



Information  
and Communication  
Networks

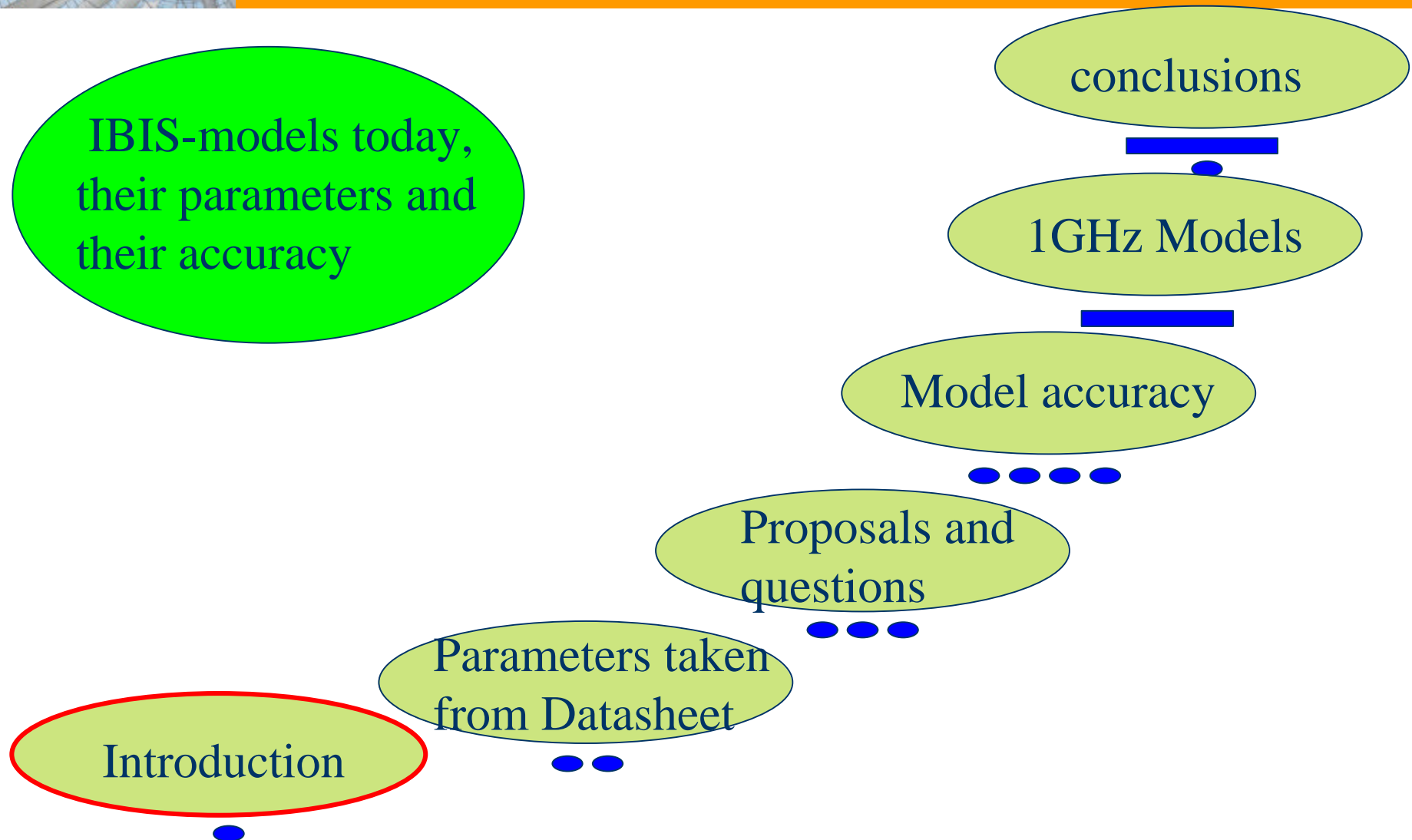
# **IBIS-models today, their parameters and their accuracy**

**Eckhard Lenski    Siemens AG**

IBIS summit meeting DAC 2002



# Table of content





# Introduction

**ICN WN OP TDC TC 3    Modeling group**

Behavioral models since 1993

Model-sources

- measurements            1%
- HSPICE                    40%
- IBIS                        50%
- Databook                 9%

Library with more than 1500 models ( of IOs )

Models for new technologies            ( LVDS , CAN , PCML , ... )



# Datasheet definitions

IBIS-models today,  
their parameters and  
their accuracy

Introduction

Parameters taken  
from Datasheet

Proposals and  
questions

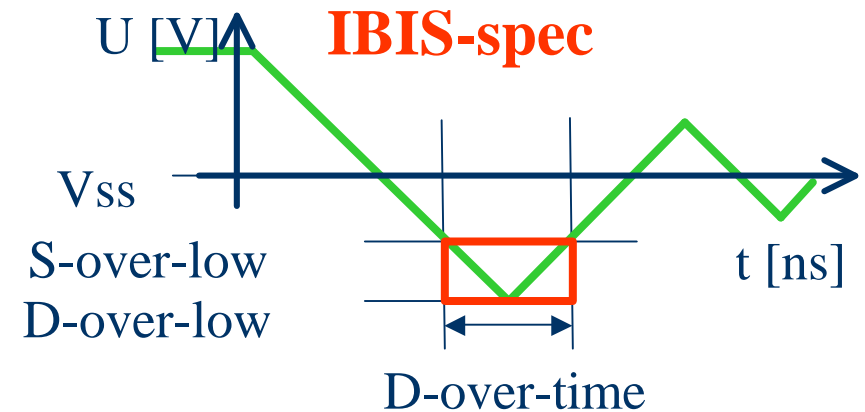
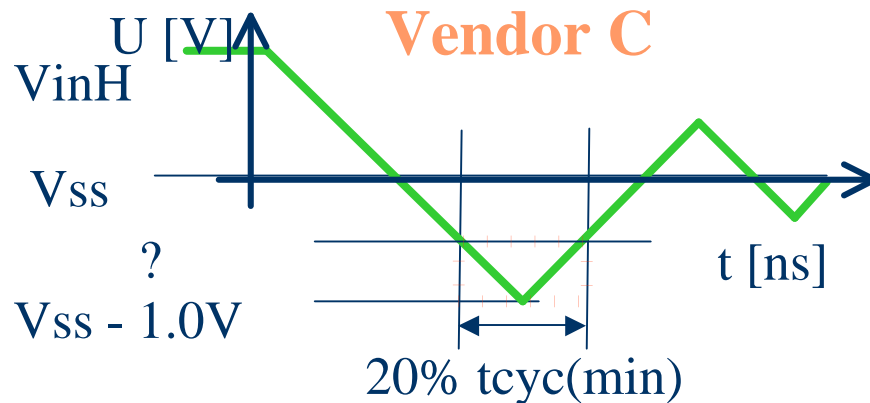
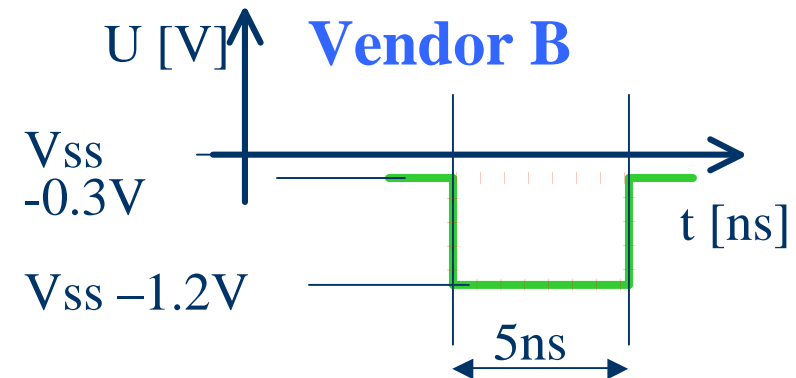
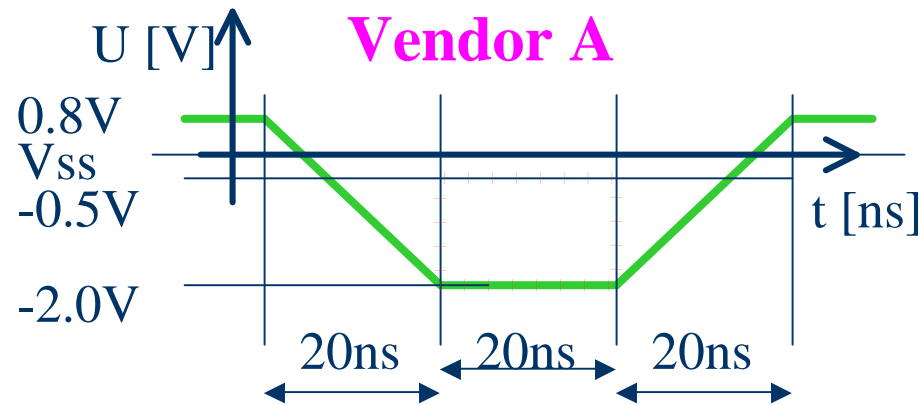
Model accuracy

1GHz Models

conclusions



# Over-undershoot examples

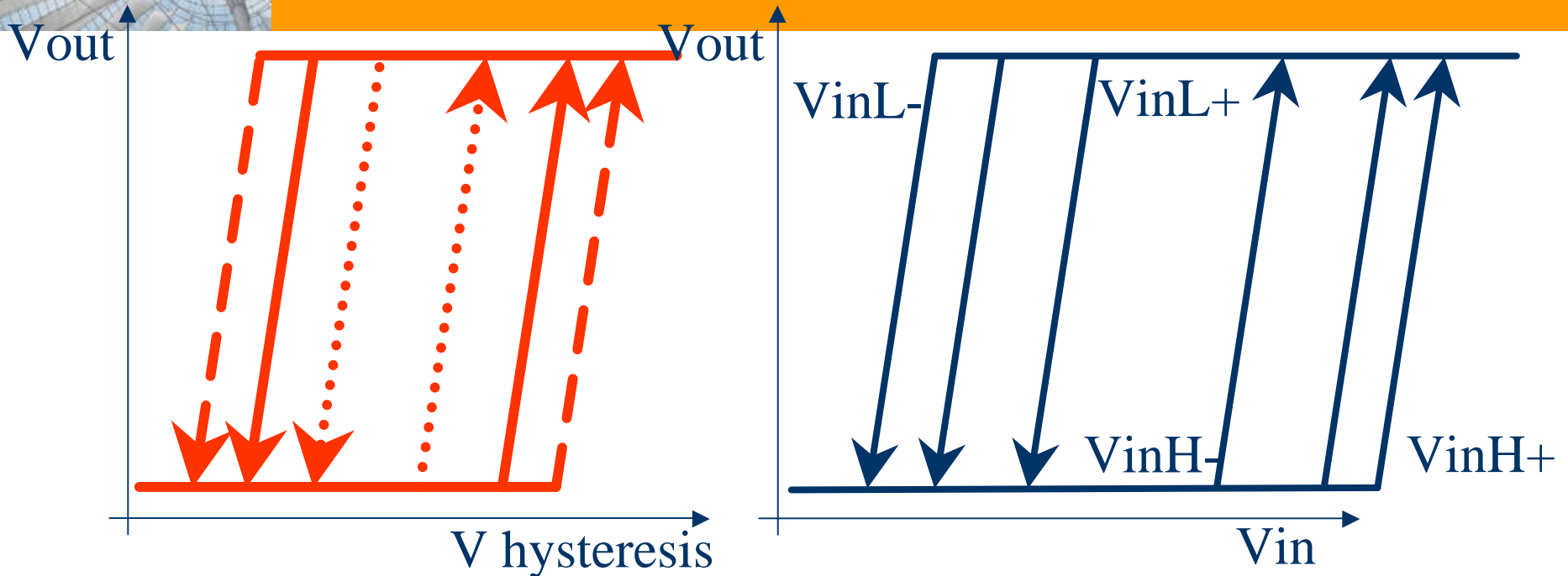


Use dc. cond. for static-over and  
max. rat. for dynamic-over values





# Schmitt-Trigger



	Min		Max
Negative trigger voltage	0.8	1.25	1.7
Positiv trigger voltage	1.3	1.85	2.4
Hysteresis voltage	0.2	0.6	1.0

Use values of trigger voltages, don't use hysteresis





# Proposal and questions

IBIS-models today,  
their parameters and  
their accuracy

Introduction

Parameters taken  
from Datasheet

Proposals and  
questions

Model accuracy

1GHz Models

conclusions



# Differential model selector -1

## Schematic

Not all pins shown



## Pinfile

Not all pins shown

1	Control	ALVC_REC-XXX-1_IN	1	Control	ALVC_REC-XXX-1_IN
2	Eclpos	PECL_REC-XXX-2_IN	2	ttl-in	TTL_REC-XXX-4_IN
3	Eclneg	PECL_REC-XXX-3_IN	3	Nc	NC
4	1A1	ALVC_IO-XXX-1_BI	4	1A1	ALVC_IO-XXX-1_BI
.....			.....		

[Diff Pin] inv\_pin vdiff tdelay\_typ tdelay\_min tdelay\_max  
2 3 150mV 0ns 0ns 0ns | for Ecl only

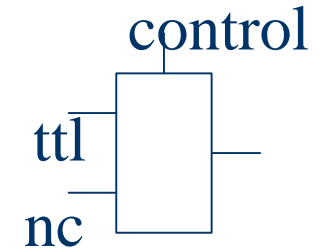
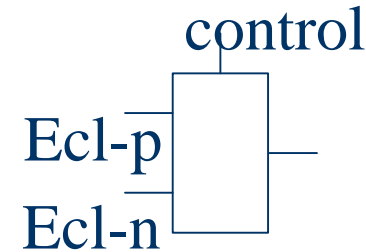




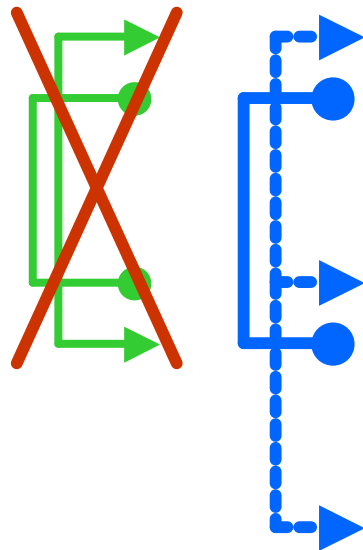
# Differential model selector -2

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- |   |         |                   |
|---|---------|-------------------|
| 1 | Control | ALVC_REC-XXX-1_IN |
| 2 | pos     | YYYY_REC-XXX-5_IN |
| 3 | neg     | ZZZZ_REC-XXX-6_IN |
| 4 | 1A1     | ALVC_IO-XXX-1_BI  |



.....



[Model Selector]      YYYY\_REC-XXX-5\_IN  
 PECL\_REC-XXX-2\_IN  
 TTL\_REC-XXX-4\_IN

[Model Selector]      ZZZZ\_REC-XXX-6\_IN  
 PECL\_REC-XXX-3\_IN  
 NC

[Diff Pin]  
 2                      3      .....

Create two components (pinfiles )



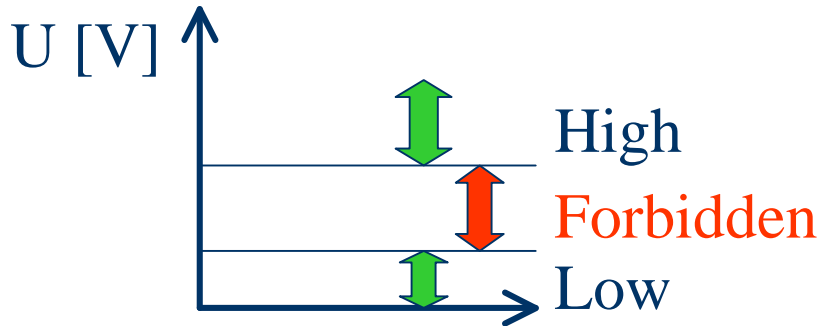
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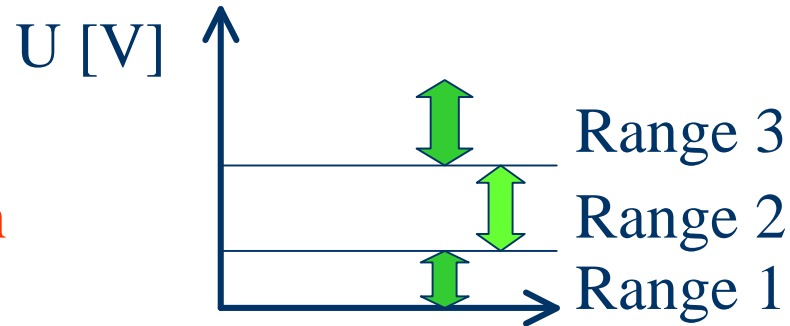
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# Receiver with three ranges



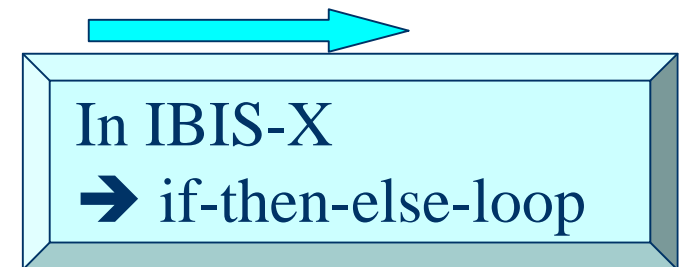
VinH	2.0V	Vcc+0.3
VinL	-0.3V	0.8V



Vin-range3	2.2V	Vcc + 0.3V
Vin-range2	1.0V	2.0V
Vin-range1	-0.3V	0.8V

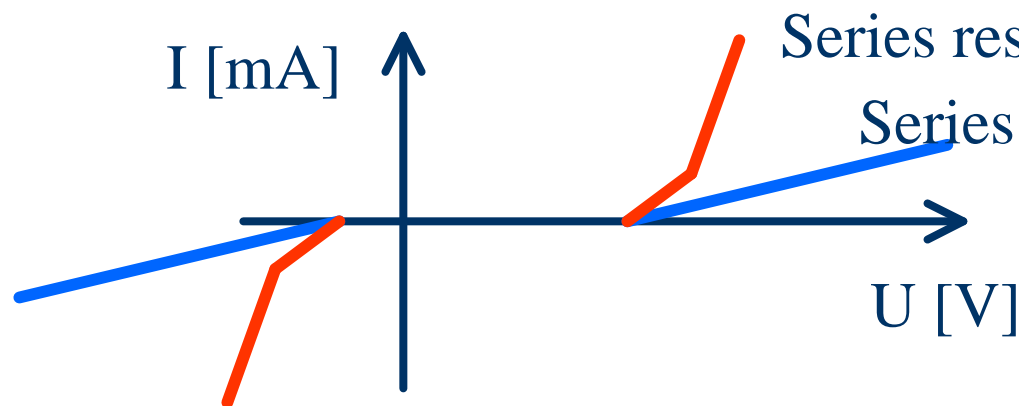
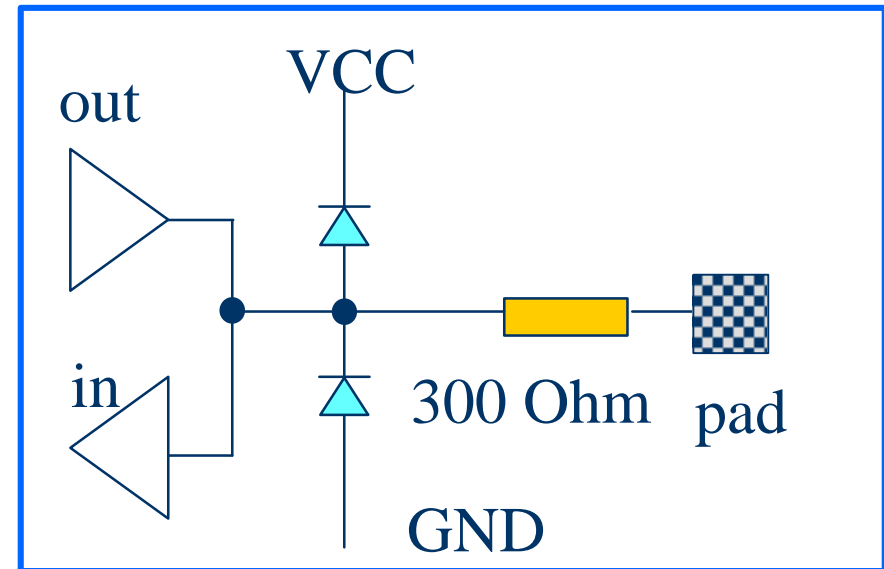
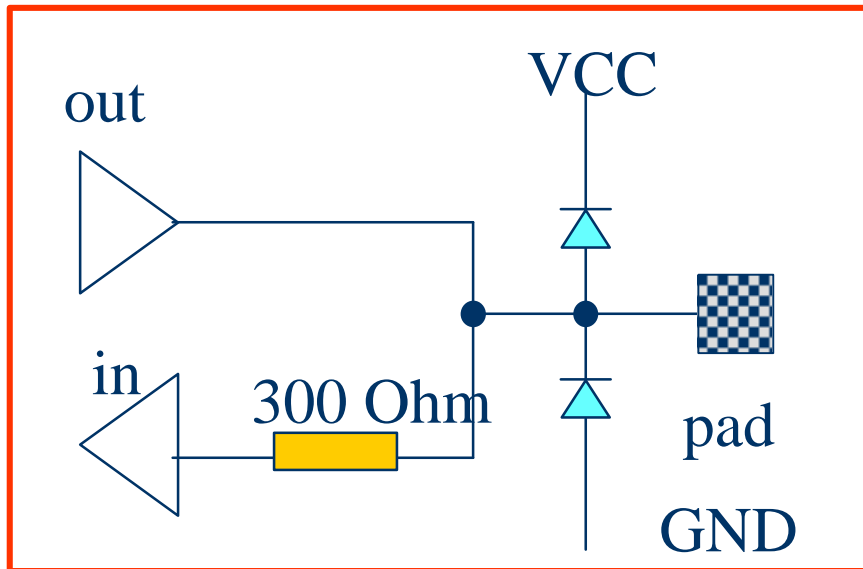
What to do ?

A	VinL-12	-0.3V	0.8V
	VinH-12	1.0V	2.0V
B	VinL-13	-0.3V	0.8V
	VinH-13	2.2V	Vcc + 0.3V
C	VinL-23	1.0V	2.0V
	VinH-23	2.2V	Vcc + 0.3V





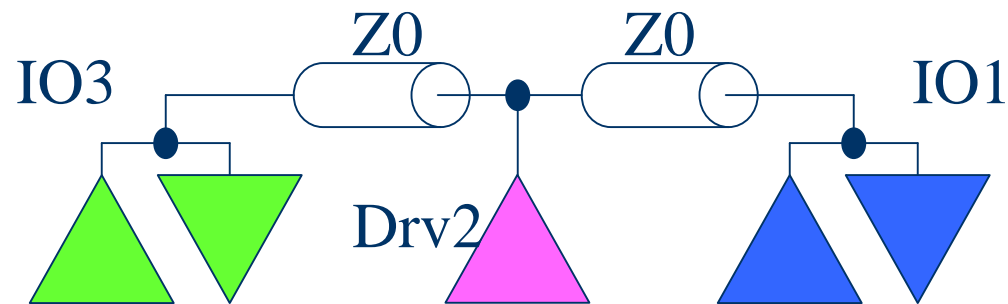
# Input with series resistor



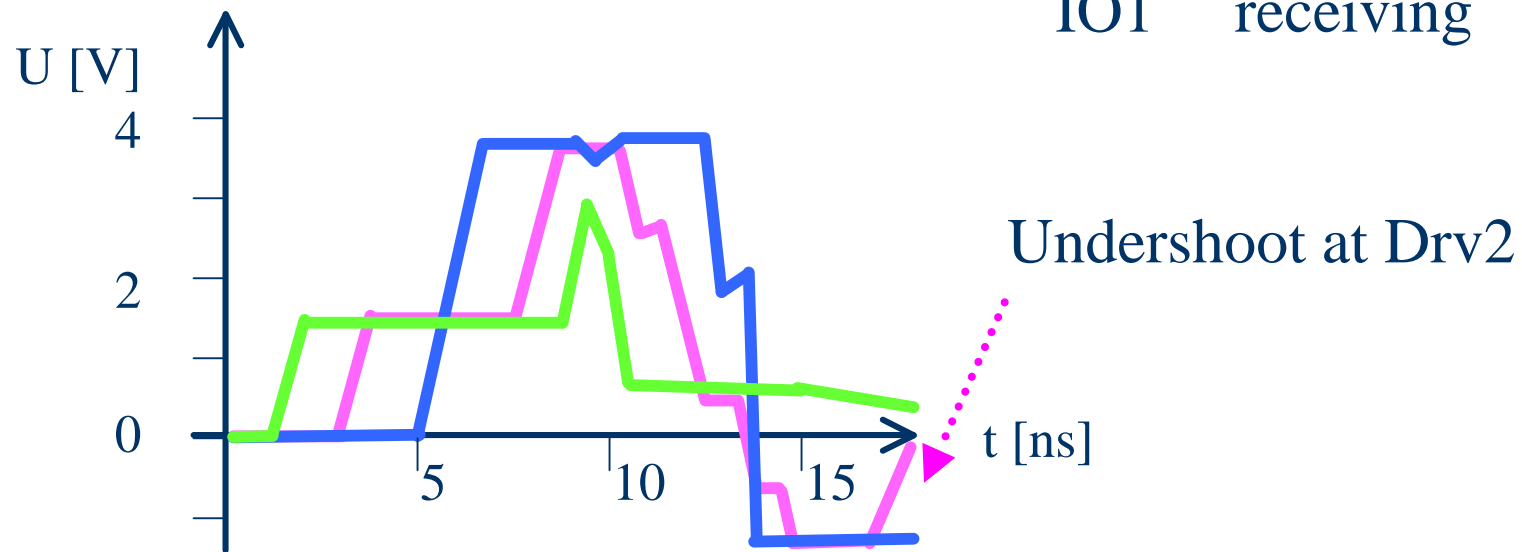
Put in package-model !?!  
Resistor needed at all ?



# Over-undershoot for driver



IO3 driving  
Drv2 3-state  
IO1 receiving



Over-Undershoot parameter needed also for drivers



# What is an accurate model ?

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their parameters and  
their accuracy

Introduction

Parameters taken  
from Datasheet

Proposals and  
questions

Model accuracy

1GHz Models

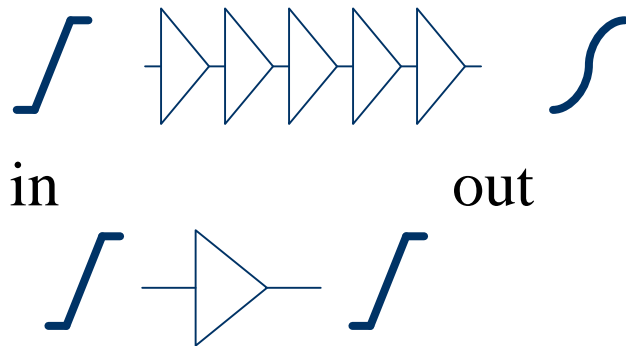
conclusions



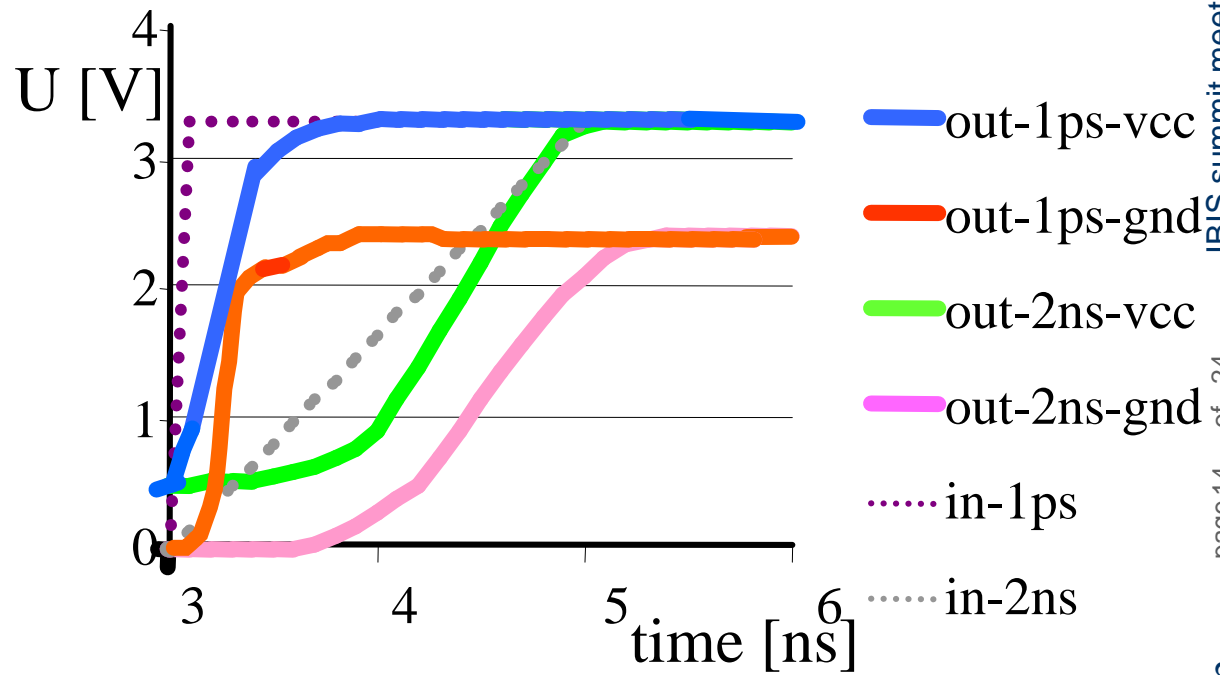
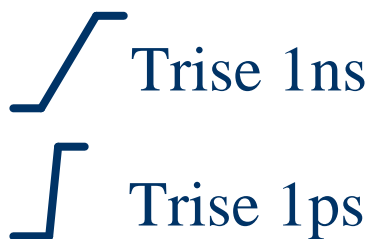
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# Stimulus form, number of stages

number of stages



Stimuli form



Use 5 or more stages and a stimulus of 1ps



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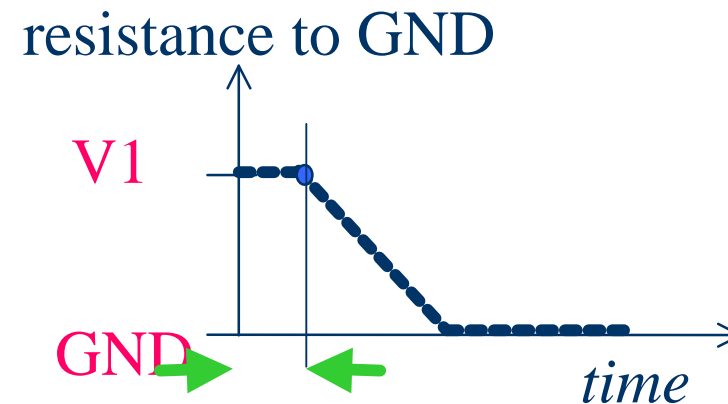
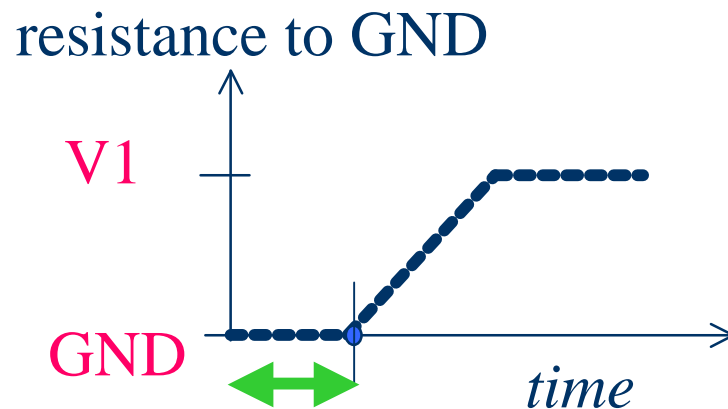
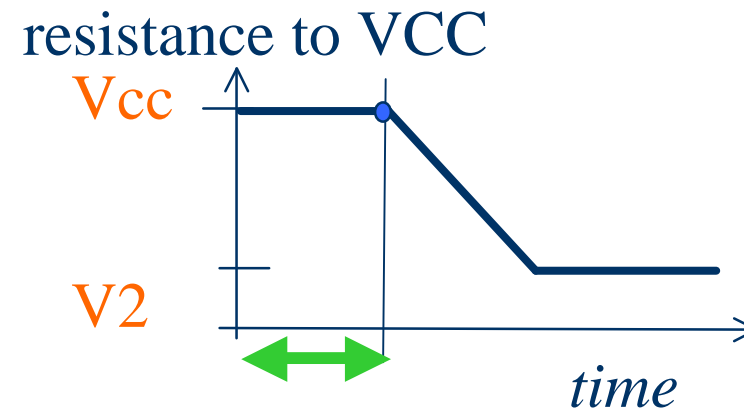
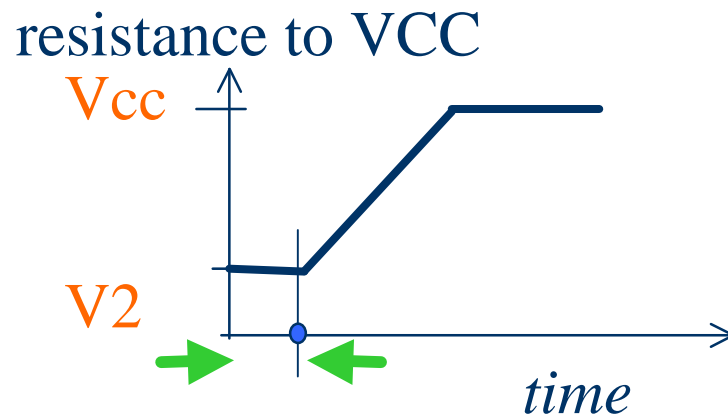
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# Starting points of waveform



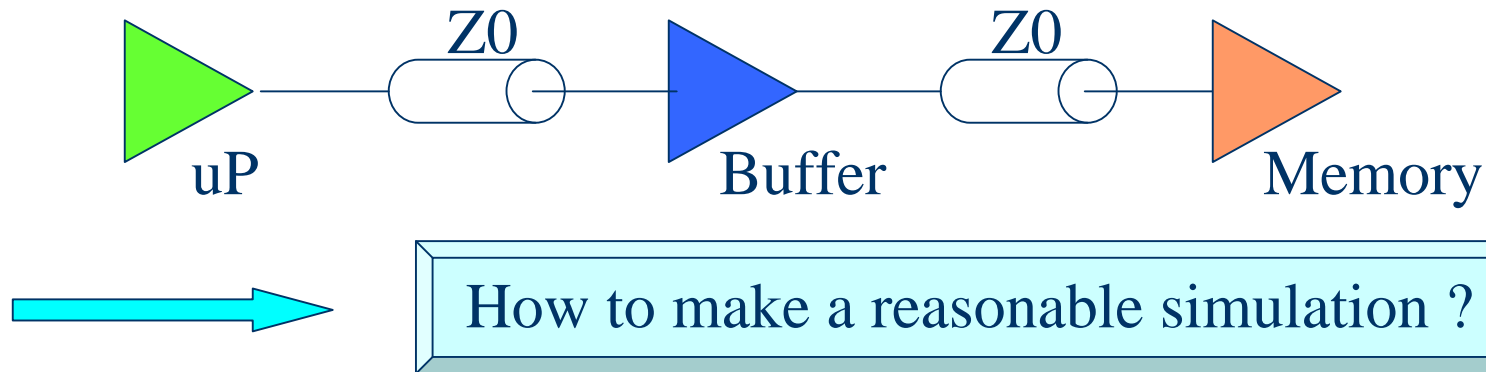
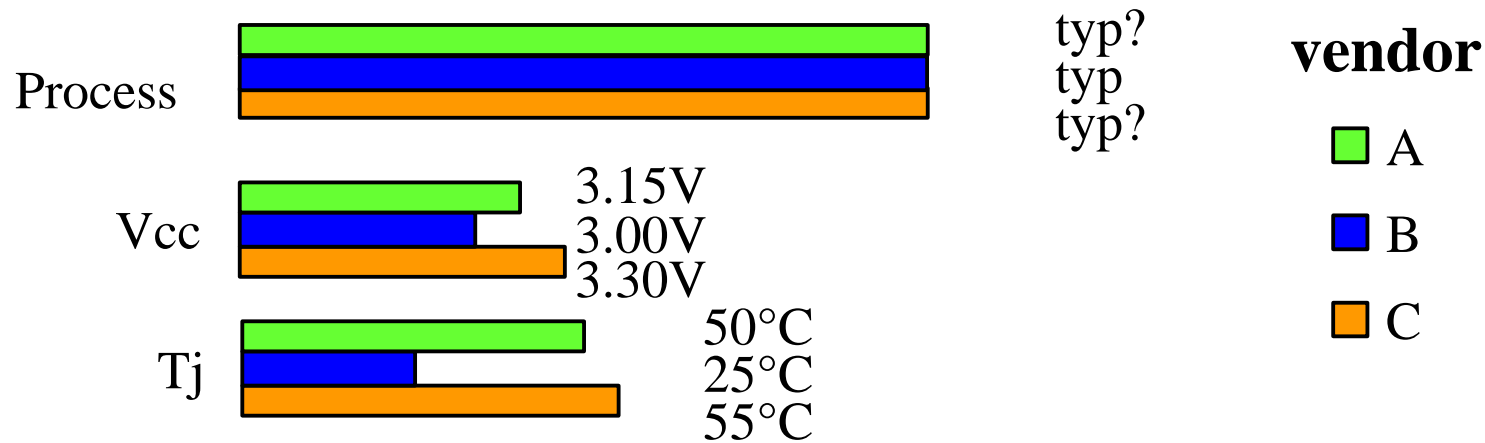
“Lead-in-time“ (described in ibis-4); how much is allowed ?



# Conditions for min-typ-max models

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Example : typical model parameters from 3 vendors





# Timestep for waveforms

[Ramp]  
 $dV/dt_r$        $1.14V/0.30ns$   
 $R_{load} = 50.00$

[Rising Waveform]  
 $R_{fixture} = 50.00$   
 $V_{fixture} = 0.000$

....  
0.40nS      1.58mV  
0.60nS      -5.84mV  
0.80nS      0.0834V  
1.00nS      0.76V  
1.20nS      1.51V  
1.40nS      1.76V  
....

different timestep for simulation and printing

smaller value of  $dt_r$  or  $dt_f$

Timestep for printing should be

$\frac{dt_r}{10}$

( = 30ps )



# 1 GHz Models

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IBIS-models today,  
their parameters and  
their accuracy

Introduction

Parameters taken  
from Datasheet

Proposals and  
questions

Model accuracy

1GHz Models

conclusions



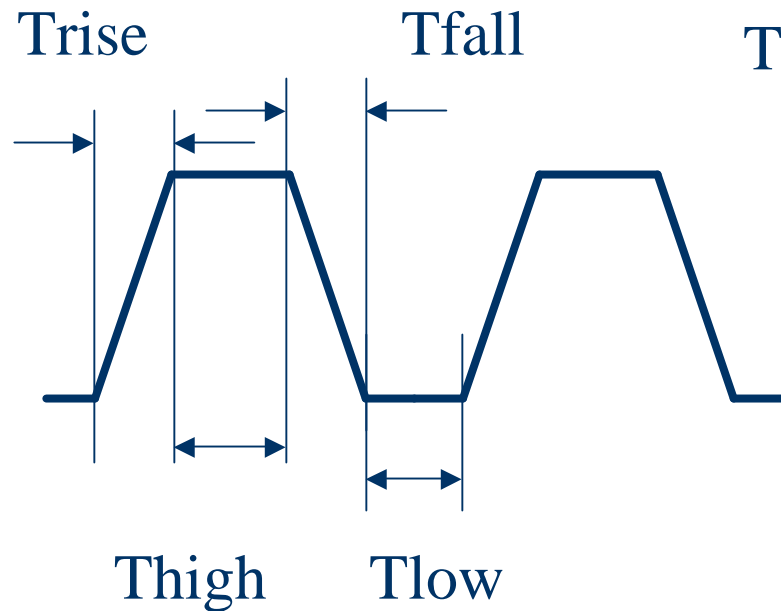
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# Definition



$$Trise = Tfall = Thigh = Tlow = Tperiod/4$$

$$f = 1 / Tperiod = 1 \text{ GHz}$$

$$Trise = 250\text{ps}$$

We have to separate in

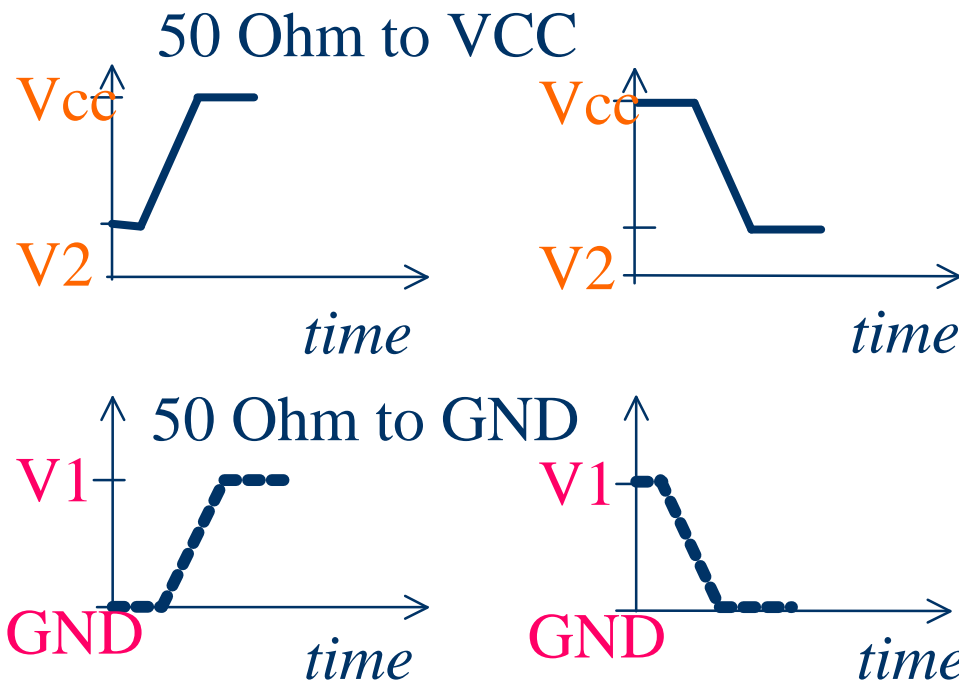
- IO-Model

- Package model



# IO-model

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V-t-waveforms :

Look the same for  
1ns or 100ps

Models with rise-falltime of 250ps like LVDS, PECL and even CMOS show good results , but without package model

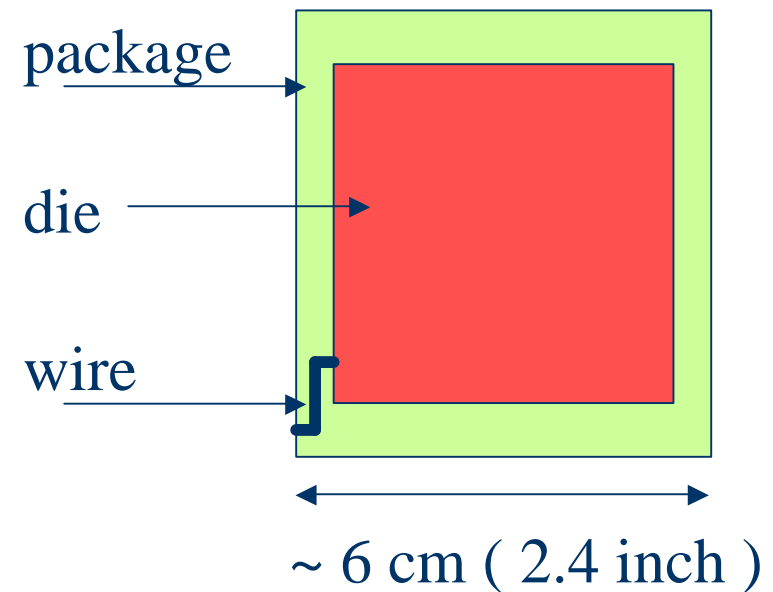
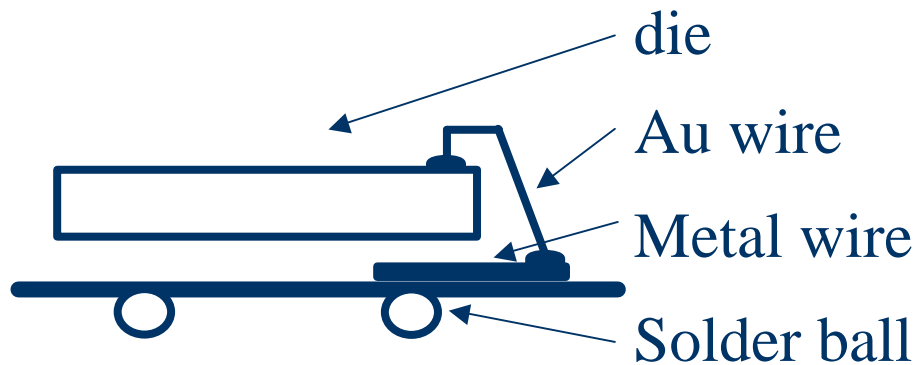




# Package model -1

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## Schematic of BGA-Package



EPBGA with 1600 pins  
wire length up to 2.5 cm ( 1 inch )



## Package model -2

Correlation between package parameters and risetime

Crit. Line delay =  $T_r / 5$

Risetime Crit. Line length

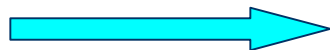
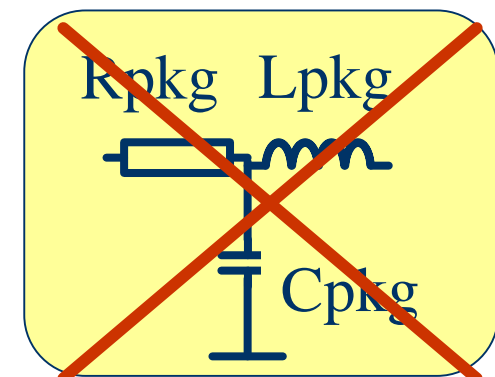
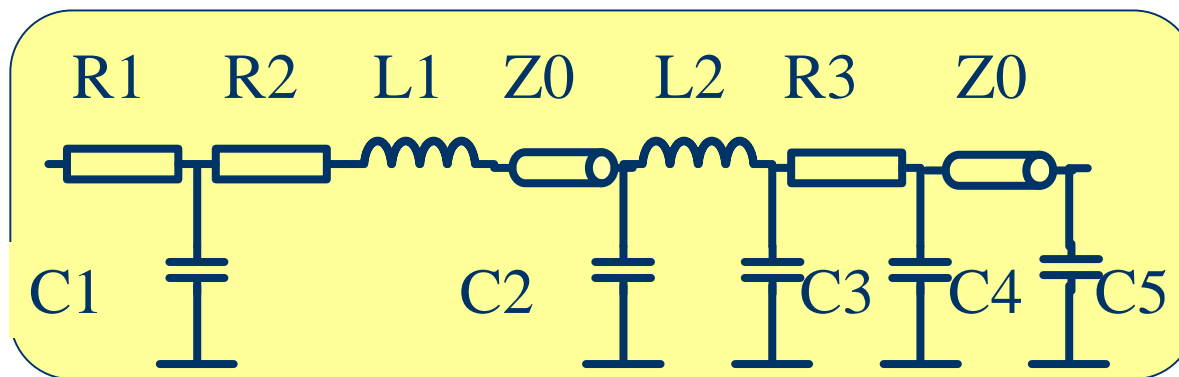
Prop. Delay 5ns/m ( 1.52 ns/feet )

1 ns

4 cm ( 1.57 inch )

250 ps

1 cm ( 0.39 inch )



Packages used with model rise-falltimes < 250ps  
must be modeled as ( coupled ) transmission lines



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# Conclusions

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IBIS-models today,  
their parameters and  
their accuracy

conclusions

1GHz Models

Model accuracy

Proposals and  
questions

Parameters taken  
from Datasheet

Introduction



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IBIS-models today, their parameters and their accuracy.



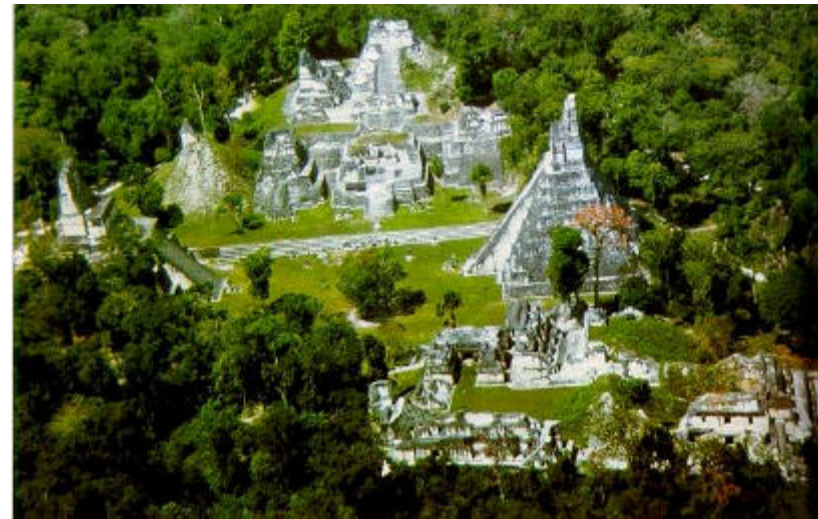
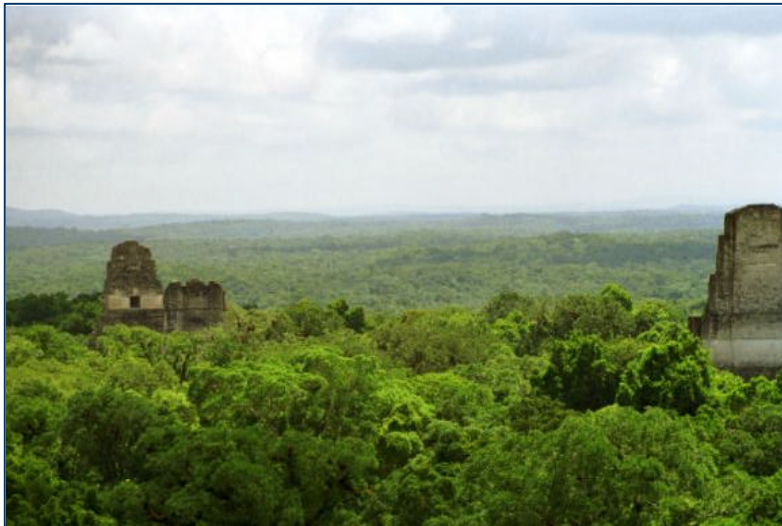
# Summary

- many missing parameters can be taken out of the datasheet
- IBIS-X and/or IBIS-4 could help
- clarify the conditions how to create a model
- IBIS models work well up to 1GHz



# It's getting clearer

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