High Speed Cells Characterization. Methods of the time delay measurement

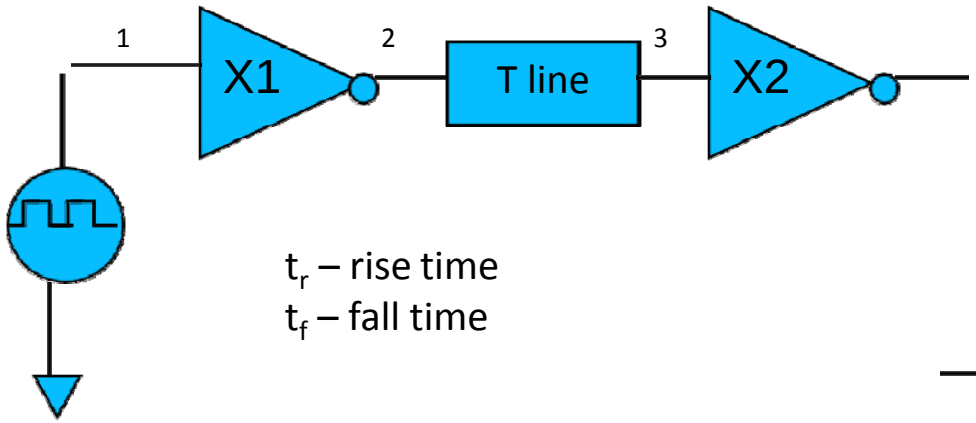
Author: Shatalov Sergey
Supervisor : (Shishina L.U)

OUTLINE

In this article following methods will be presented:

- The ring oscillator path delay measurement method
- Phase detection module.
- Built in self test method.

PATH DELAY



t_r – rise time
t_f – fall time

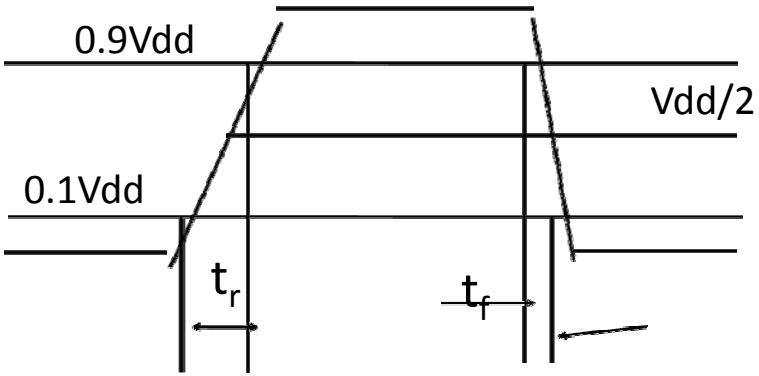
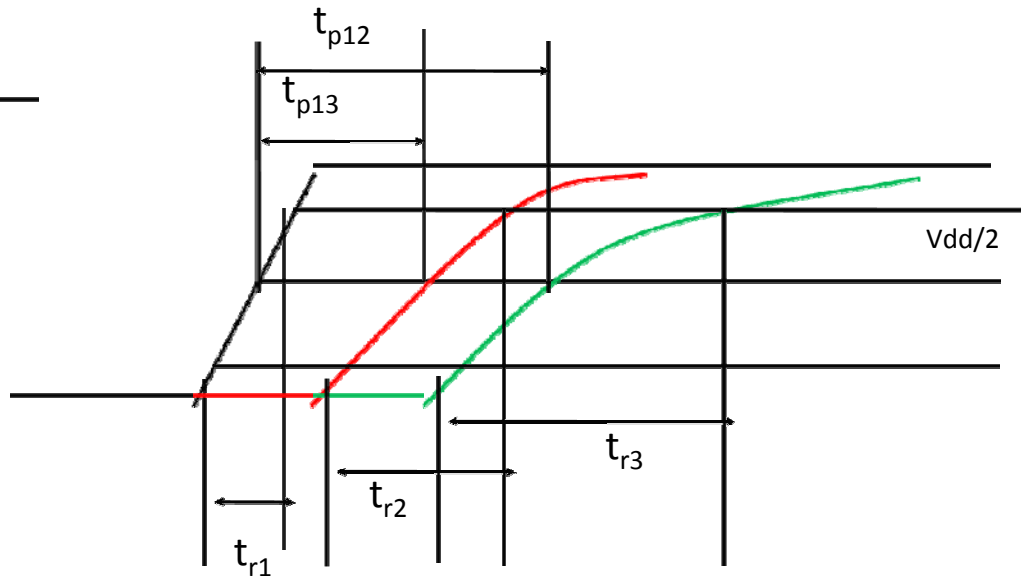


Figure 1

Equivalent circuit of an interconnect with two logic modules in a path.



$t_{r1/r2/r3}$ – rise transition time at net 1/2/3
t_{p12} – propagation time between net1 and net 2
t_{p13} – propagation time between net1 and net 3 (path delay)

Figure 2

Rise edge waveform example which corresponds to Figure 1 circuit

THE RING OSCILLATOR PATH DELAY MEASUREMENT METHOD

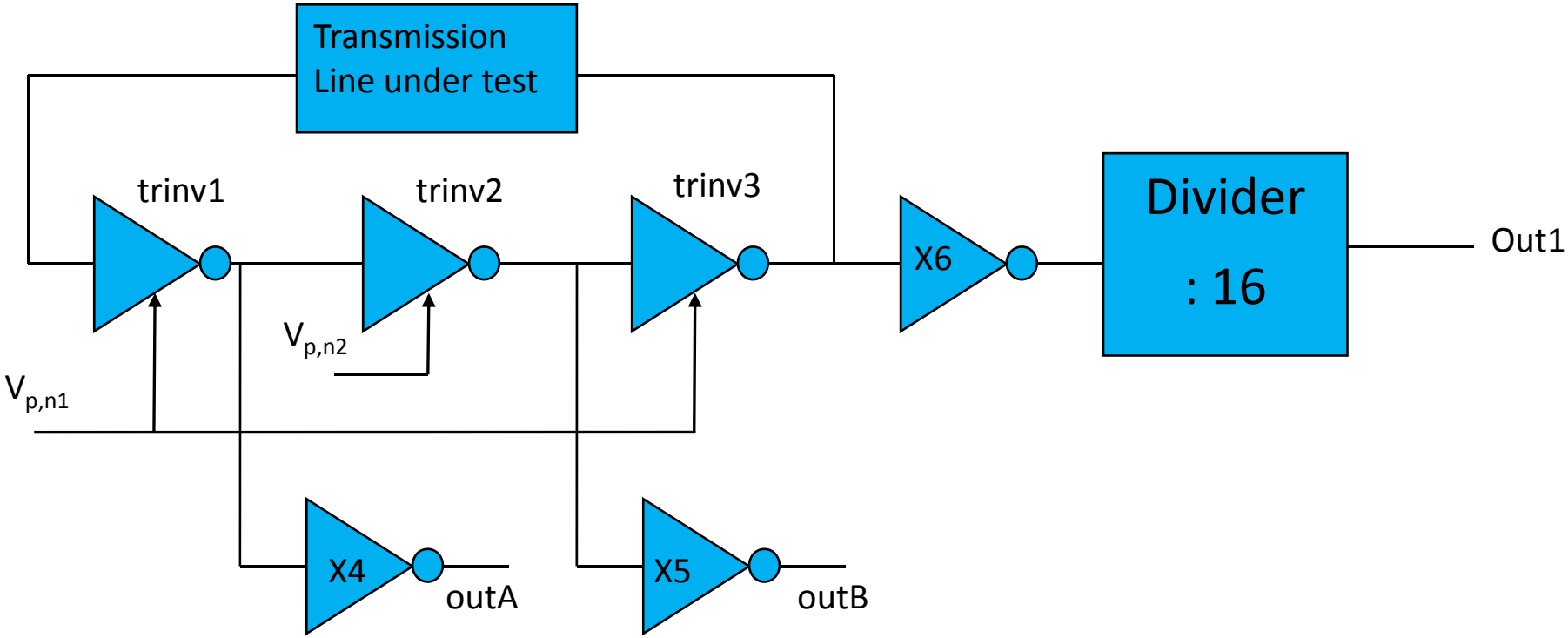
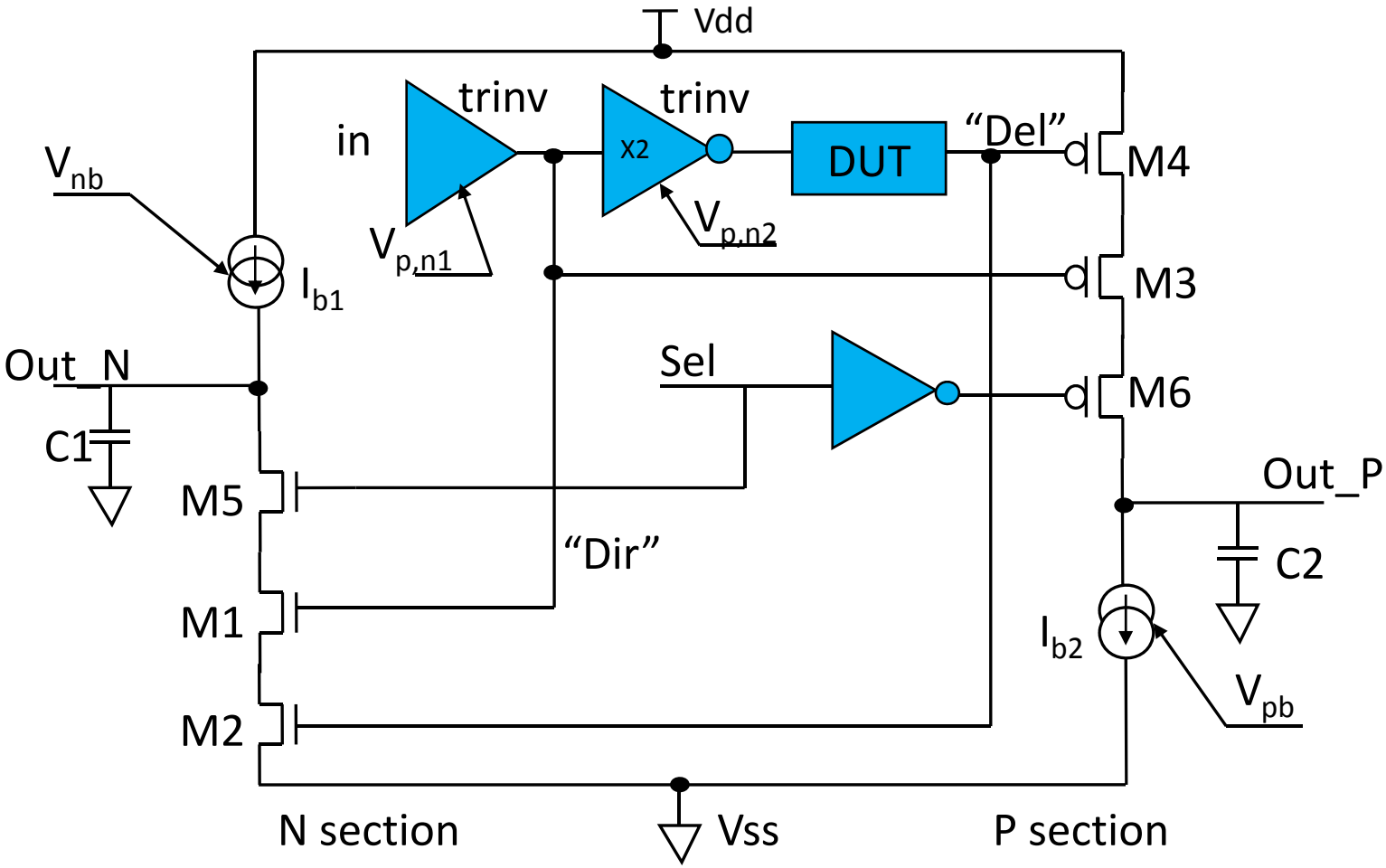


Figure 3 – Ring oscillator based path delay measurement structure

The signal period measured for the reference oscillator is :

$$T_1 = 2(t_{pr}+t_{pf})_{trinv1} + (t_{pr}+t_{pf})_{trinv2}\,, \qquad \{1\}$$

PHASE DETECTION MODULE



DUT – device under test (transmission line or cell)

Figure 4 – The phase detection module "phdet"

Source: http://ieeexplore.ieee.org Time delay measurement methods for integrated transmission lines

BUILT-IN SELF-TEST METHOD

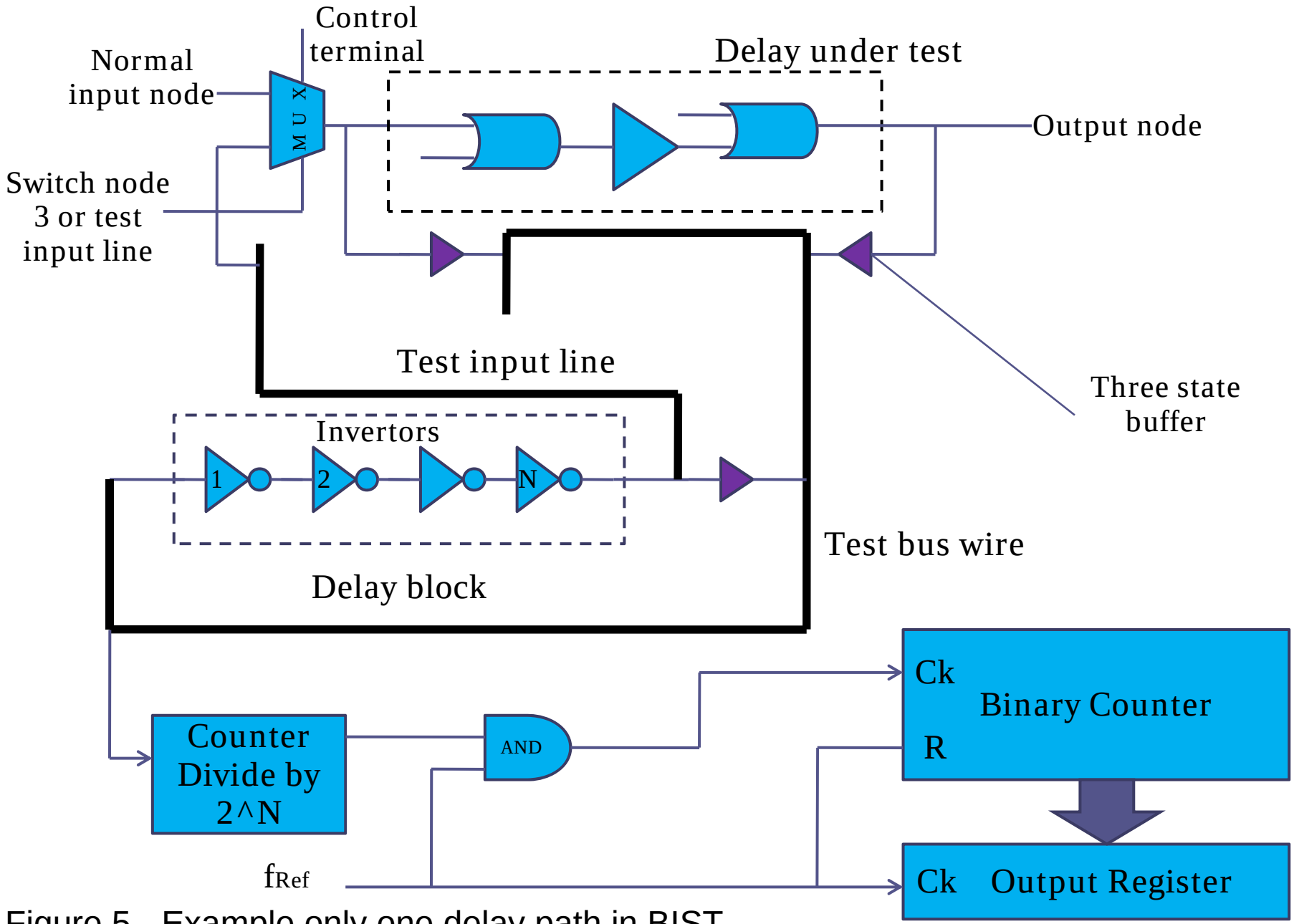
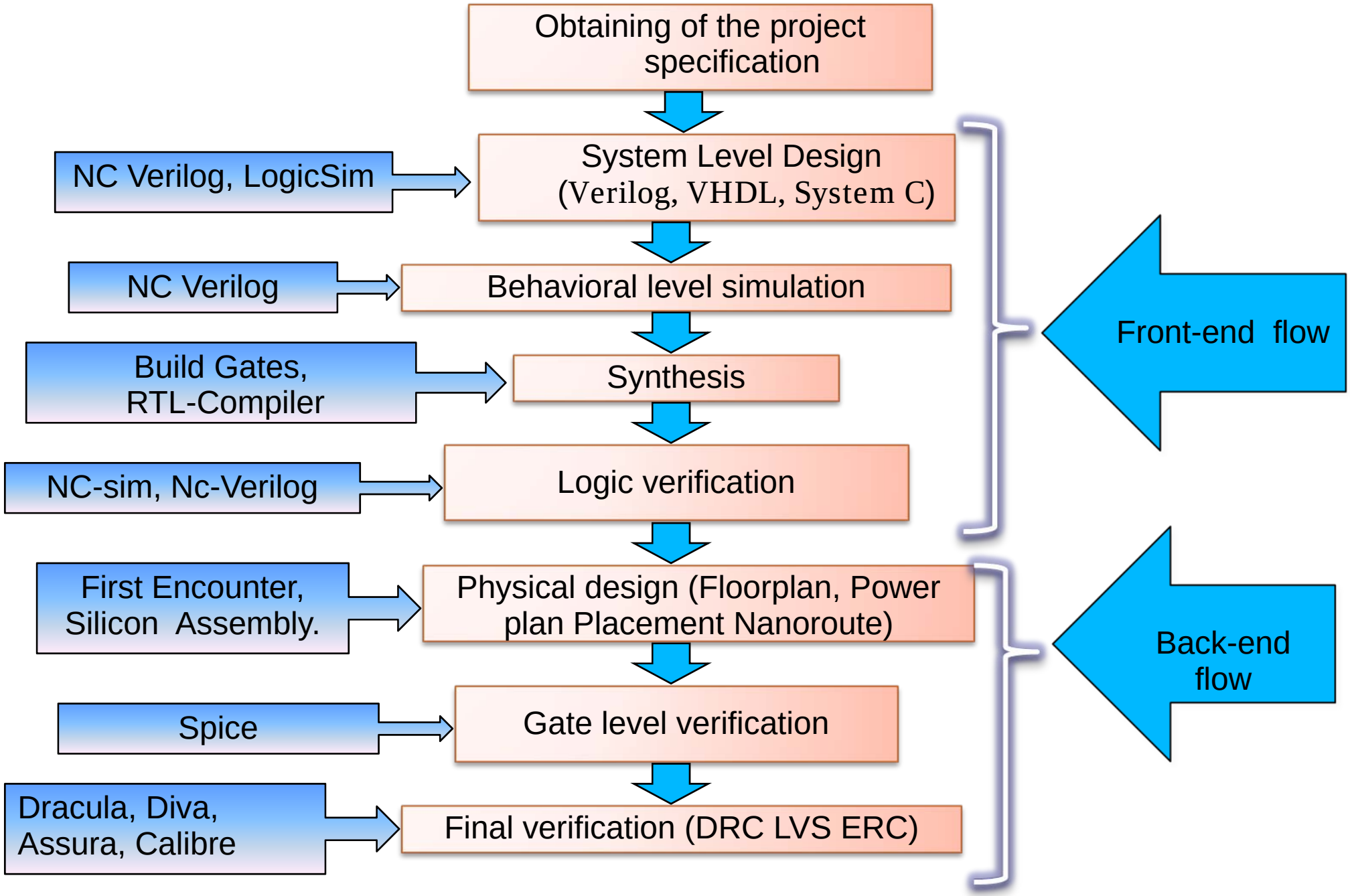


Figure 5 - Example only one delay path in BIST

Source: http://www.freepatentsonline.com/5923676.html - Bist architecture for measurement of integrated circuit delays

VLSI PROCESS DESIGN FLOW



CONCLUSION

- The review of methods has been spent.
- All of these methods are successfully applied in practice for characterization cells on the test chip (in silicon).
- The problem of necessity automation of process designing of the ring oscillators has been found.
- This problem is solving now .

REFERENCES
[1] http://www.freepatentsonline.com/5923676.html - Bist architecture for measurement of integrated circuit delays
[2] http://ieeexplore.ieee.org/xpls/abs_all.jsp?tp=&arnumber=608710&isnumber=13317 - Time delay measurement methods for integrated transmission lines
[3] http://www.simucad.com/simulationstandard/1997/mar/a2/a2.html Measuring Ring Oscillator Time Delay for CMOS, SOI and TFT Technologies
[4] www.keithley.com.cn/data?asset=51070 Ring Oscillator Frequency Measurements Using an Automated Parametric Test System

Thank you for your attention.