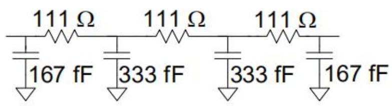
5.2 Dynamic power consumption will go down because it is quadratically dependent on V_{DD}. Static power will go up because subthreshold leakage is exponentially dependent on V_t.

5.4 The signal makes4 transitions in 10 cycles, so the activity factor is (1/2)(4/10) = 0.2.

5.10 For a 2% delay increase, the supply should droop by less than about 2% of VDD (e.g. 20 mV @ 1.0 V). Thus the effective resistance must be R = 20 mV / 100 mA = 0.2 Ω. This requires a width of W = 2.5 kΩ * μm / 0.2 Ω = 12.5 mm.

6.2 The wire width is 1.2 μm so the wire is 5000 μm/1.2 μm = 4167 squares in length. The total resistance is (0.08 Ω/sq)•(4167 sq) = 333 Ω. The total capacitance is (0.2 fF/μm)•(5000 μm) = 1 pF.



6.8

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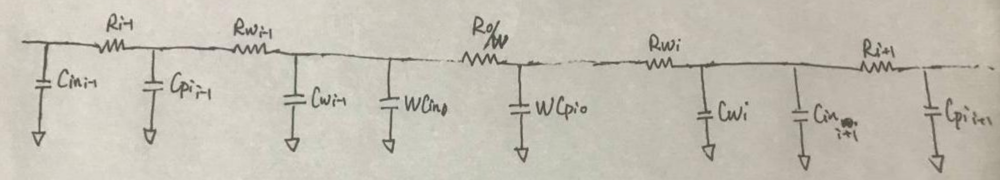
6.8. 令中间一级的尺寸为 W，有 $R_i = \cancel{W}R_0/W$ $C_i = \cancel{W} W C_{in0} + W C_{pi0}$



$$t_{pd} = R_{i-1}\cdot C_{pi\,i-1} + (R_{i-1}+R_{wi-1})C_{wi-1} + (R_{i-1}+R_{wi-1})\cdot W C_{in0} + (R_{i-1}+R_{wi-1}+\frac{R_0}{W}) W C_{pi0}$$
$$+ (R_{i-1}+R_{wi-1}+\frac{R_0}{W}+\cancel{R_w} R_{wi}) C_{wi} + (\cdots + \frac{R_0}{W}+\cdots) C_{in\,i+1} + (\cdots + \frac{R_0}{W}+\cdots) C_{pi\,i+1}$$

$$\frac{\partial t_{pd}}{\partial W} = (R_{i-1}+R_{wi-1}) C_{in0} + (R_{i-1}+R_{wi-1}) C_{pi0} - \frac{R_0 C_{wi}}{W^2} - \frac{R_0 C_{in\,i+1}}{W^2} - \frac{R_0 C_{pi\,i+1}}{W^2} = 0$$

$$\therefore (R_{i-1}+R_{wi+1})(C_{in0}+C_{pi0})\cdot W = \frac{R_0}{W}\cdot(C_{wi}+C_{in\,i+1}+C_{pi\,i+1})$$

$$\therefore (R_{i-1}+R_{wi+1}) C_i = \cancel{R_{i+1}C_f}\ R_i(C_{wi}+C_{i+1})$$

6.5

由(6.26)式:

$$t_{pd} = \frac{R}{W}\left[C_w l + NCW(1+P_{inv})\right] + R_w l\left(\frac{C_w}{2}\frac{L}{N} + CW\right) \quad ①$$

$$\frac{\partial t_{pd}}{\partial N} = CR(1+P_{inv}) - \frac{R_w C_w L^2}{2N^2}$$

令 $\frac{\partial t_{pd}}{\partial N} = 0 \Rightarrow \frac{L}{N} = \sqrt{\frac{2RC(1+P_{inv})}{R_w C_w}}$ (6.27)

代入 $P_{inv} = 0.5$, $\frac{L}{N} = \sqrt{\frac{3RC}{R_w C_w}} = 0.77\sqrt{\frac{5RC}{R_w C_w}}$
$= 0.77\sqrt{\frac{FO_4}{R_w C_w}}$ (6.28)

由①式:

$$t_{pd} = \frac{RC_w l}{W} + RNC(1+P_{inv}) + \frac{R_w C_w l^2}{2N} + R_w CWl$$

$$\frac{\partial t_{pd}}{\partial W} = -\frac{RC_w l}{W^2} + R_w C l$$

令 $\frac{\partial t_{pd}}{\partial W} = 0 \Rightarrow R_w C l = \frac{RC_w l}{W^2} \Rightarrow W = \sqrt{\frac{RC_w}{R_w C}}$ (6.30)

由①式:

$$\frac{t_{pd}}{l} = \frac{R}{W}\left[C_w + \frac{N}{l}CW(1+P_{inv})\right] + R_w\left(\frac{C_w l}{2N} + CW\right)$$

将(6.27)和(6.30)代入上式: $\frac{t_{pd}}{l} = \left(2+\sqrt{2(1+P_{inv})}\right)\sqrt{RCR_wC_w}$

代入 $P_{inv}=0.5$, $\frac{t_{pd}}{l} = \frac{2+\sqrt{3}}{\sqrt{5}}\sqrt{5RCR_wC_w} = 1.67\sqrt{FO_4 R_w C_w}$
(6.29)

$C = C_w \cdot l + NCW(1+P_{inv})$ ⇐ 总电容

$E = C V_{DD}^2$

$\therefore \frac{E}{l} = \left[C_w + \frac{NCW}{l}(1+P_{inv})\right]V_{DD}^2$

代入(6.27)和(6.30)式,有

$$\frac{E}{l} = \left[C_w + \frac{NCW(1+P_{inv})}{l}\right]V_{DD}^2 = C_w\left(1+\sqrt{\frac{1+P_{inv}}{2}}\right)V_{DD}^2 \overset{P_{inv}=0.5}{\approx} 1.87 C_w V_{DD}^2$$

(6.31)