Hardware Modeling [VU] (191.011)
– WS25 –
VHDL Delay Mechanisms

Florian Huemer & Sebastian Wiedemann & Dylan Baumann

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Introduction

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Delay Mech.
Delay Types
Pure
Inertial
Comparison
VHDL

- Previously: `after` for delaying the assignments of signals
    - Why is this needed? ⇒ Delays exist in real hardware
- Two types of delay
    - *Pure* delay: finite signal propagation speed
    - *Inertial* delay: (dis)charging of capacitance
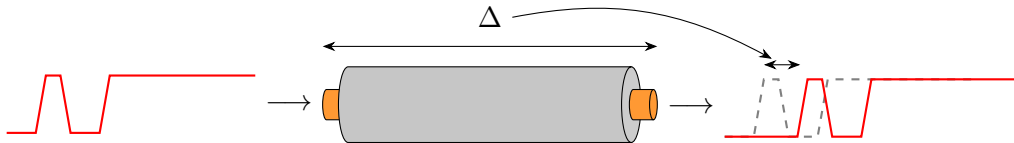
1

Pure Delay

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Delay Types
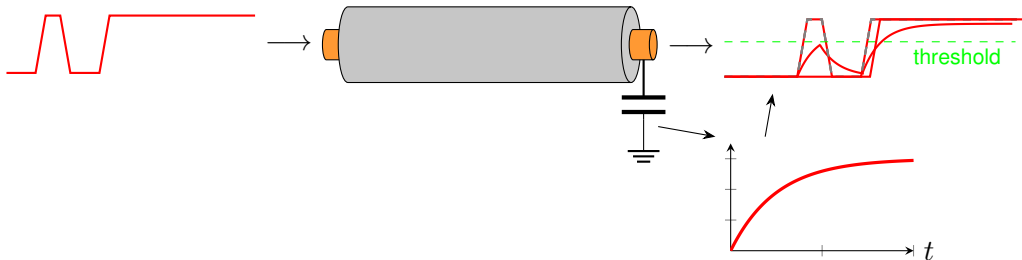Pure
Inertial
Comparison
VHDL

Inertial Delay

threshold

Pure vs. Inertial Delay

- Pure delay
  - Output wave is input wave "shifted backward" in time
  - Arbitrary small pulses are propagated
  - Use where capacitance negligible
- Inertial delay
  - Output wave is input wave "shifted backward" in time plus pulse-width filter
  - Only pulses above a certain width propagate
  - Use where capacitance relevant
- Further, more specialized, models exist

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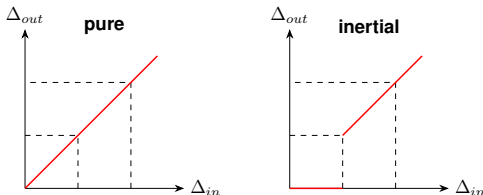
- VHDL contains support for delays
  ```
  target <= [ delay_mechanism ] waveform;
  ```
- Both presented delay models are supported
  - Supports pure delay via `transport`
  - Supports inertial delay via `reject` and `inertial`

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- Keyword `transport` before the `waveform` in an assignment

  `target <= transport waveform`
- Signal assignment is simply delayed by some time
  - Time given by `waveform`'s `after` clause
 - Per default `0 ns`
- Example

i
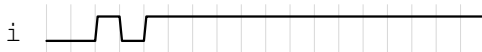
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- Default mechanism, explicit via `inertial` in an assignment

  ```
  target <= [reject time_expression] inertial waveform
  ```
- Signal assignment is delayed and too short pulses are filtered out
  - Minimum pulse width optionally defined by reject clause
  - Per default time expression associated with first element of `waveform`
- Example
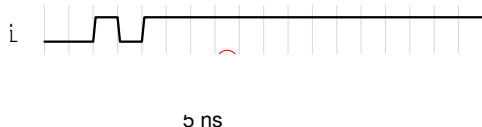
5 ns

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Remarks

- Default is inertial delay!
- Pulse rejection time positive and smaller or equal the `after` time
- All equivalent

```
o <= i after 1 ns;
o <= inertial i after 1 ns;
o <= reject 1 ns inertial i after 1 ns;
```

- *Any* pulse shorter than the limit is rejected
- Pure delay: can convert to equivalent `inertial` delay

```
o <= transport i after 10 ns;
o <= reject 0 ns inertial i after 10 ns;
```

Lecture Complete!