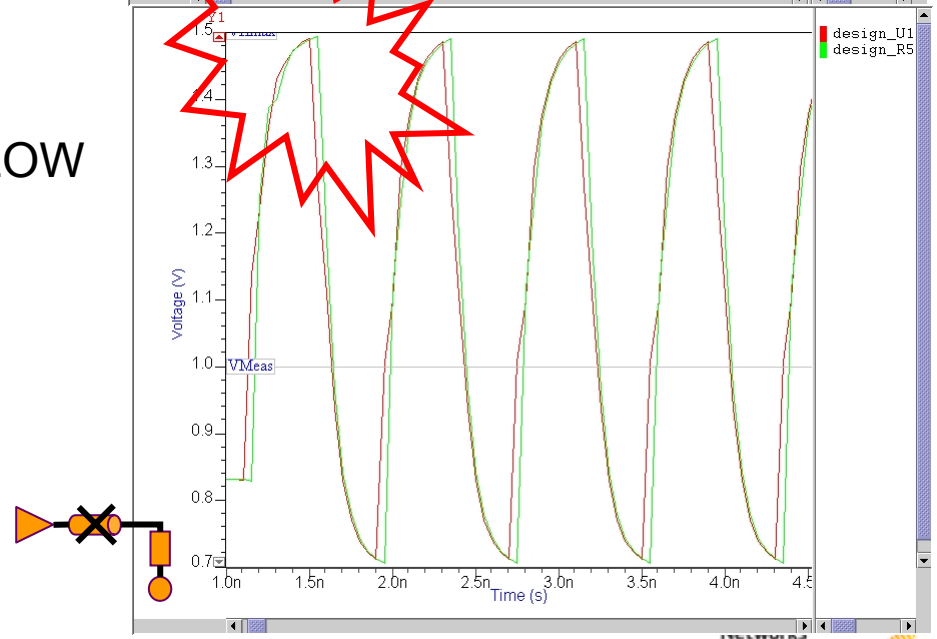


Rising edge part of driver schedule

Rising part not yet finished,

But the „tool“ switches to LOW





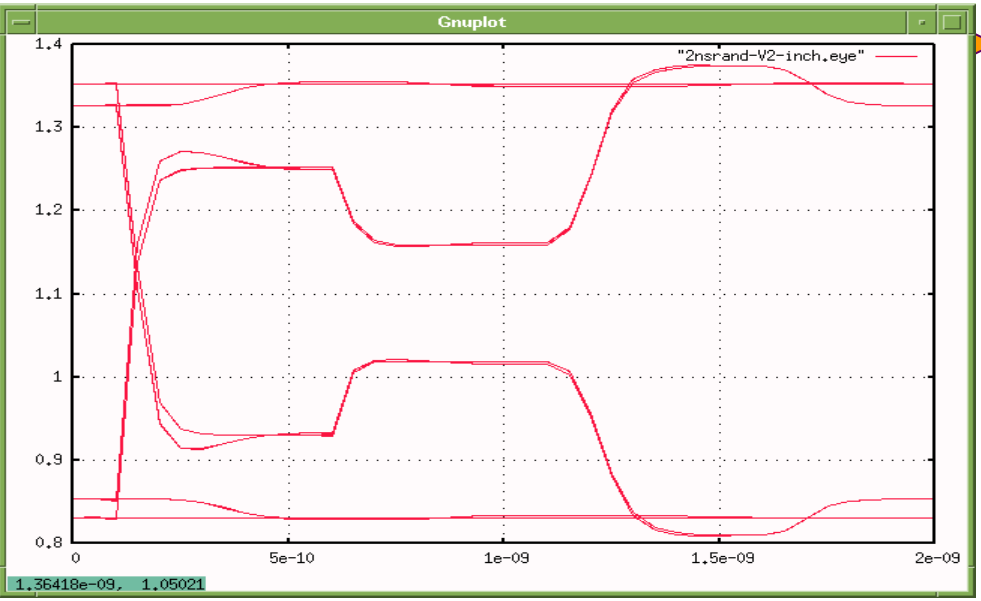
There is not enough time for the first bit

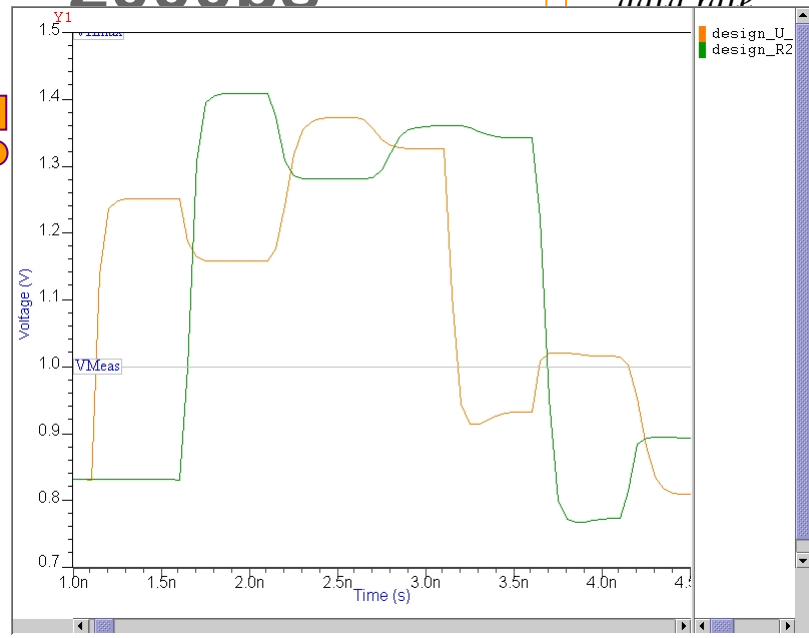
Because the tool starts switching off

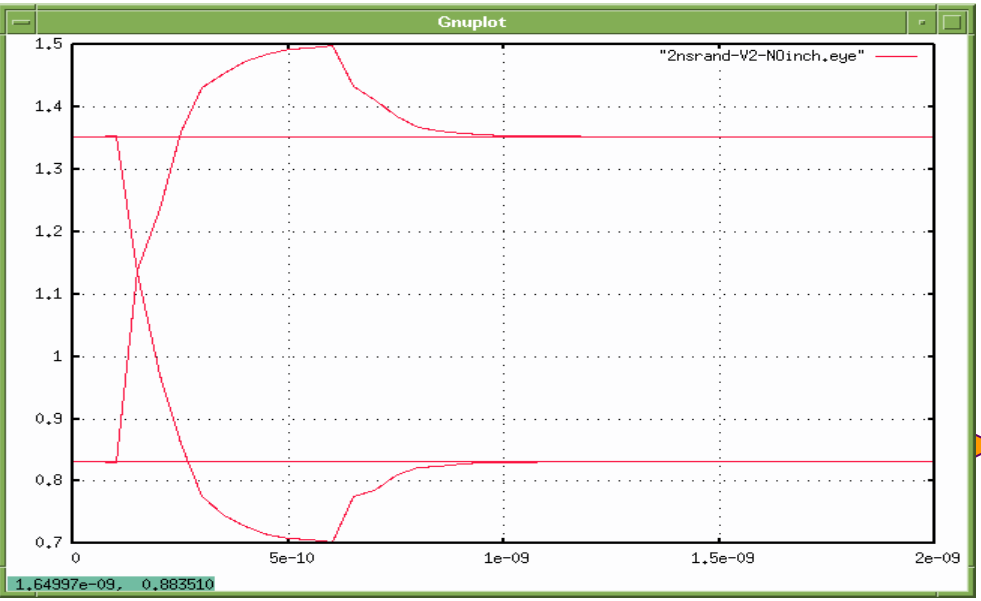
eye diagrams preliminary

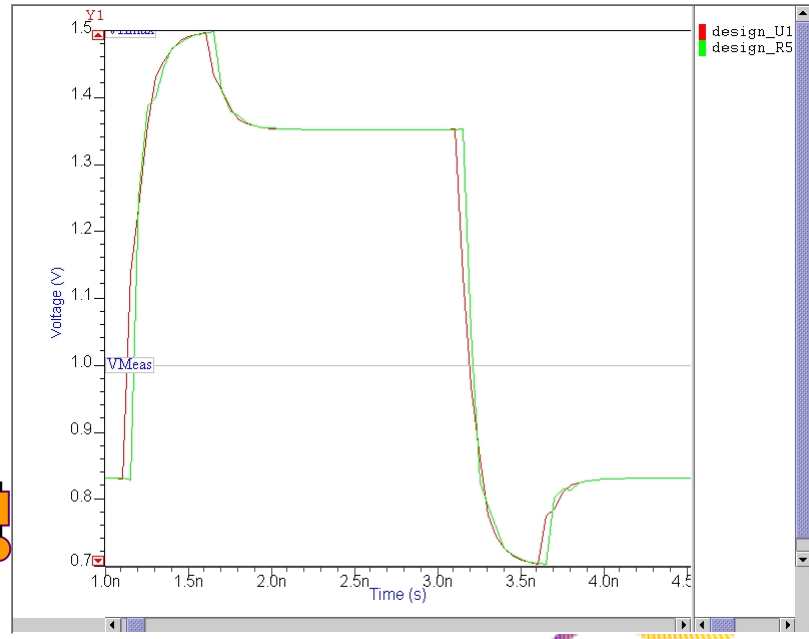
!! Under construction !!

driver schedule @ (250MHz) UI = 2000ps



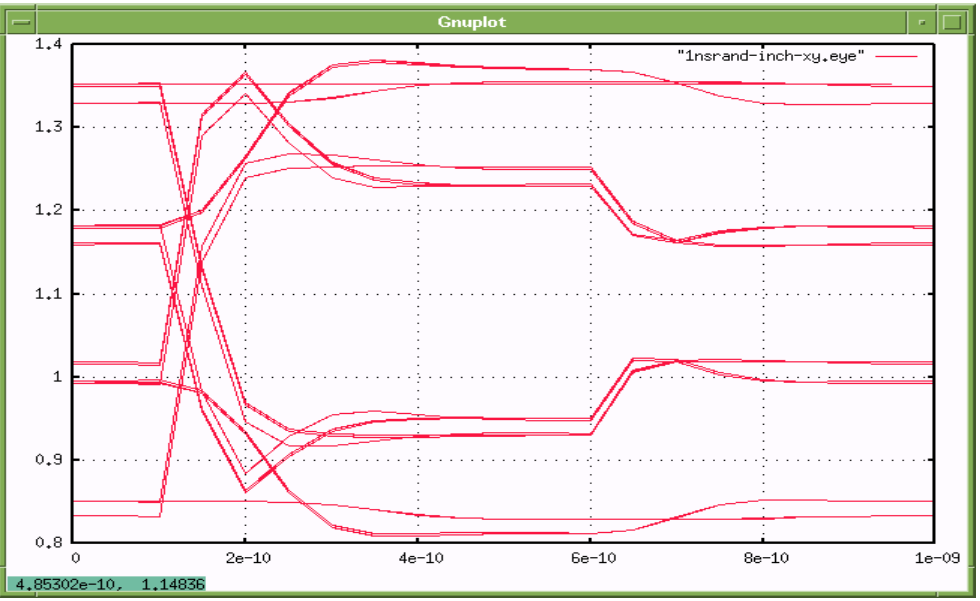


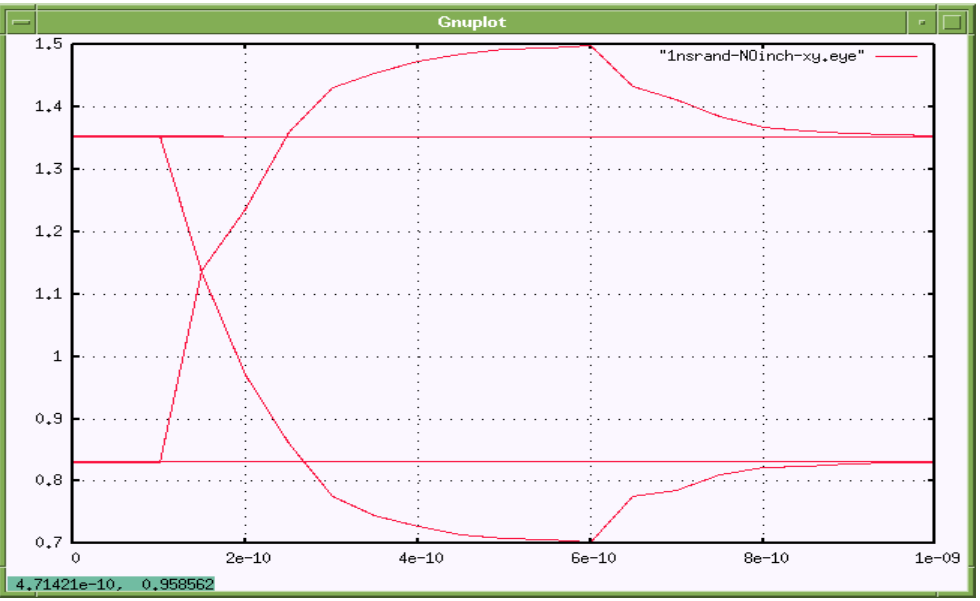


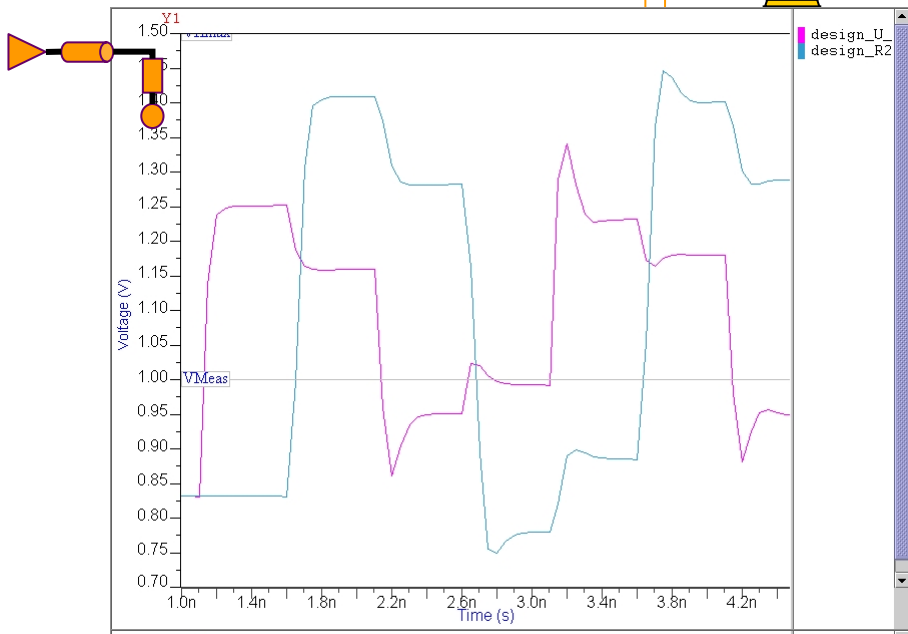


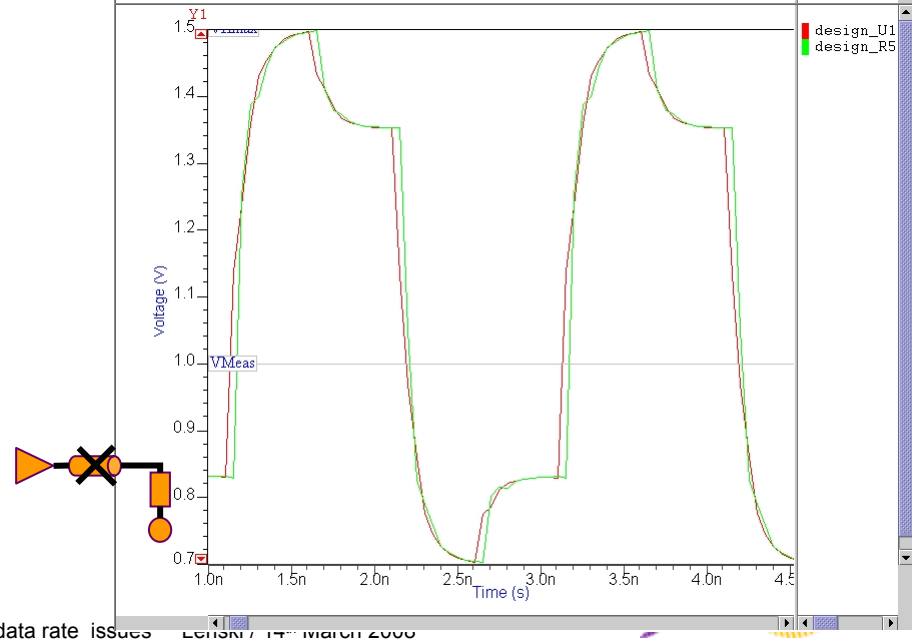
driver schedule @ (500MHz) UI = 1000ps

Frequency / data rate



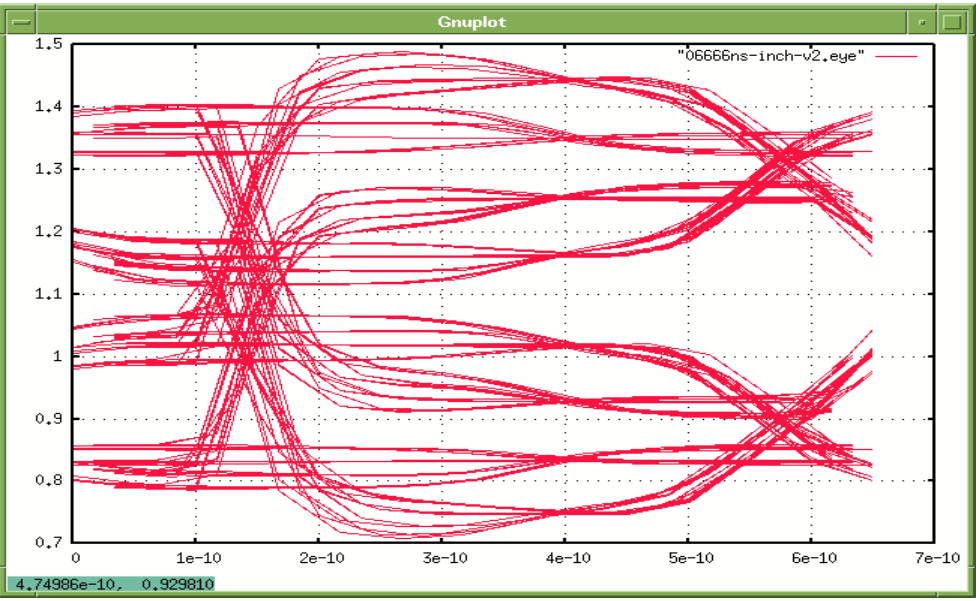


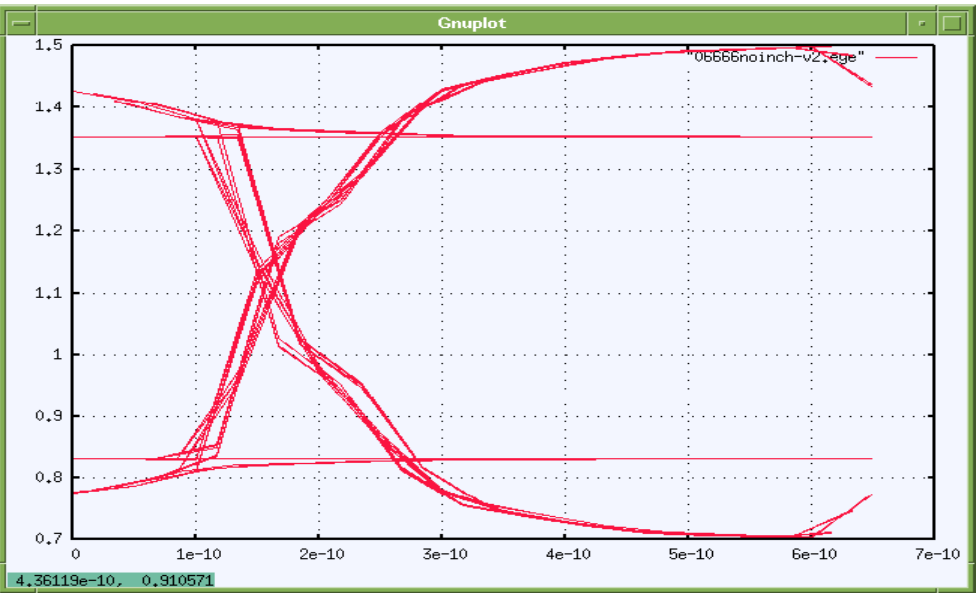


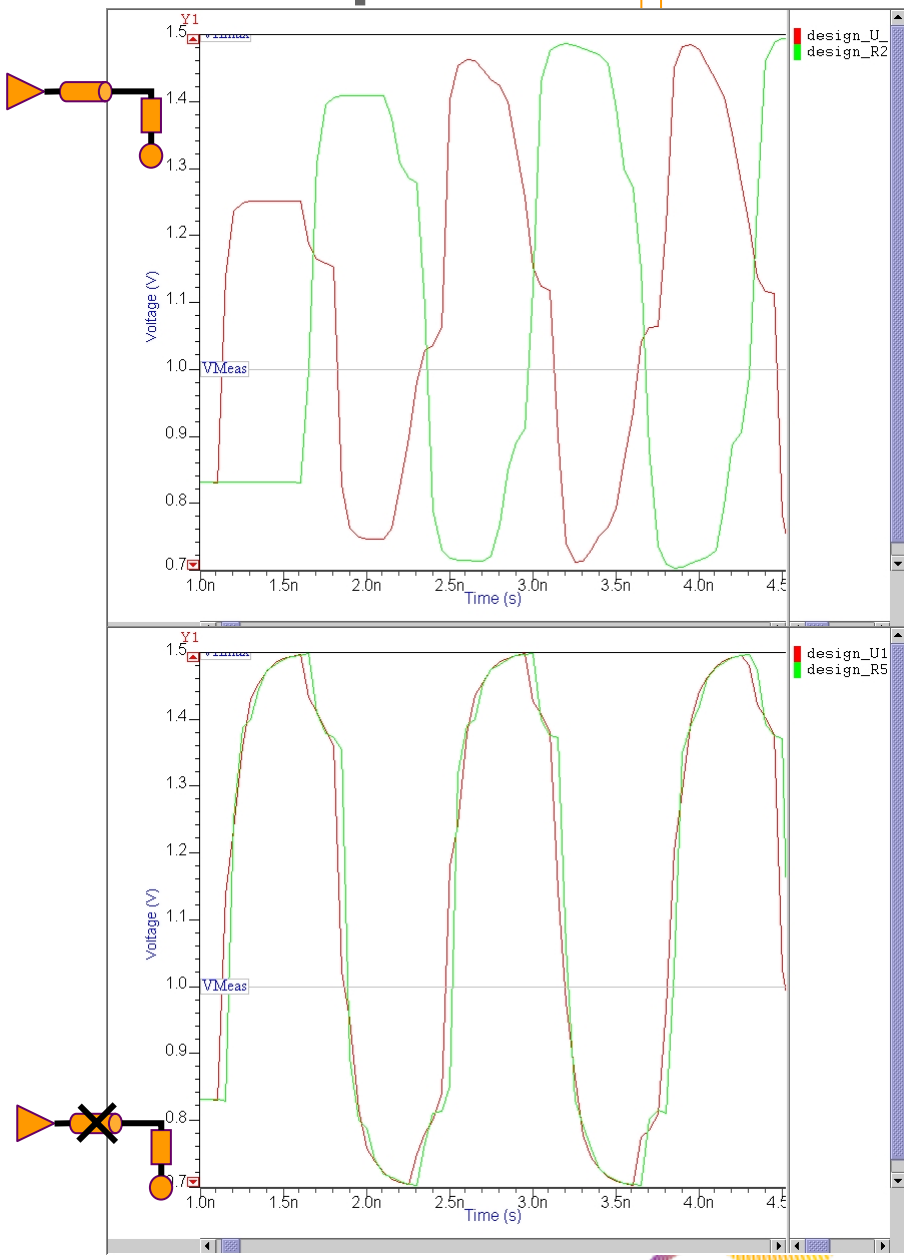


driver schedule @ (750MHz) UI = 666.66ps

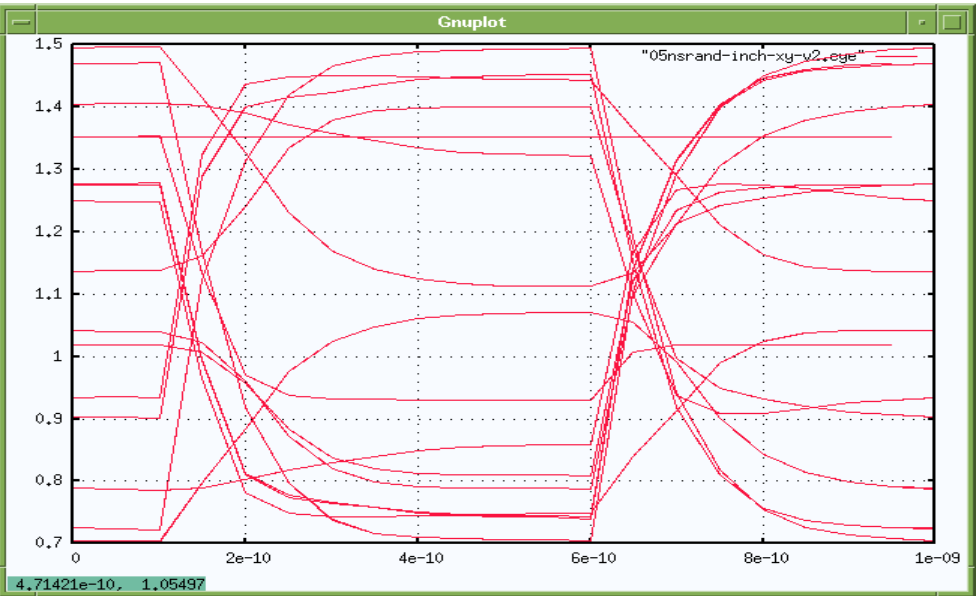
Frequency / data rate

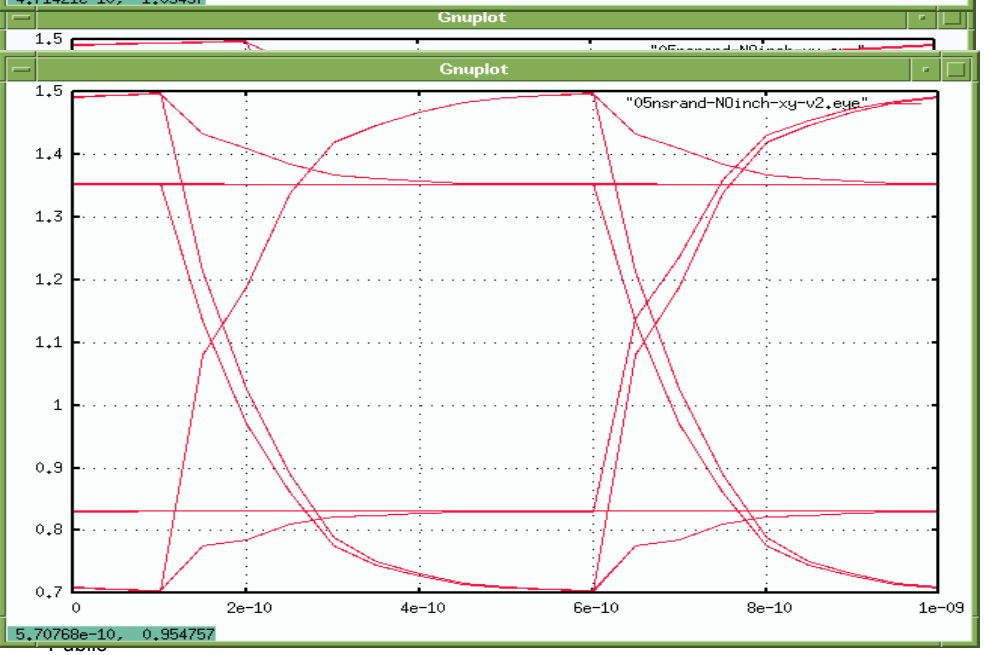


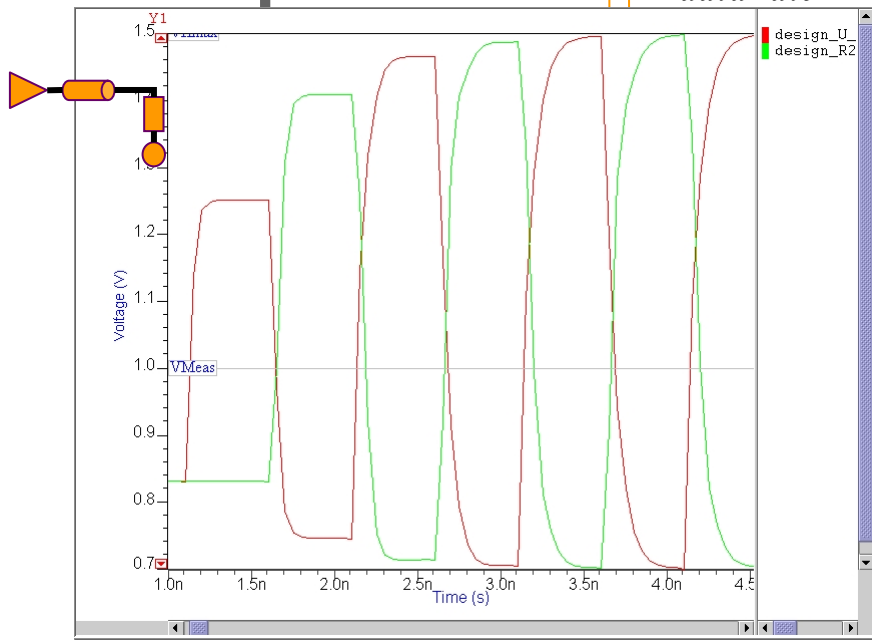


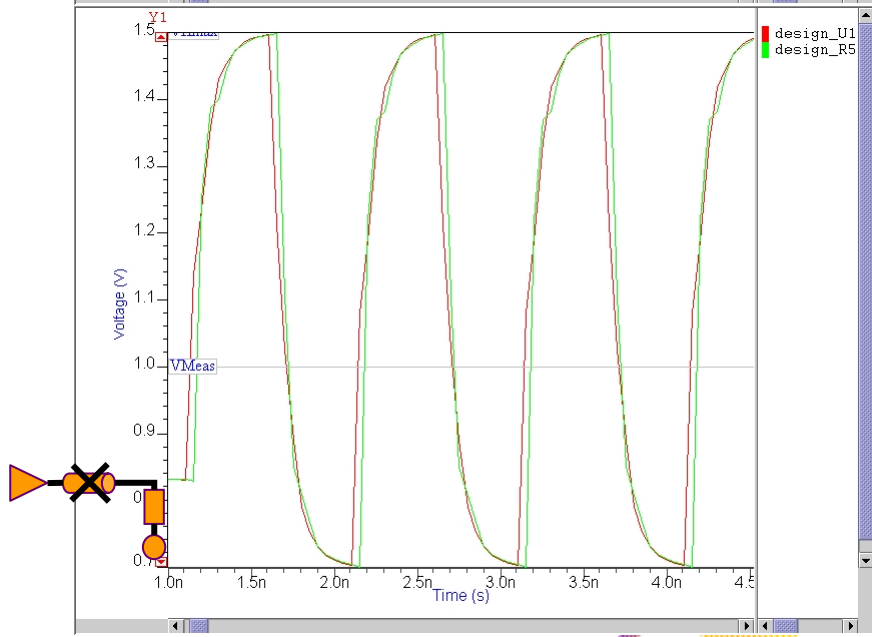


driver schedule @ (1000MHz) UI = 500ps

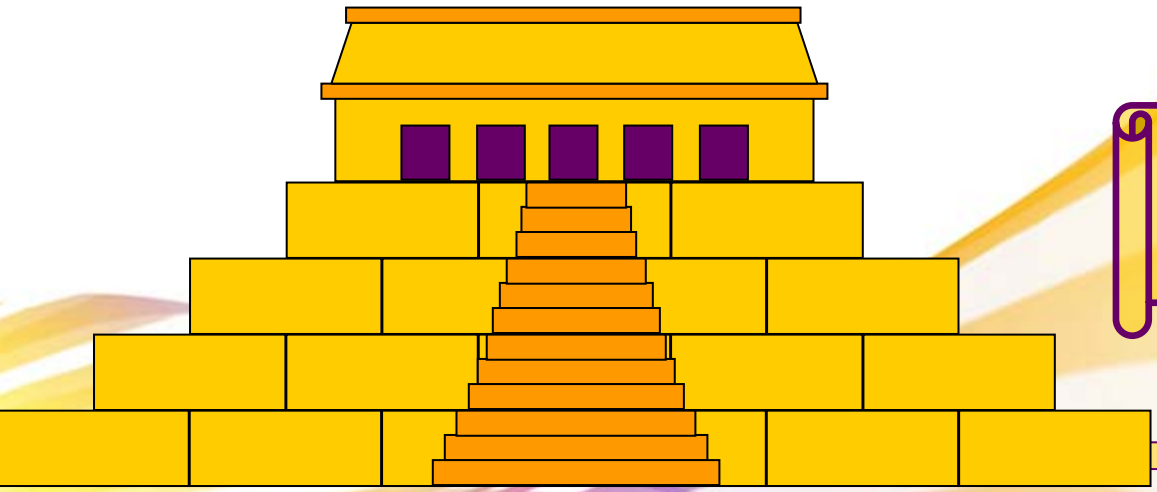








summary



driver schedule: pre-/de-emphasis and frequency/data-rate issues

Pre-/De-emphasis

Examples

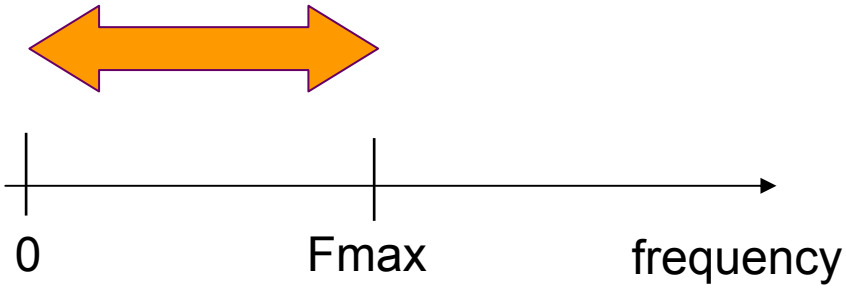
Driver schedule retrospections

Frequency /data rate

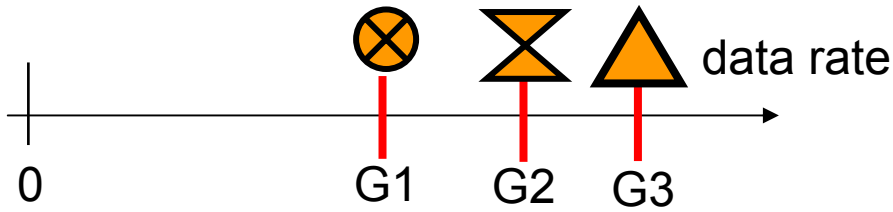
scope of application

summary

- For normal pushpull-cmos



- For Driver schedule modeling pre-emphasis



- 1.25Gbps
- 2.5Gbps
- 3.125Gbps

encoded pattern

summary

- For normal cmos
  - 10 pattern is encoded in the model
- For Driver schedule modeling pre-emphasis
  - 1100 pattern is encoded in the model

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Summary

summary

- Ibis models (exception of driver schedule) are ‚valid' for a frequency range which is set by the risefalltime of the model

- Driver schedule modeling pre-emphasis are valid only for one datarate/frequency, corresponding to the UI they are made for

- Tool don't cares about encoded bitpattern in model or the included bit-time / UI

- User has to take care that the „frequency" corresponds to UI

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Thank You

- **Questions ?**