Digitron Dynamic Design

① $T_{delay} = CV/I$ $\quad I = \frac{CV}{T_{delay}} = \frac{(10^{-12})(3.3)}{1.5 \times 10^{-9}} = 2.2mA$

$L_n = L_p = 0.5um$

nmos $w = w_n$ $\quad w_n = 2.2 \times 10^{-3} = \frac{k_p}{2} \cdot \frac{W_n}{L_n} (V_{DD} - V_{tn})^2$

pmos $w = w_p$ $\quad 2.2 \times 10^{-3} = \frac{200uA}{2} \cdot \frac{W_n}{0.5um} (3.3 - 0.5)^2$

$W_n = 1.403um$

w_p $2.2 \times 10^{-3} = \frac{k_p}{2} \cdot \frac{w_p}{L_p} (-V_{DD} - V_{tp})$

$2.2 \times 10^{-3} = \frac{80uA}{2} \cdot \frac{w_p}{0.5u} (-3.3 + 0.5)^2$

$w_p = 3.507um$

$L_n = L_p = 0.5um$

② $T_p = 0.5ns$
$C = 0.25pF$

$T_p = 2.4 R_{on} C$

$R_{on} = \frac{L_p}{2.4C} = \frac{0.5 \times 10^{-9}}{2.4(10^{-12} \times 0.25)} = 833.33\Omega$

$K_n = \frac{1}{R_{on}(V_{DD} - V_{to})} = \frac{1}{833.33(3.3 - 0.5)} = 428.6uA/V^2$

$\left(\frac{W}{L}\right)_n = \frac{k_n}{k_n'} = \frac{428.6}{200} = \frac{2143}{1} = \frac{2.14 \times 0.35}{0.35} \approx \frac{0.75um}{0.35um}$

$\left(\frac{W}{L}\right)_p = \frac{k_n}{k_p}\left(\frac{W}{L}\right)_n = \frac{5.357}{1} = \frac{1.875um}{0.35um}$

3 $C = 0.25 pF$, $F_{max} = 400 mHz$

$t_p = \frac{1}{5 F_{max}} = \frac{1}{5(400)} = 0.5 ns$, $R_{on} = \frac{0.5 \times 10^{-9}}{2.4 \times 0.25 \times 10^{-12}} = 833.33 \Omega$

$K_n = \frac{1}{R_{on}(V_{DD} - V_{t0})} = \frac{1}{833.33(3.3 - 0.5)} = 428.6 \mu A / V^2$

$\left(\frac{W}{L}\right)_n = \frac{0.75 um}{0.35 um}$.

$\left(\frac{W}{L}\right)_p = \frac{1.875 um}{0.35 um}$

5 Vin - Redline
Vout 1 - D. Green
Vout 2 - Blue
Vout 3 - Purple
Vout 4 - L. Green
Vout 5 - Yellow