Hardware Characterization

Required measurements

http://ra.ziti.uni-heidelberg.de/pages/student_work/seminar/ws0304/richard_sohnius/praesentation.pdf

Transition times. Characterized and measured between 30 % and 70 %. Standardized reporting between 10 % and 90 %.

- area
- power
- timing contstraints (setup/Hold time, recovery/removal time)
- propagation delay time
- input capacitance

Power:

- Dynamic power (switching power)
- Static power (leakage power)
- Passive power (internal power. power used by sequential cells when inputs change without output change)

Delay:

https://www.csee.umbc.edu/~cpatel2/links/641/slides/lect05_LIB.pdf

- sum of intrinsic delay, slope delay, transition delay and connect delay
- intrinsic delay is fixed value independent of surroundings
- slope delay is produced by the slew of the input signal
- transition delay is the time required to change the capacitance of the next stage input pins
- connect delay is delay caused by the wire between output and next input pins

Delay model of Liberate (.lib) is the CMOS Non-Linear Delay Model.

- Delay and transition time are modeled as function of Input slew and Output load
- Data is stored in a 2D LUT (look-up table)
- Intermediate values are interpolated
- Data points are usually not equidistant

solutions

feedback loop with a counter?

Solutions

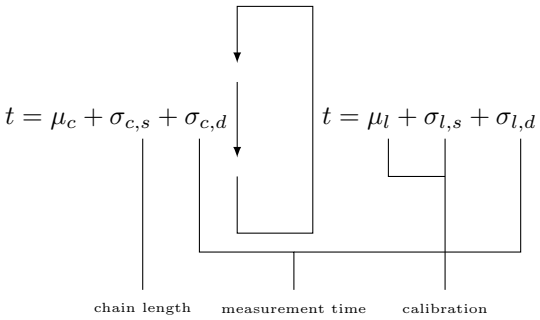

Figure 1: math

$$\sigma_{tot} = \sqrt{\frac{\sigma_{c,s}^2}{\text{components}} + \frac{\sigma_{c,d}^2 + \sigma_{l,d}^2}{\text{counts}}} \tag{1}$$

$$LSB = \frac{t_{period}^2}{t_{measurement}} \tag{2}$$

Testbenches

Numerically Controlled Oscillator

Control when the accumulator flows over. Needs a very fast counter. Overflow amount gets carried over to next cycle.

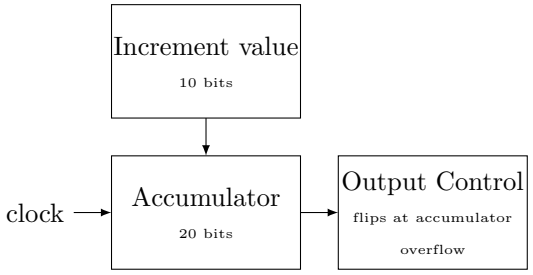

Figure 2: NCO

Time to Digital Converter (TDC)

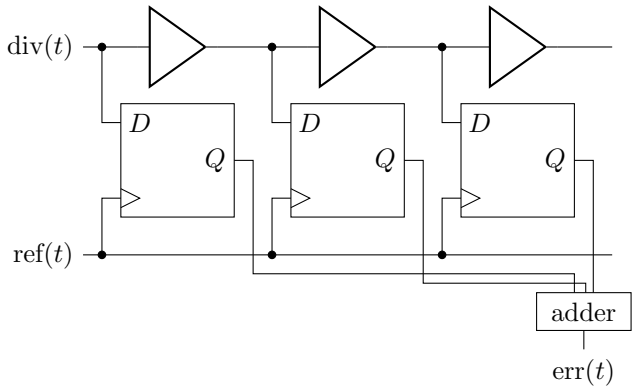

Figure 3: TDC

Phase Detector

The phase detector produces a 1 between the time the reference signal switches to a one, and the divider switches to a one.

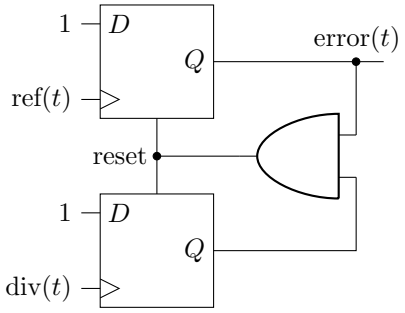

Figure 4: Phase detector

Digitally controlled oscillator

Uses digitally controlled switches to change the output load

Grey Counter

8-bit grey counter designed with Alex

Digital Divider

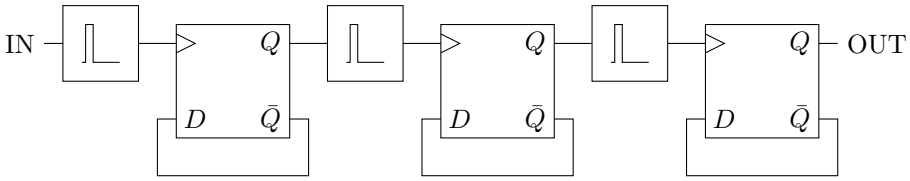

Figure 5: Digital divider

4-bit Multiplexer and Demultiplexer

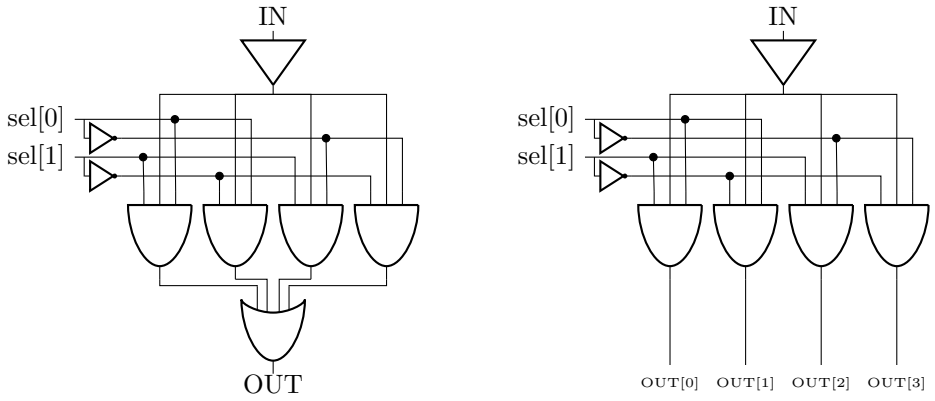

Figure 6: MUX

Changable Ring Oscillator

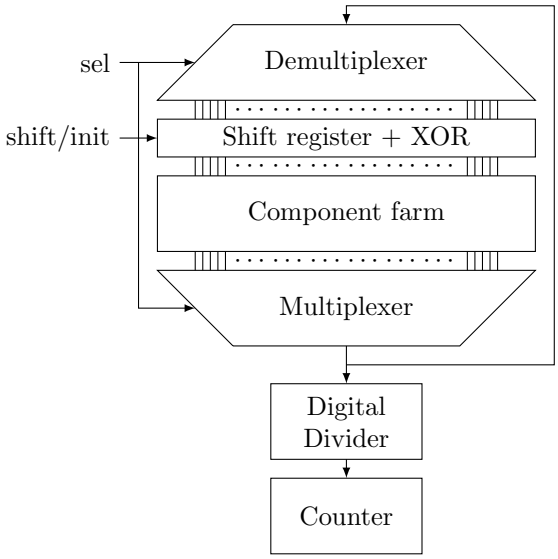

Figure 7: Changable Ring Oscillator

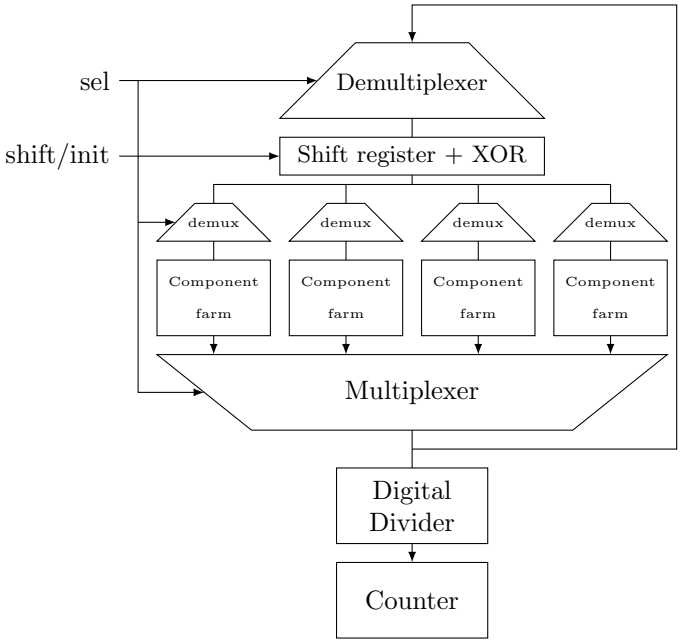

Figure 8: Changable Ring Oscillator 2

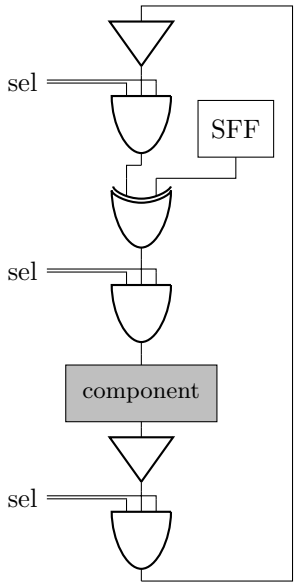

Figure 9: critical path of dynamic ring oscillator