
Nokia Siemens
Networks

Decoding IBISCHK
static vs dynamic waveforms

Eckhard Lenski

DATE , Nice , France

23rd April 2009

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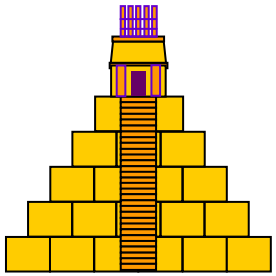
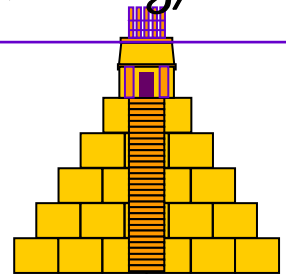
Decoding ibischk for static and dynamic waveforms

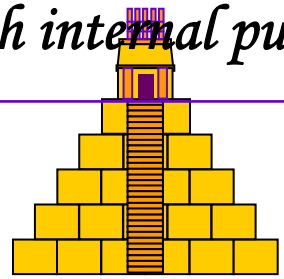
Summary



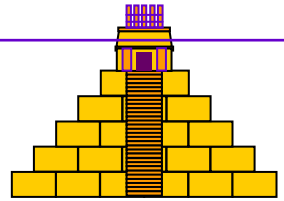
Ibischk Warning/errors



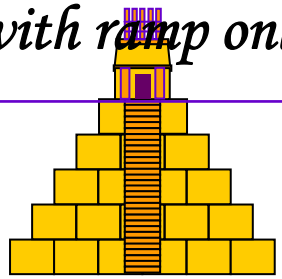
Example 1 : 3-state driver with internal pullup

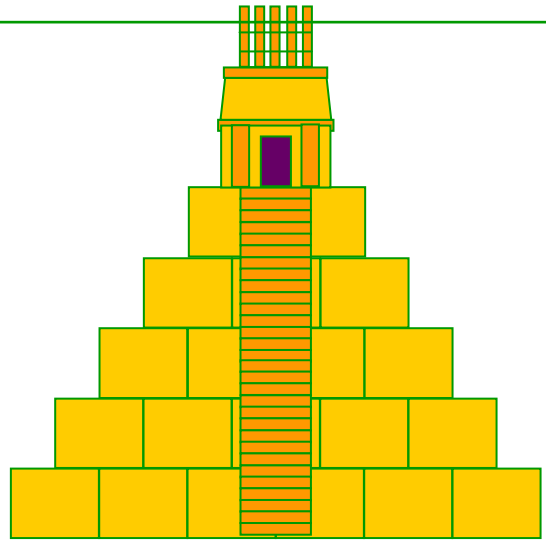


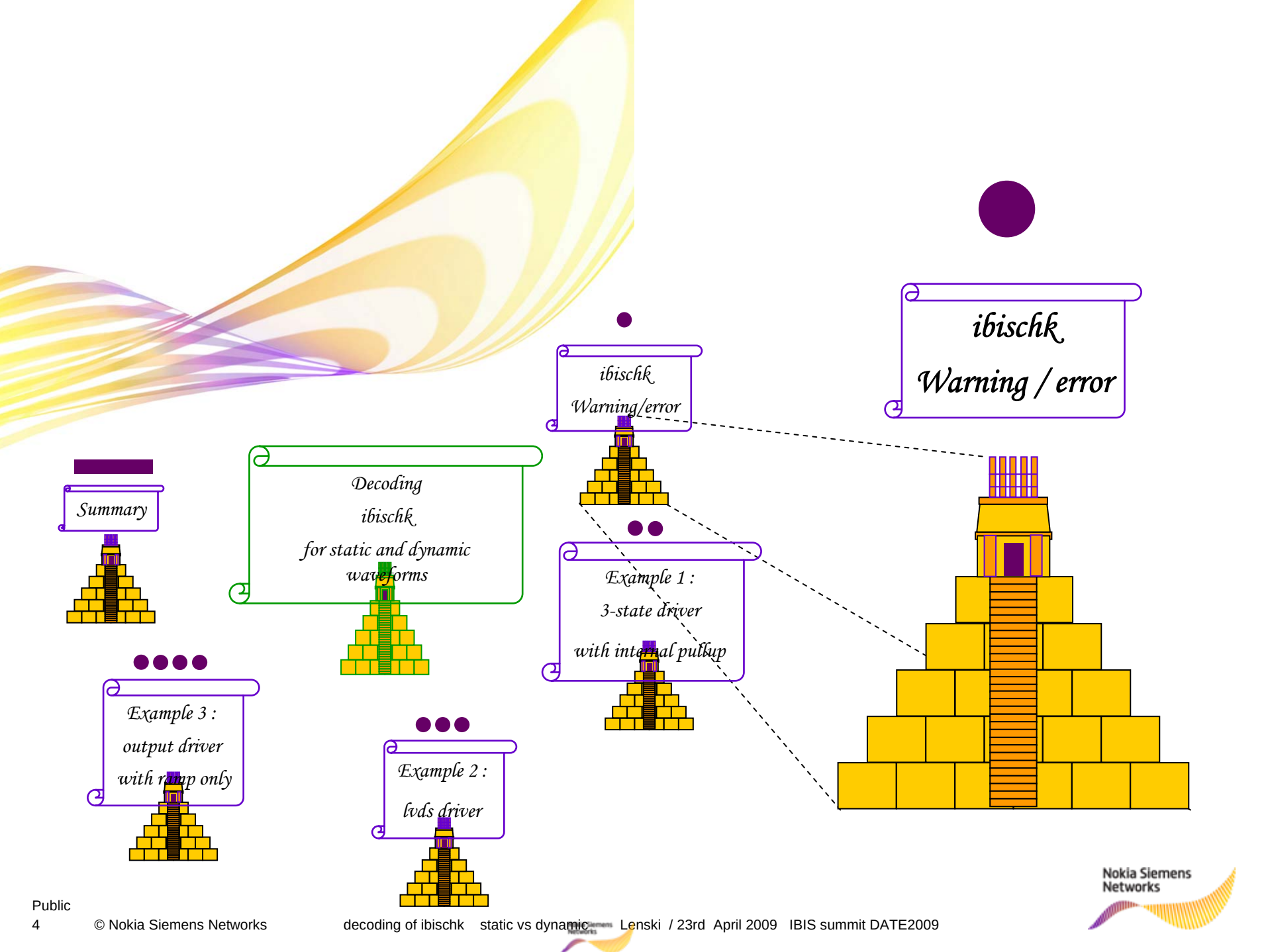
Example 2 : lvds driver



Example 3 : output driver with ramp only






ibischk
Warning / error
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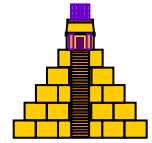
Summary
Decoding
ibischk
for static and dynamic
waveforms
Example 1 :
3-state driver
with internal pullup
Example 3 :
output driver
with ramp only
Example 2 :
lvds driver

IBIS CHECK

ibischk



Parser program for checking ibis models

- Parameter limits for
  - C_comp ; package R , L , C ; Ramp time
- Warning and errors
  - Component related checks
  - Diff pin checks
  - …..
  - …..
  - Waveform checks

Michael Mirmak,
Ibischk4 parser spec
Oct, 02, 2005

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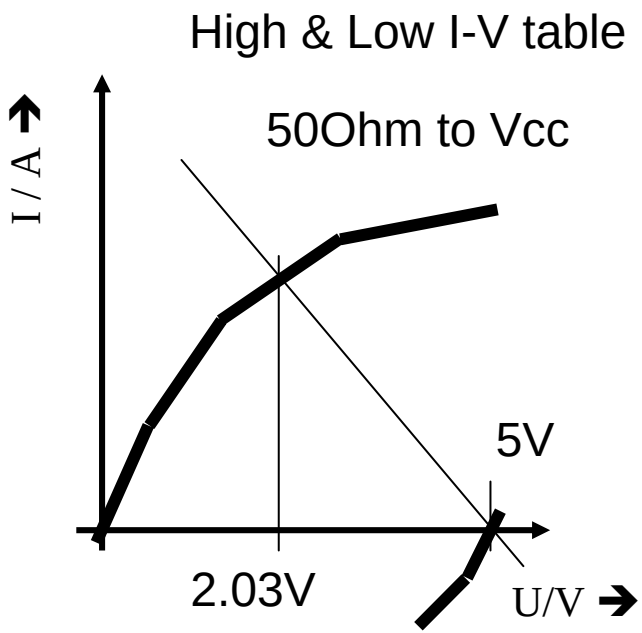
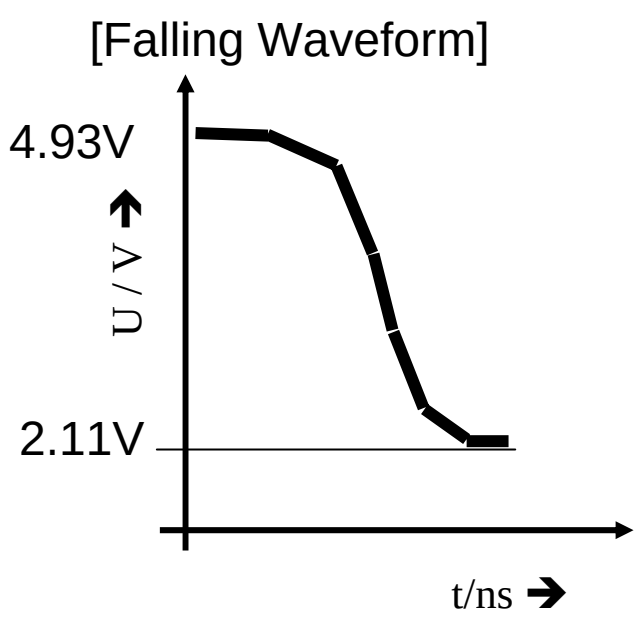
Waveform check: Warning message

WARNING - Model LVCMOS_5V_D5510_TRI: The [Falling Waveform]
with [R_fixture]=50 Ohms and [V_fixture]=5.0V
has TYP column DC endpoints of 2.11V and 4.93v, but
an equivalent load applied to the model's I-V tables yields
different voltages (2.03V and 5.00V),
a difference of 2.59% and 2.26%, respectively.



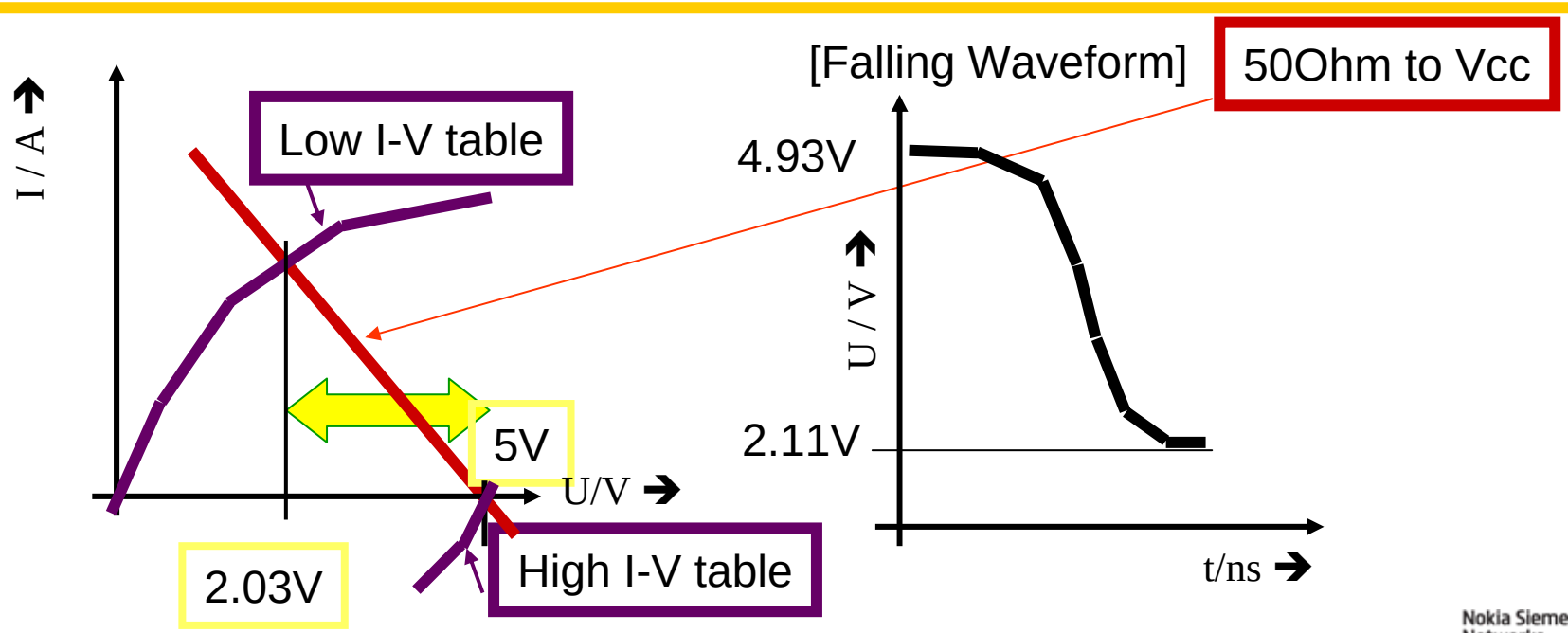


V-t-tables matching to V-I-data

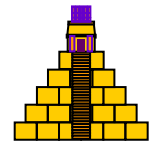
- Reference voltage points are calculated from the two static I-V-tables for ‚High' and ‚Low'

- The load lines are based on V_fixture and R_fixture

- The difference between the reference voltages is the ideal voltage swing



error/warning percentage



V-t tables matching to I-V data

- Calculation with 3 (or more) digits
- Output message with 2 digits
- Warning : mismatch greater than 2% but less than 10%
- Error : mismatch greater than 10%

Thanks to Bob Ross
for the discussions

Calculations for warning message (2 digits)

Dynamic swing	Static swing
4.93V	5.00V
2.11V	2.03V
2.82V	2.97V

Difference ‚Low-level‘		Difference ‚High-level‘	
VinL_dyn	2.11V	VinH_stat	5.00V
VinL_stat	2.03V	VinH_dyn	4.93V
	0.08V		0.07V

Low calculation :

0.08v : 2.97v

➔ 2.69%

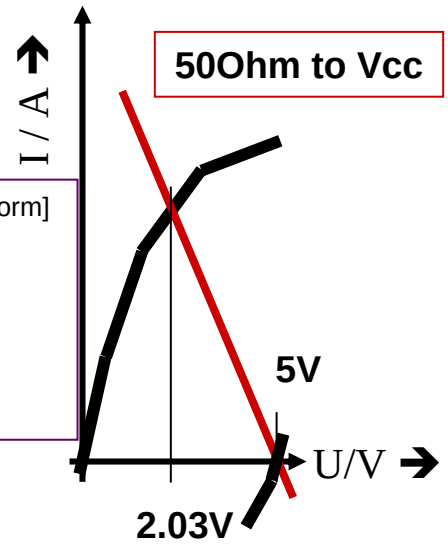
High calculation :

0.07v : 2.97v

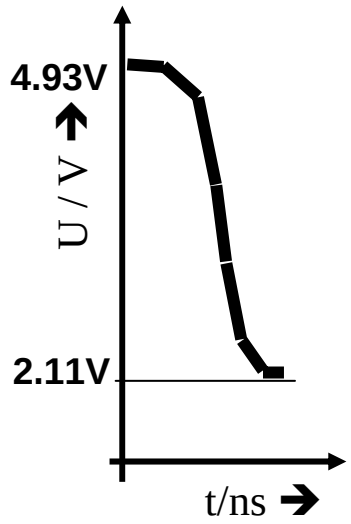
➔ 2.36%

WARNING - Model LVCMOS_3P3V_DR310_TRI: The [Falling Waveform]
with [R_fixture]=50 Ohms and [V_fixture_min]=5.0V
has TYP column DC endpoints of 2.11V and 4.93v, but
an equivalent load applied to the model's I-V tables yields
different voltages (2.03V and 5.00V),
a difference of 2.59% and 2.26%, respectively.

Low & High I-V table



[Falling Waveform]



Difference to ibischk-results:

➔ 2.59% 2.26%

Calculations for warning message (3 digits)

Dynamic swing	Static swing
4.933V	5.000V
2.109V	2.032V
2.824V	2.968V

Difference ‚Low-level‘		Difference ‚High-level‘	
VinL_dyn	2.109V	VinH_stat	5.000V
VinL_stat	2.032V	VinH_dyn	4.933V
	0.077V		0.067V

Low calculation :

0.077v : 2.968v

➔ 2.59%

High calculation :

0.067v : 2.968v

➔ 2.26%

WARNING - Model LVCMOS_3P3V_DR310_TRI: The [Falling Waveform]
with [R_fixture]=50 Ohms and [V_fixture_min]=5.0V
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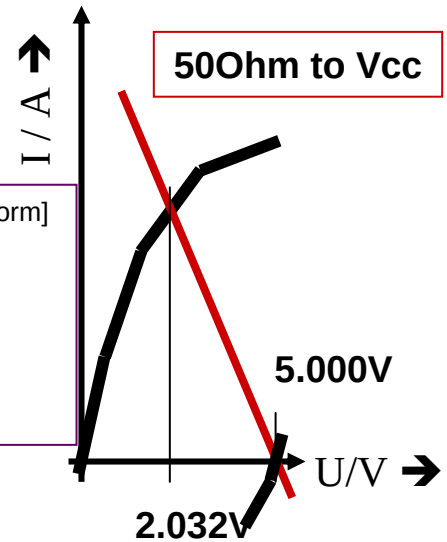
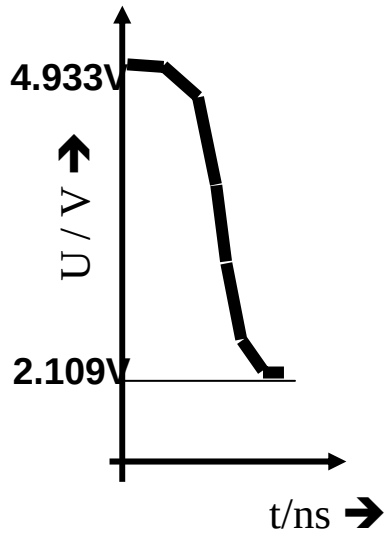
Low & High I-V table

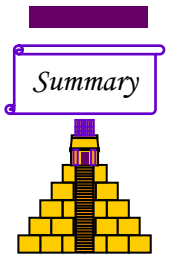


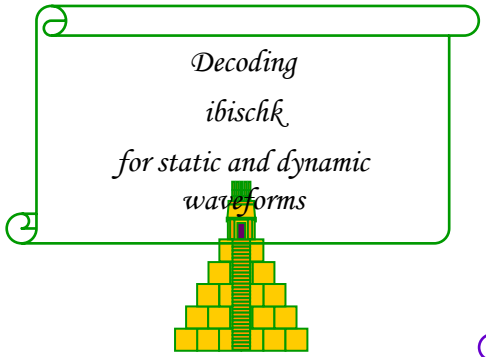
[Falling Waveform]



No Difference to ibischk-results:

➔ 2.59% 2.26%


Summary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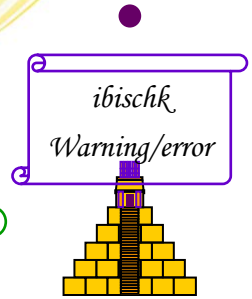
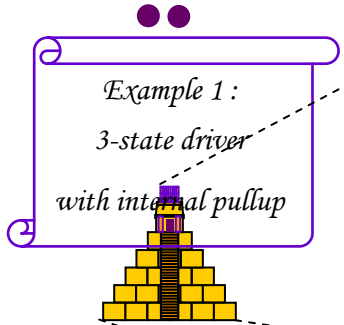
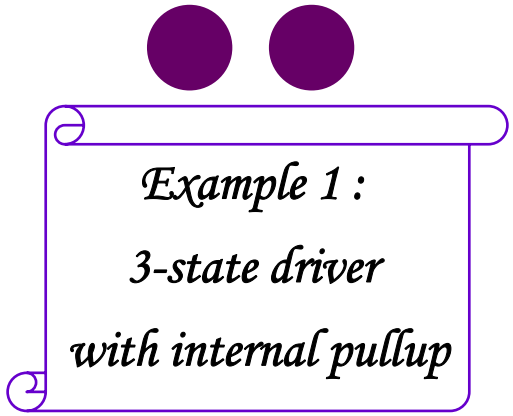

ibischk
Warning/error


Example 1 :
3-state driver
with internal pullup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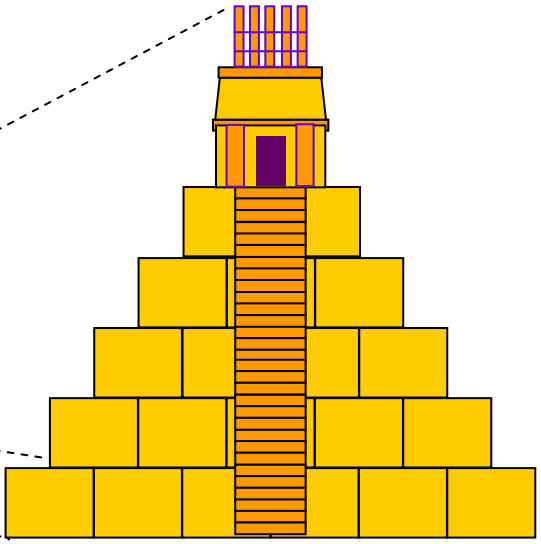
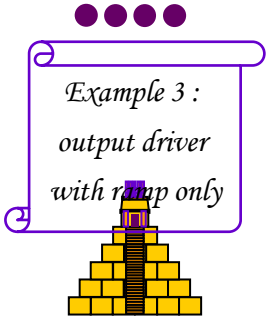
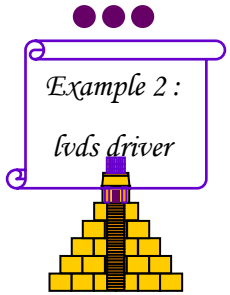
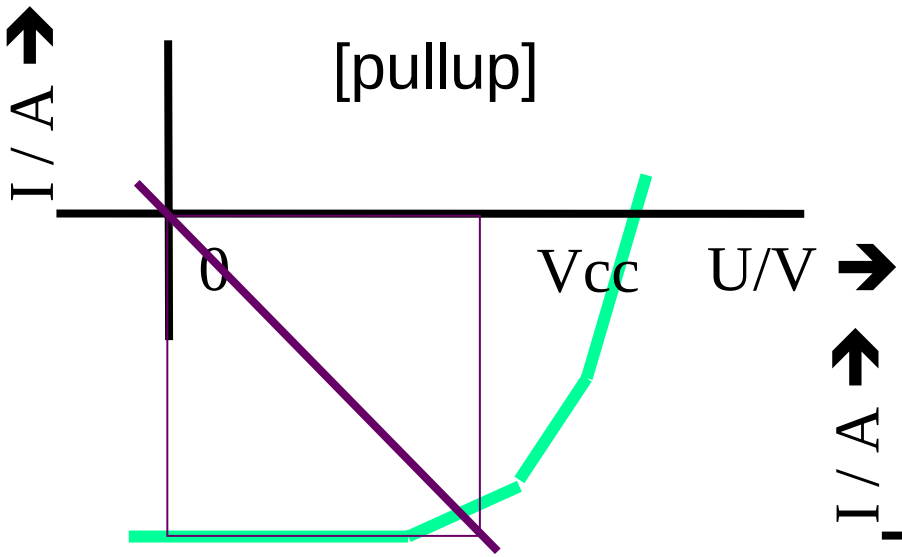


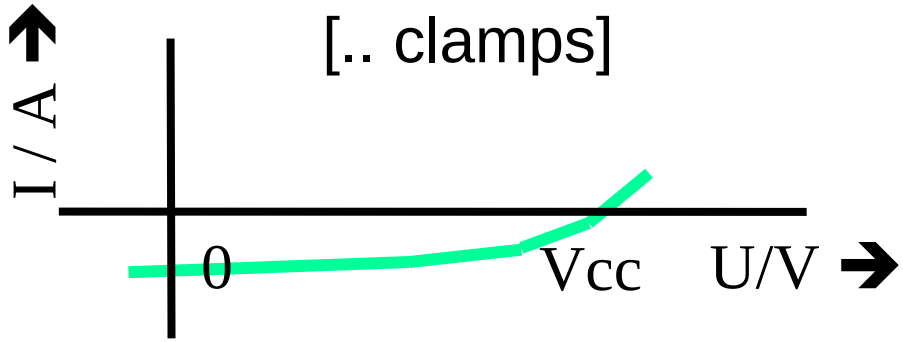

Example 3 :
output driver
with pullup only

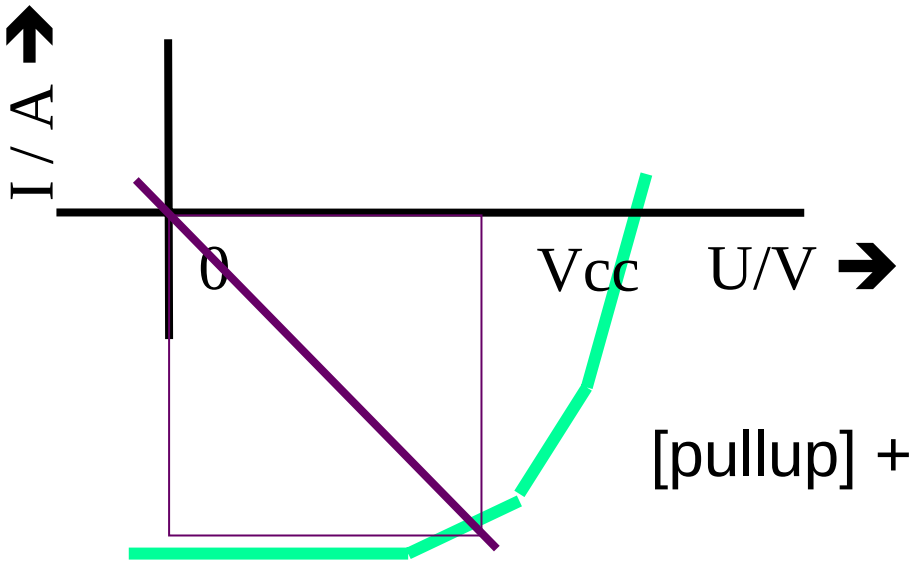

Example 2 :
lvds driver

Static curves for high

3-state driver



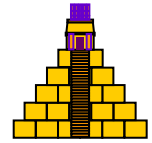


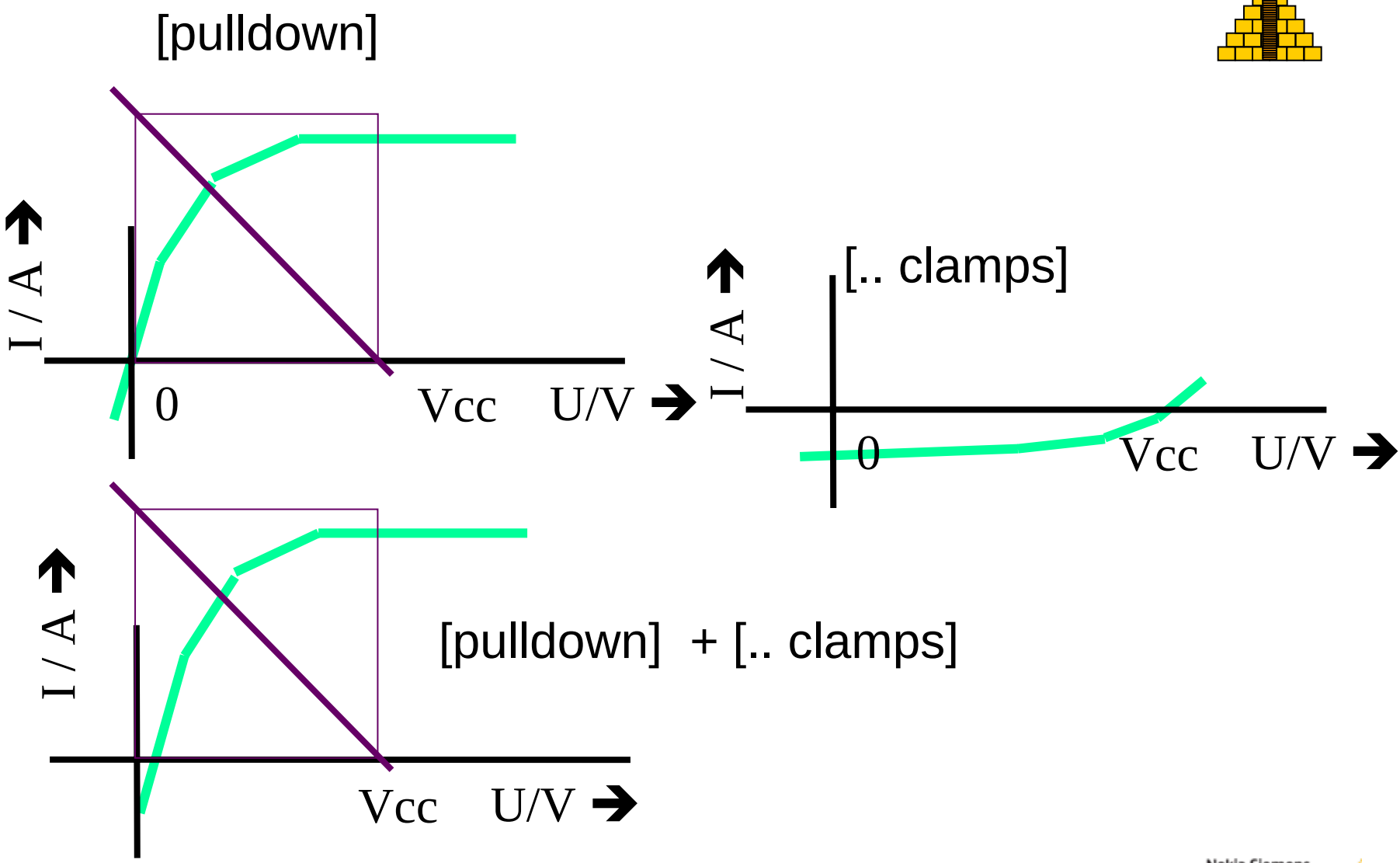


[pullup] + [.. clamps]

Static curves for low

3-state driver





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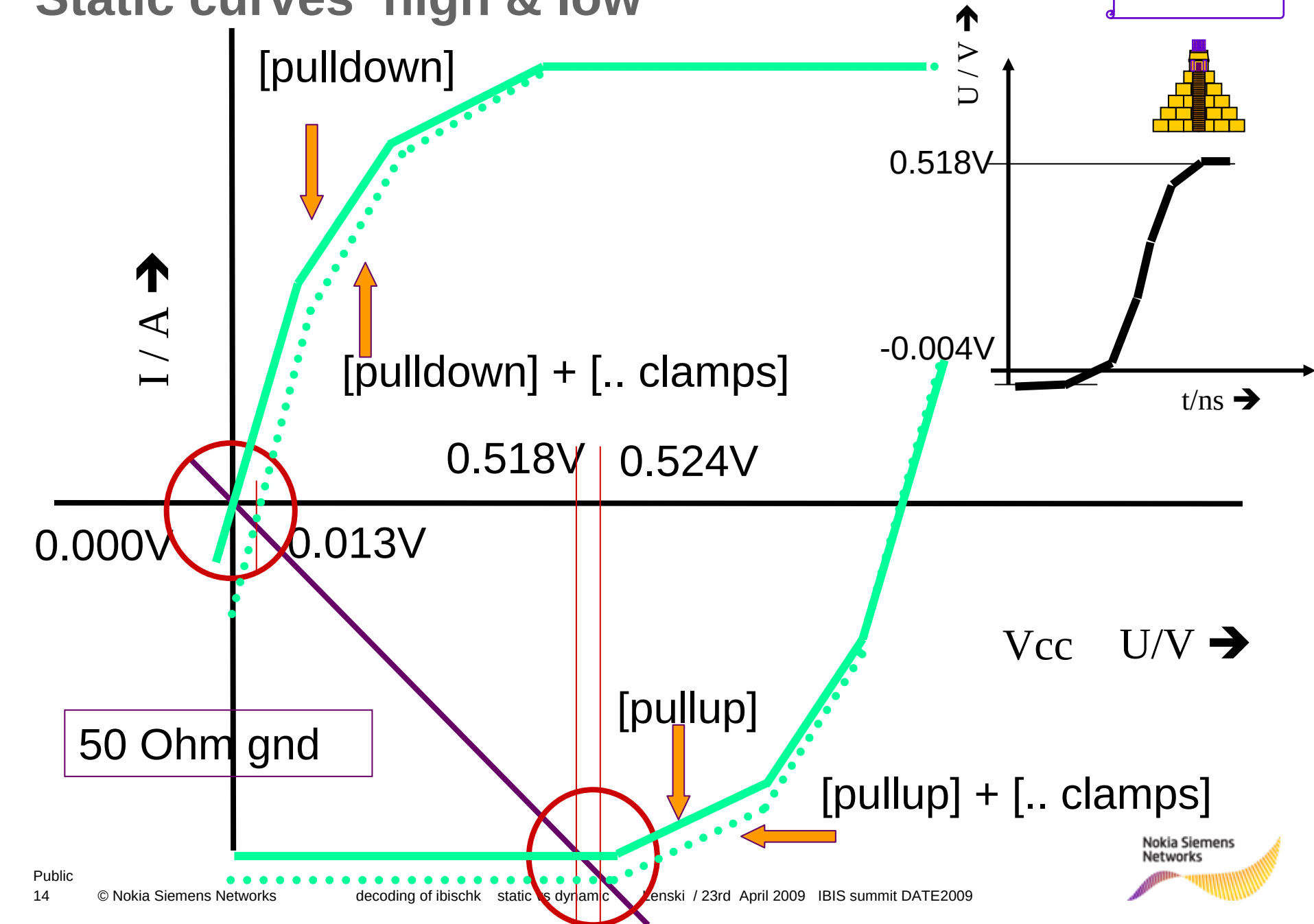
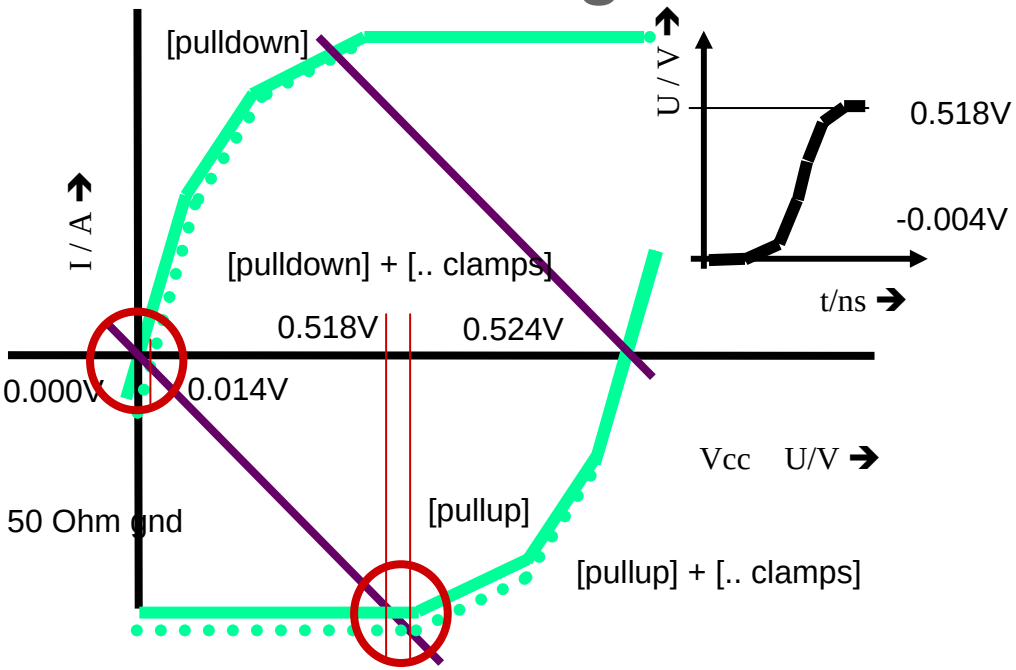
Static curves high & low

3-state driver



Static curves high & low warning

3-state driver



Waveform :

0.518V

-0.004V

Model I-V-table :

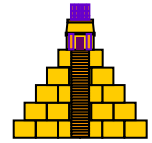
0.524V

0.014V

WARNING - Model LVCMOS_3P3V_DR310_TRI: The [Rising Waveform]
with [R_fixture]=50 Ohms and [V_fixture]=0.0V
has TYP column DC endpoints of 0.00V and 0.52v, but
an equivalent load applied to the model's I-V tables yields
different voltages (0.01V and 0.52V),
a difference of 3.53% and 1.18%, respectively.

Ibischk warning origin

3-state driver



Where does the difference come from ?

- Internal pulldown only active in tristate

- Dynamic switching of the output : “ high to low “

(From [pullup] to [pulldown])

- IBIS static calculations:

High = [pullup] + [.. clamps]

Low = [pulldown] + [.. clamps]

Tristate = [.. clamps]

What to do ?

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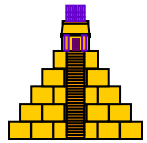
Usage of submodel (splitting of clamps)



What we did : Usage of [submodel]

With […clamps] only in mode ‚non-driving‘

Makes sure that internal pulldown only active in tristate

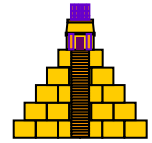
Dynamic switching high to low:
From [pullup] to [pulldown]

IBIS static calculations:

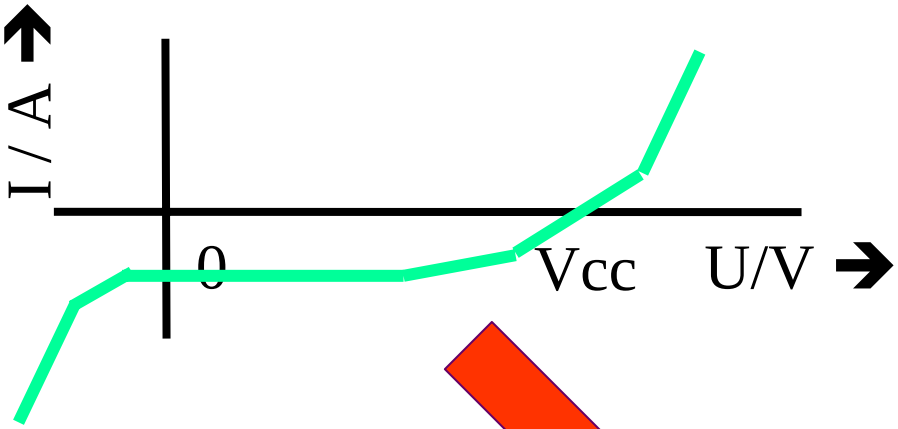
High = [pullup] + (model) [.. clamps]
Low = [pulldown] + (model) [.. clamps]
Tristate = (model) [.. clamps] + (submodel) [.. clamps]

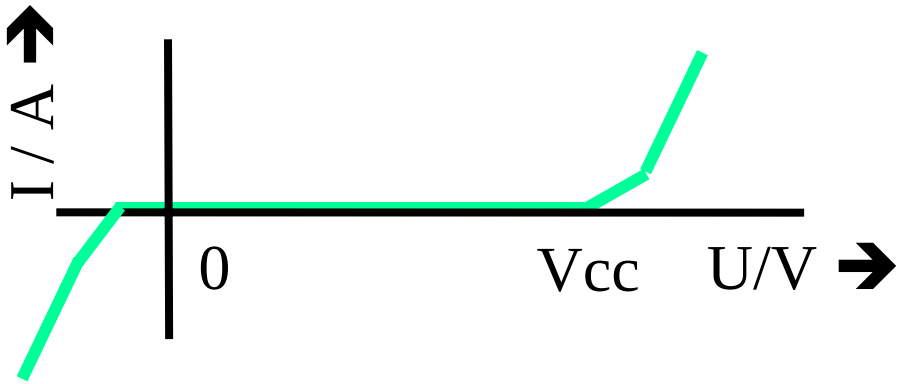
Separation of original clamps

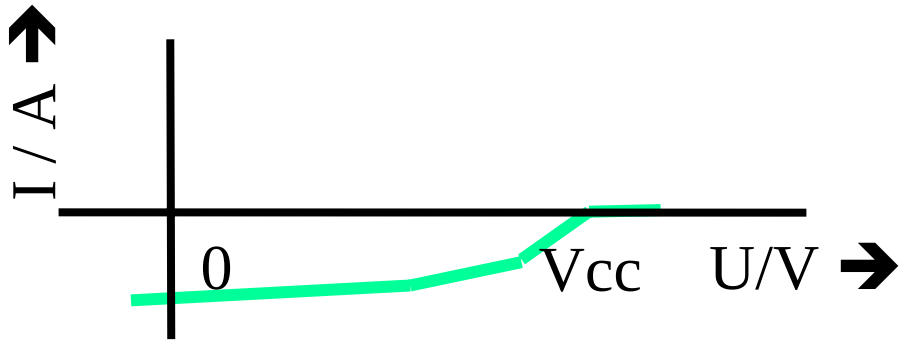
3-state driver



Original [.. clamps]







Corrected (model) [.. clamps]

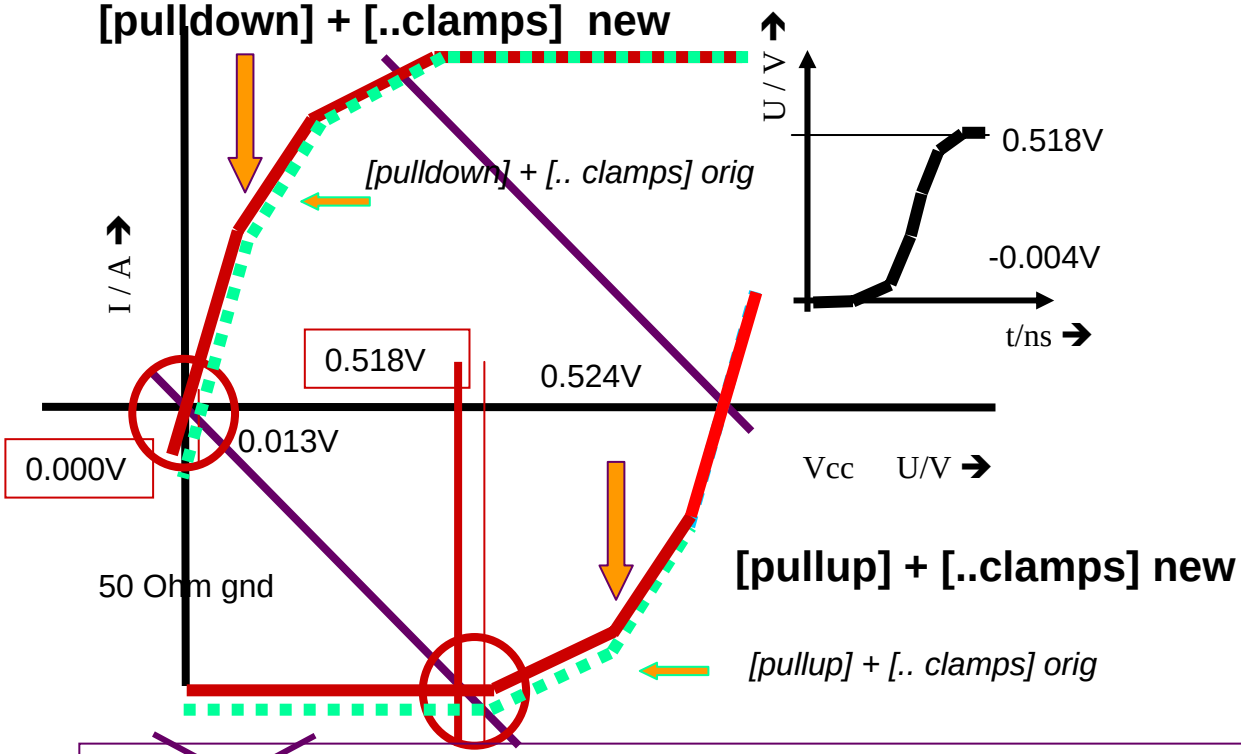
with diode behavior

New (submodel) [.. clamps]

with internal pullup behavior

Static curves high & low (model with submodel)

3-state driver



Waveform :

0.518V

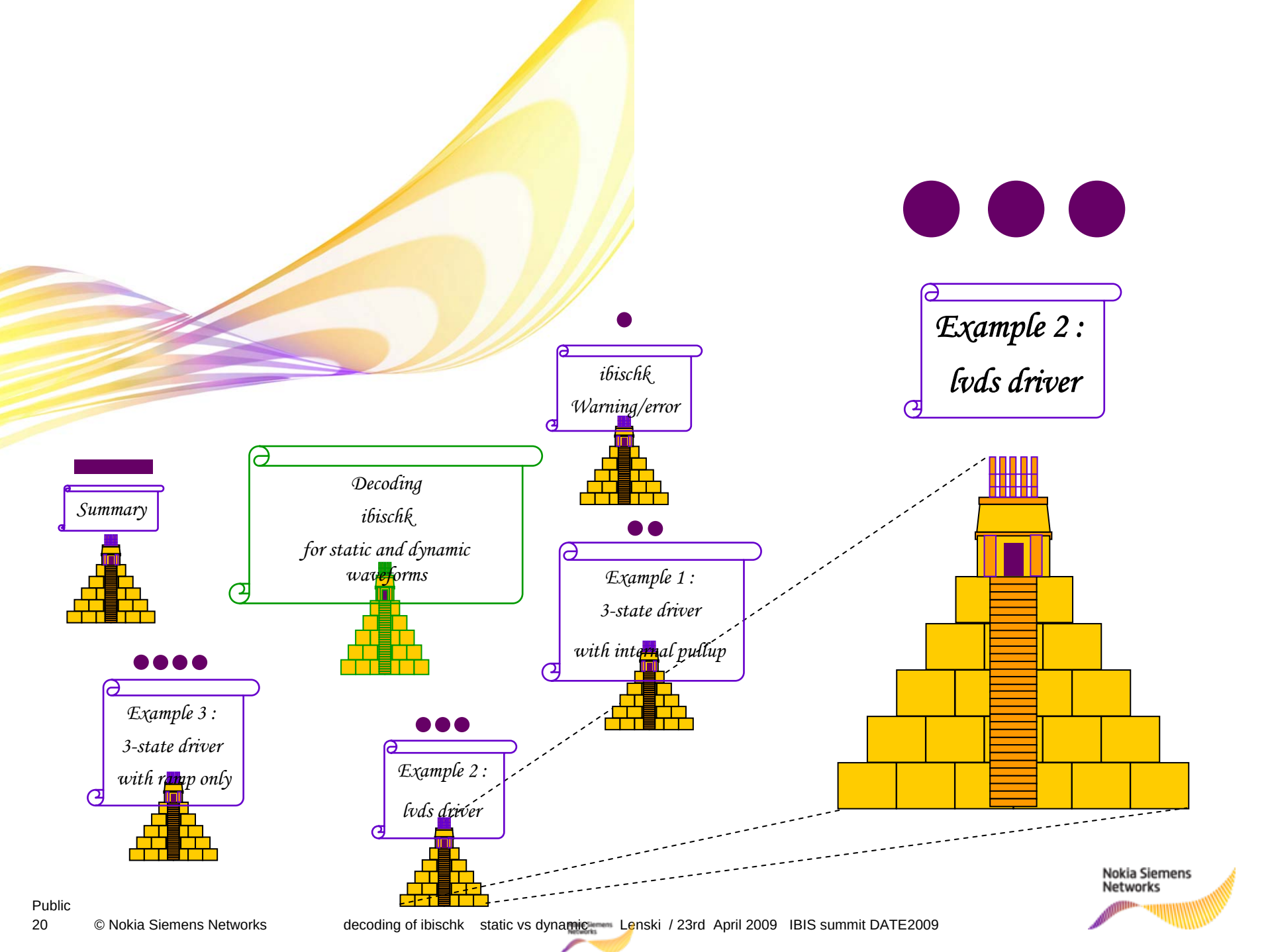
-0.004V

Model I-V-table :

0.518V

0.000V

WARNING - Model LVCMOS_3P3V_DR310_TRI: The [Rising Waveform]
with [R_fixture]=50 Ohms and [V_fixture]=0.0V
has TYP column DC endpoints of 0.00V and 0.52v, but
an equivalent load applied to the model's I-V tables yields
different voltages (0.00V and 0.52V),
a difference of 0.77% and 0.58%, respectively.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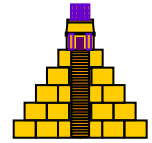
lvds driver

error/warning percentage

Lvds driver



V-t tables matching to I-V data

- 25mV difference
- is this a big error ?

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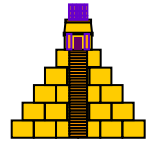
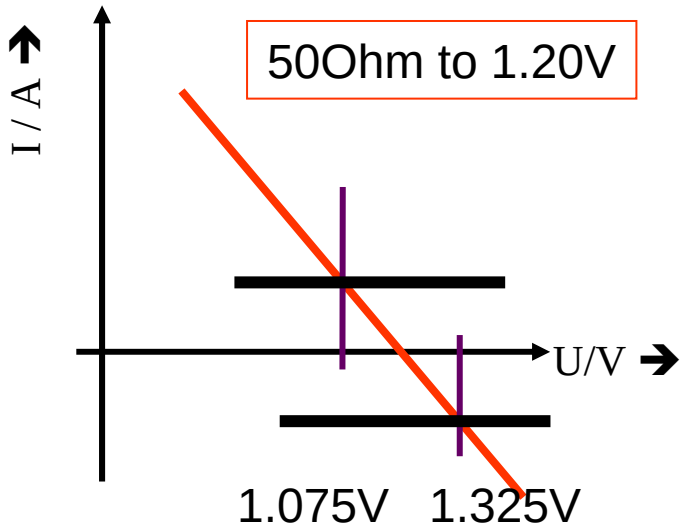
Waveform check: Error message

lvds driver

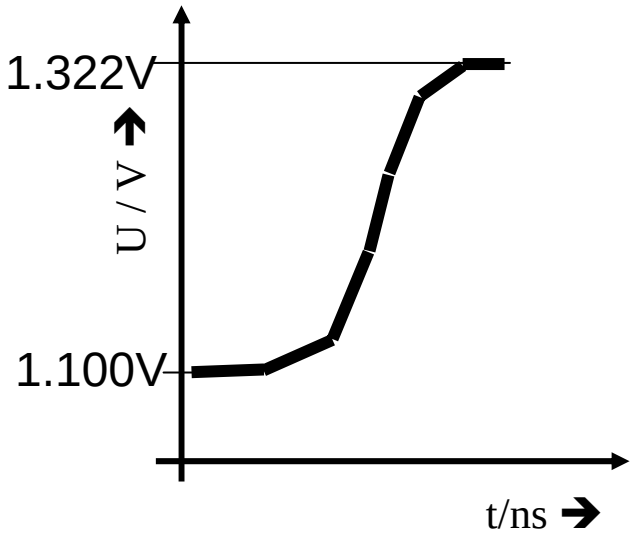


ERROR - Model LVDS_3P3V_D5510_TRI: The [Rising Waveform]
with [R_fixture]=50 Ohms and [V_fixture]=1.2V
has TYP column DC endpoints of 1.10v and 1.32v, but
an equivalent load applied to the model's I-V tables yields
different voltages (1.08V and 1.33V),
a difference of 10.00% and 1.20%, respectively.

High & Low I-V table



[Rising Waveform]



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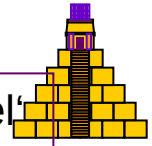
Calculation of error/warning percentage

lvds driver



Dynamic swing	Static swing	Difference ‚Low-level'	Difference ‚High-level'
1.322V	1.325V	VinL_dyn 1.100V	VinH_dyn 1.325V
1.100V	1.075V	VinL_stat 1.075V	VinH_stat 1.322V
0.222V	0.250V	0.025V	0.003V

Low calculation :

0.025v : 0.250v

➔ 10.00%

High calculation :

0.003v : 0.250v

➔ 1.20%

Be accurate,

a difference of just 25mV

can give an error of 10%

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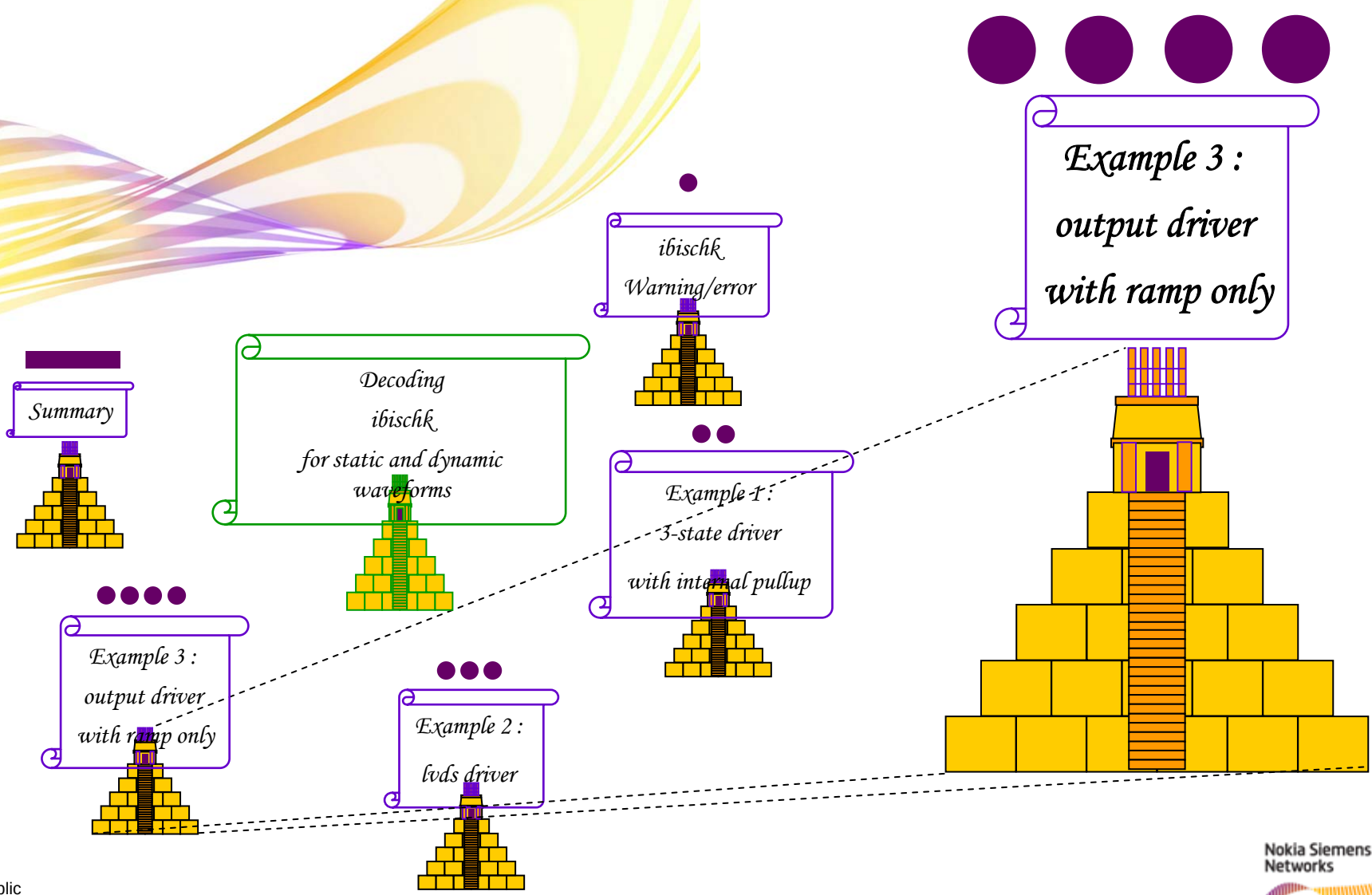
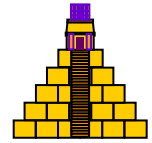

Summary
Decoding ibischk for static and dynamic waveforms
ibischk Warning/error
Example 3 : output driver with ramp only
Example 1 : 3-state driver with internal pullup
Example 3 : output driver with ramp only
Example 2 : lvds driver

[Driver schedule] boost driver

ramp driver



No V-t tables for matching to I-V data

- what to do with ramp only drivers (model_type output)
- switching from …. to …..

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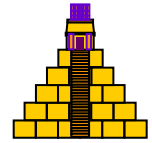
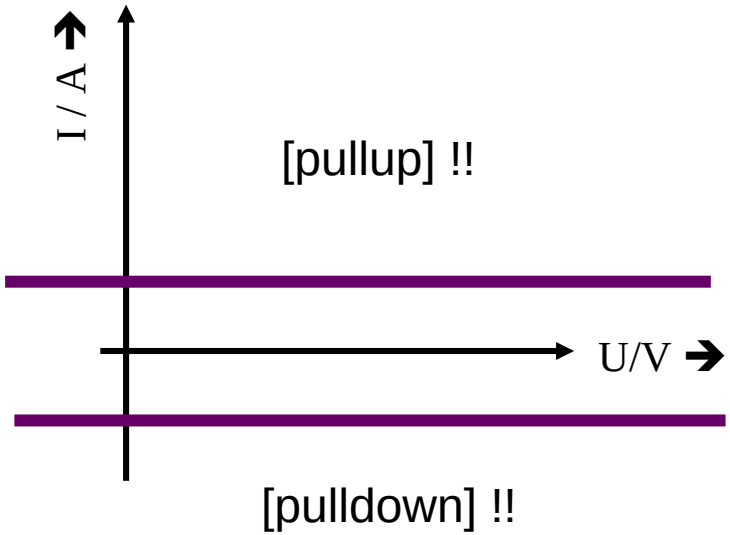
[ramp] and static curves

ramp driver



dv/dt_r	0.0775V / 85.2ps
dv/dt_f	0.0808V / 81.9ps

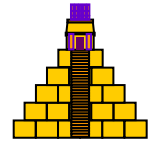
Orig. ramp



Orig. static curves

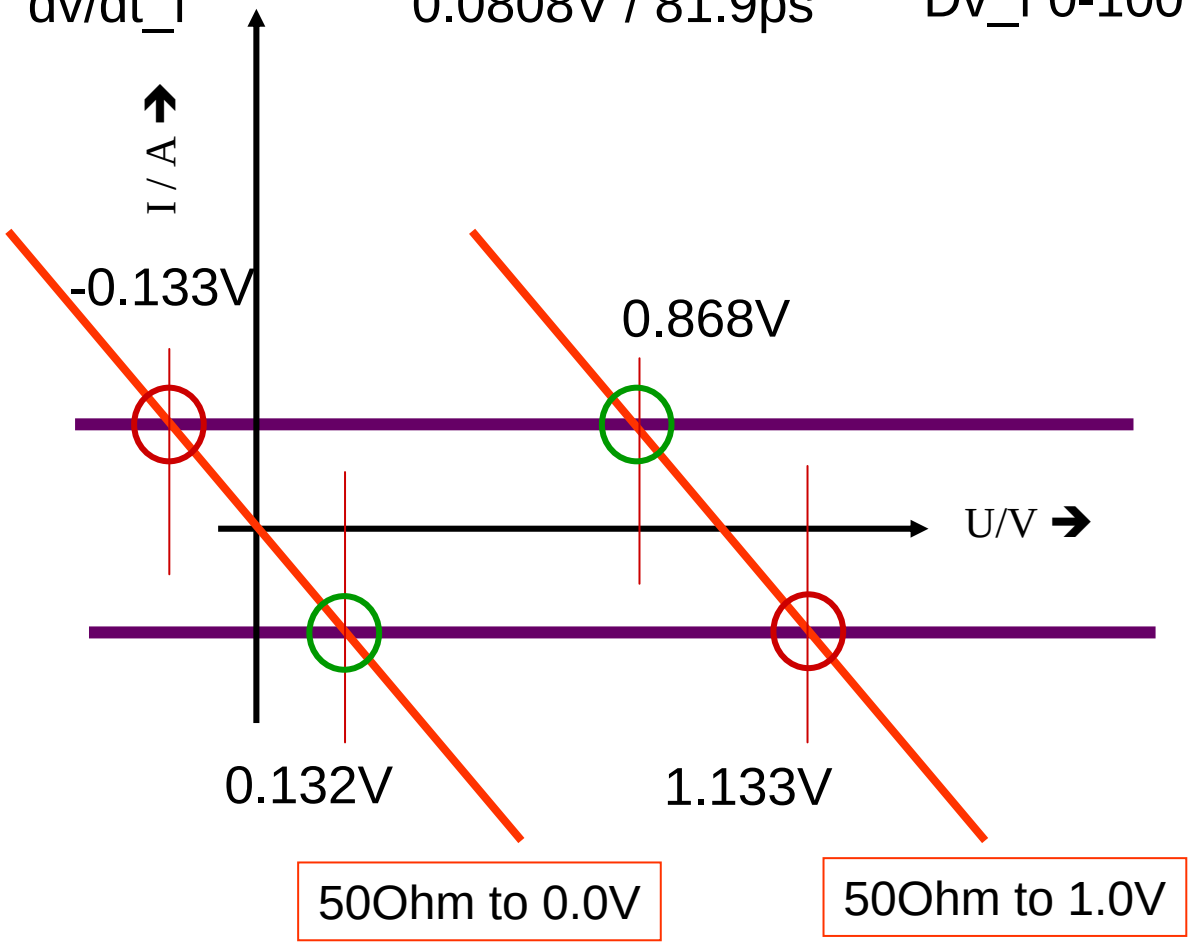
[ramp] and static curves and loadlines

ramp driver



dv/dt_r 0.0775V / 85.2ps Dv_r 0-100 % ➔ 0.129V

dv/dt_f 0.0808V / 81.9ps Dv_f 0-100 % ➔ 0.135V



[pullup] !!

[pulldown] !!

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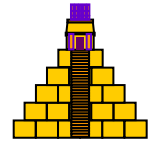
Calculation of error/warning percentage

ramp driver



How getting ibischk to work with ramp models ?

- Create default 2-points waveform (from ramp)

  0.0ns 0.86v

  1.0ns 1.00v

- Create 5-points waveform (from static values)

0.000e+00s	0.865v
2.732e-11s	0.918v
6.831e-11s	0.999v
1.093e-10s	1.068v
1.366e-10s	1.132v

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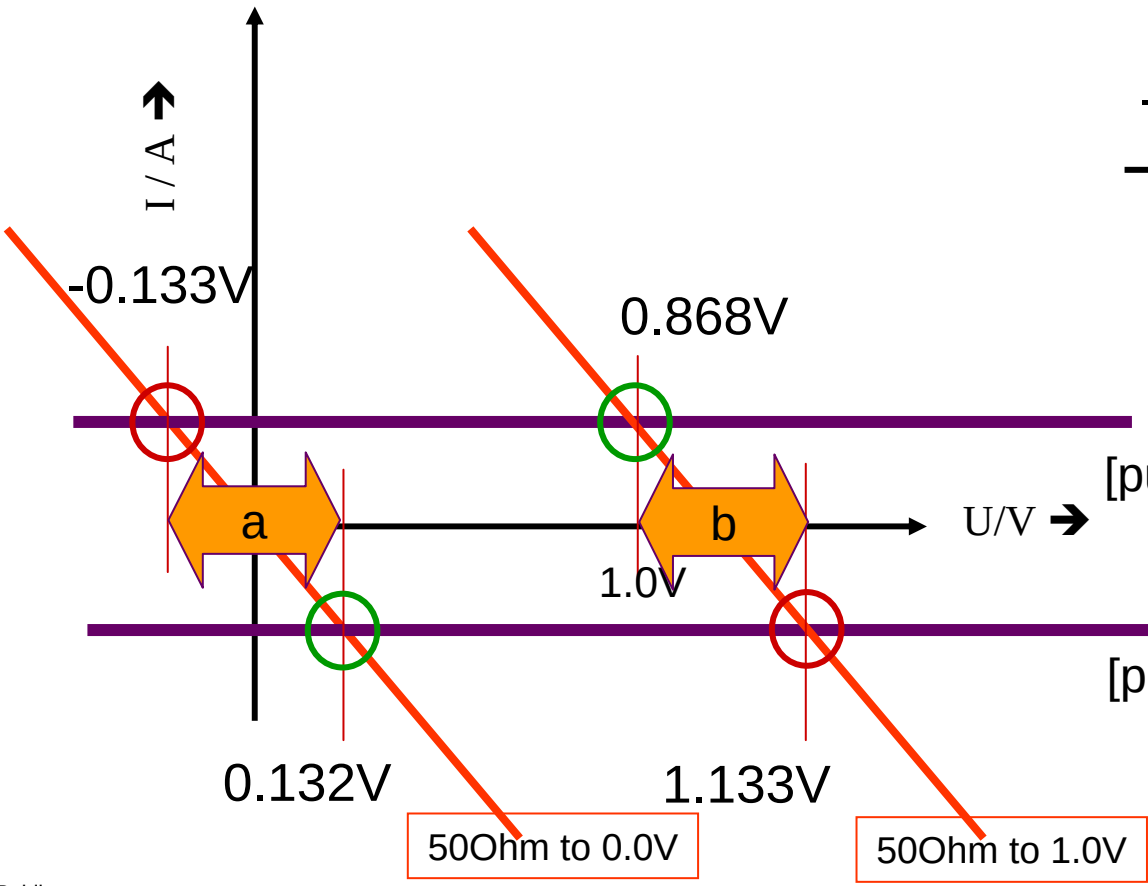
static swing calculation from [pull...]

Static swing calculation

Between [pullup] and [pulldown]

Dv Rise 50 Gnd	Dv Fall 50 Vcc
0.132V	1.133V
- -0.133V	- 0.868V
0.265V	0.265V
a	b



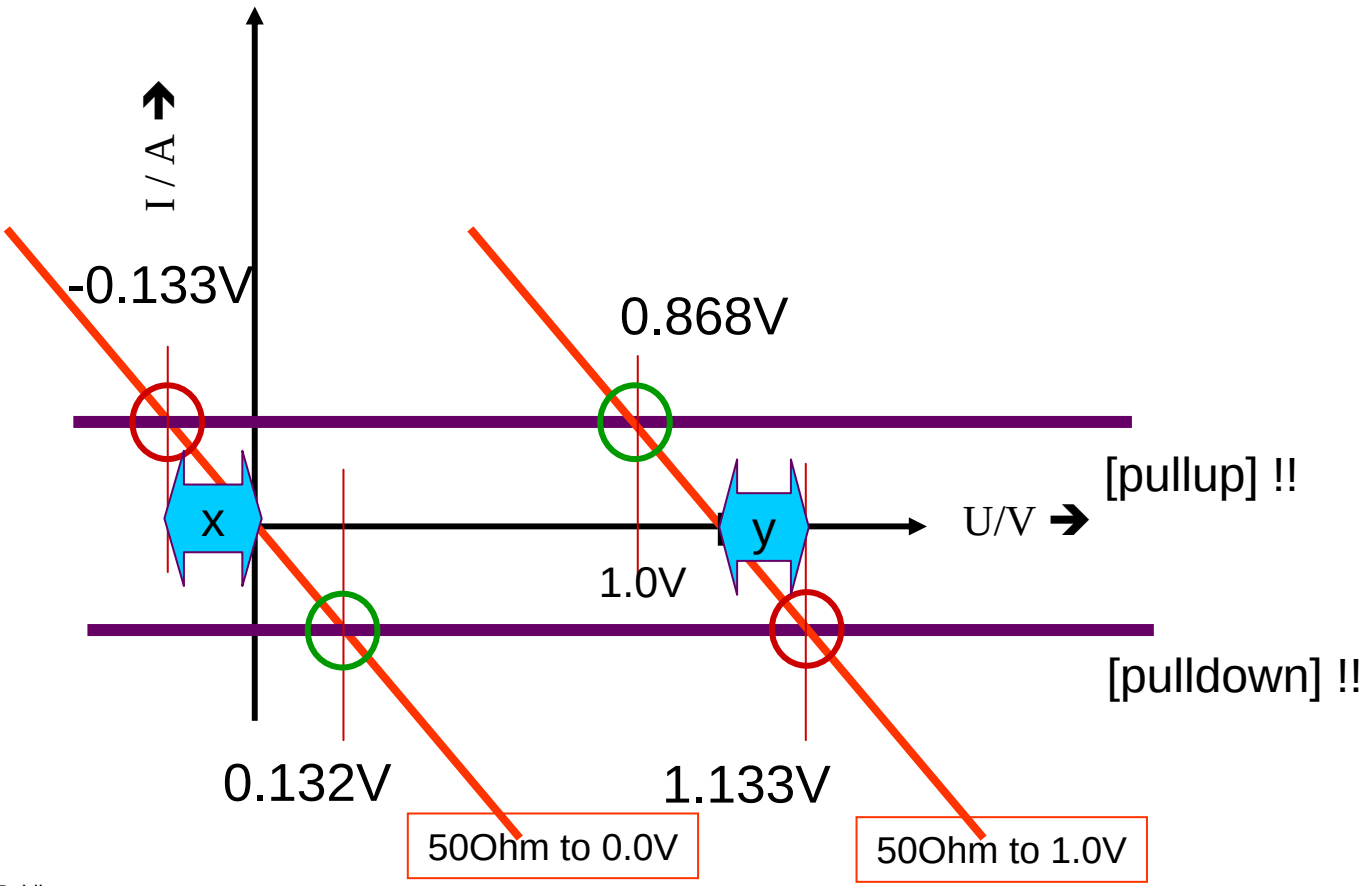
ramp driver

dynamic swing calculation from ramp values

ramp swing calculation (extrapolated from model values)

Dv_r 0-100 0.129V x [pullup] to gnd

Dv_f 0-100 0.135V y [pulldown] to vcc



ramp driver

dynamic and static swing comparison

ramp swing (0-100%)

Dv_r 0.129V

Dv_f 0.135V

x [pullup] to gnd

y [pulldown] to vcc

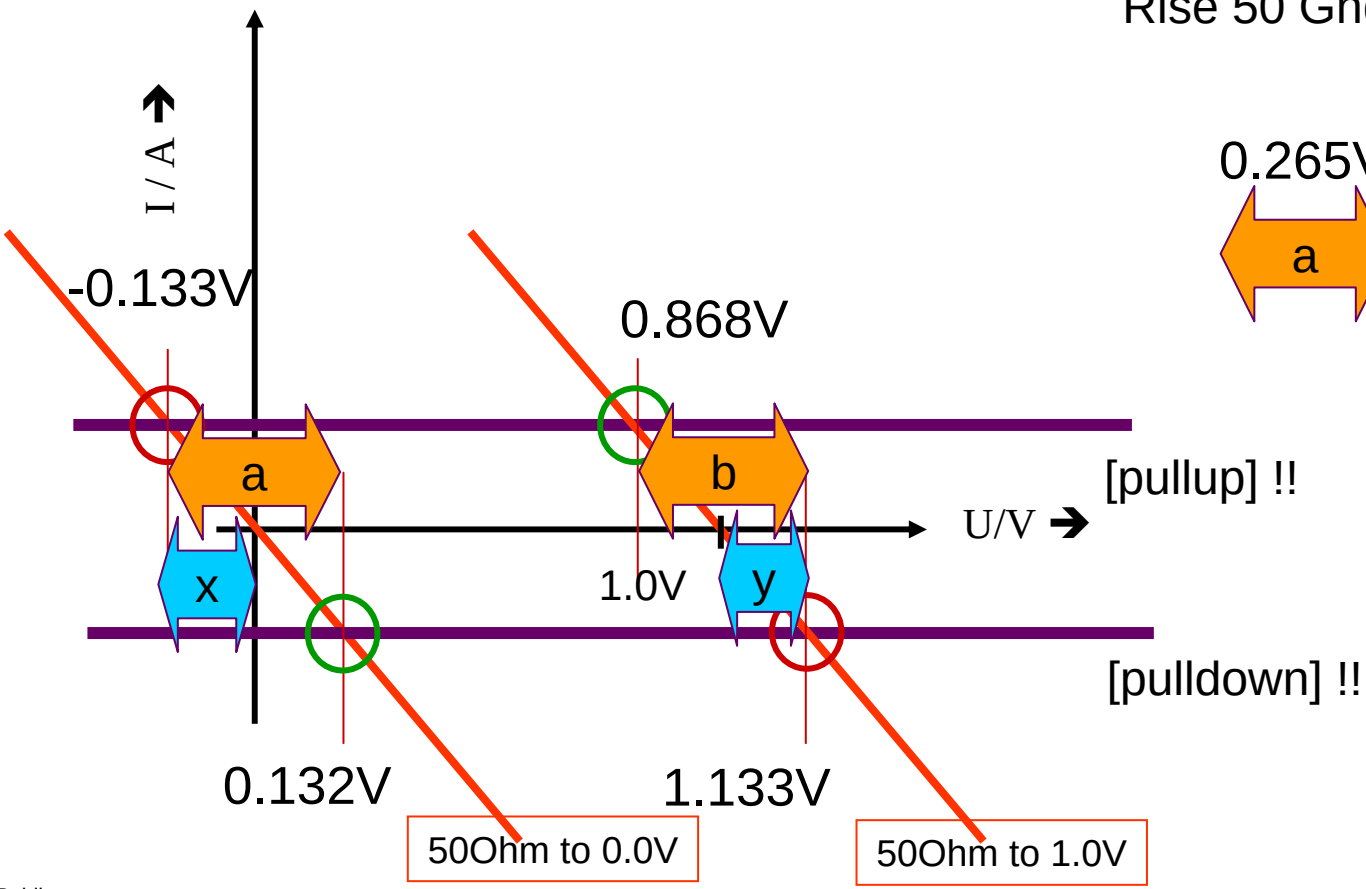
Static swing (0-100%)

Between [pullup] and [pulldown]

Rise 50 Gnd Fall 50 Vcc

0.265V a

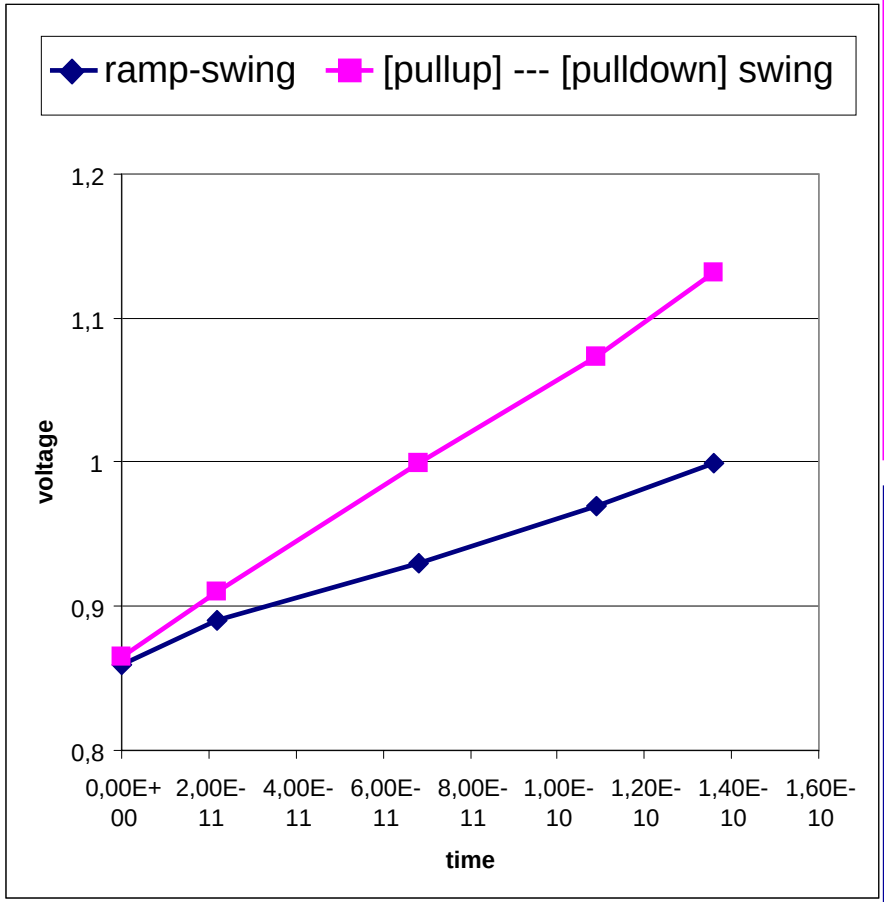
0.265V b



ramp driver

Ibischk calculations with new waveforms

ramp driver

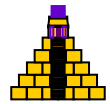


WARNING - Model BOOSTwave4_OUT: The [Falling Waveform]
with [R_fixture]=50 Ohms and [V_fixture]=1V
has TYP column DC endpoints
of 1.13V and 0.85v, but
an equivalent load applied to
the model's I-V tables yields
different voltages (1.13V and 0.87V),
a difference of 0.43% and 4.97%, respectively.

ERROR - Model Boost-orig_OUT: The [Falling Waveform]
with [R_fixture]=50 Ohms and [V_fixture]=1V
has TYP column DC endpoints
of 1.00V and 0.87v, but
an equivalent load applied to
the model's I-V tables yields
different voltages (1.13V and 0.87V),
a difference of 50.05% and 1.06%, respectively.

What about time (dt_r/f) of [ramp] ?

ramp driver

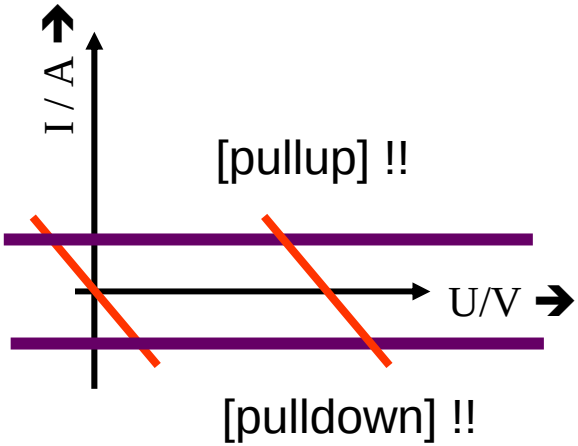


dv/dt_r	0.0775V / 85.2ps
dv/dt_f	0.0808V / 81.9ps

Dv_r 0-100 %	0.129V	0.265V
Dv_f 0-100 %	0.135V	0.265V

y — Ramp

b — Static



Option 1:

Ramp time correct, only ramp swing wrong

dv/dt_r 0.159V / 85.2ps

dv/dt_f 0.159V / 81.9ps

b‘

Change only voltage swing

Option 2:

Ramp time wrong, and ramp swing wrong

dv/dt_r 0.159V / 170.4ps

dv/dt_f 0.159V / 163.8ps

b‘ b‘*F

Change voltage swing and time

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Using a corrected ramp

Driver with ramp only

!! Always have a closer look at the ramp !!

!! After using a wrong ramp !!

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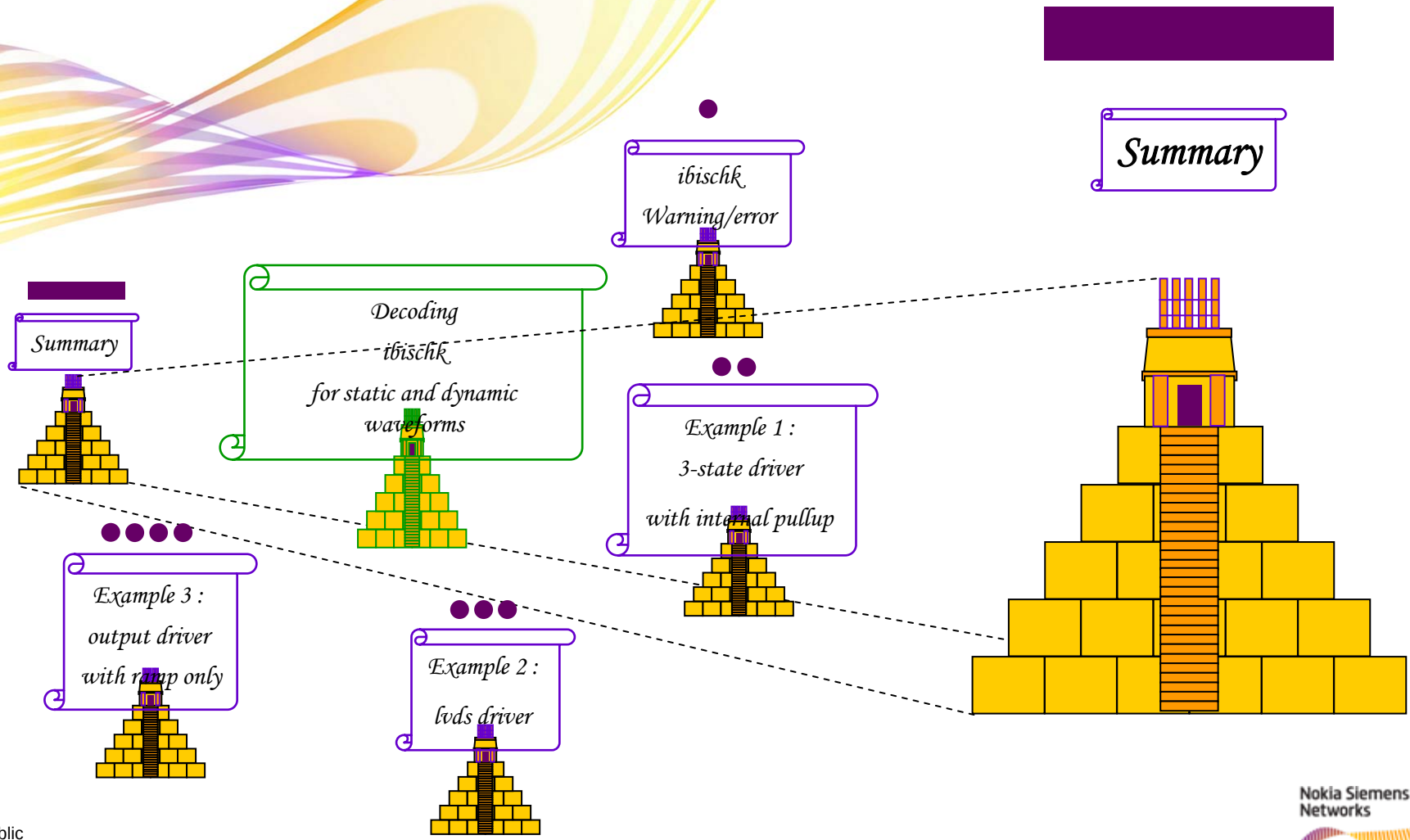
Summary
Summary
ibischk
Warning/error
Decoding
ibischk
for static and dynamic
waveforms
Example 1 :
3-state driver
with internal pullup
Example 3 :
output driver
with ramp only
Example 2 :
lvds driver

Summary for ibischk v-i vs. V-t mismatch

summary

- Don‘t calculate static swing
  - from [pulldown] to vcc (50ohm vcc)
  - from [pullup] to gnd (50 ohm gnd)

- Calculate static swing from High to Low
  - From [pullup] + [..clamps] to [pulldown] + [..clamps]
  - With loads at v-fixture and r-fixture

- for internal pullup/pulldown behavior
  use [submodel] with mode non-driving

- ramp dv-values also refers to swing from High to Low

- Add default risefall waveforms to get ibis-check information about mismatch between static and ramp/dynamic values

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Thank You

- **Questions ?**