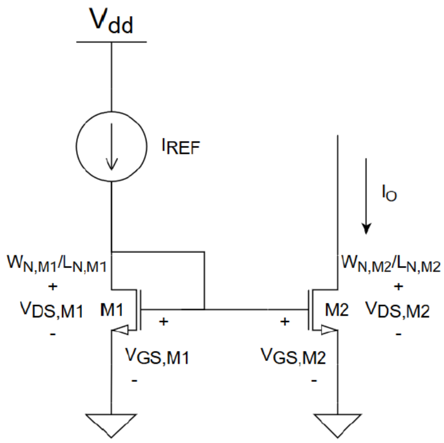
Consider the current mirror shown below.



For any long - channel NMOS,

$$I_{DS} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2(1 + \lambda V_{DS})$$

Solving for V_{GS} in terms of I_{DS},

$$V_{GS} = \left(\frac{I_{DS}}{\frac{1}{2}\mu_n C_{ox}\frac{W}{L}(1 + \lambda V_{DS})}\right)^{\frac{1}{2}} + V_{TH}$$

Notice that $V_{GS,M1} = V_{GS,M2}$. If the transistors have the same mobility μ_n, gate-oxide capacitance C_{ox} and threshold voltage V_{TH},

Since $I_{DS,M1} = I_{REF}$ and $I_{DS,M2} = I_O$,

$$\frac{I_{REF}}{\frac{W_1}{L_1}(1 + \lambda_1 V_{DS,1})} = \frac{I_O}{\frac{W_2}{L_2}(1 + \lambda_2 V_{DS,2})}$$

Finally,

$$I_O = I_{REF} \cdot \frac{\frac{W_2}{L_2}(1 + \lambda_2 V_{DS,2})}{\frac{W_1}{L_1}(1 + \lambda_1 V_{DS,1})}$$

If both transistors are sized in a way that they have the same lengths, then,

$$I_O = I_{REF} \cdot \frac{W_2(1 + \lambda V_{DS,2})}{W_1(1 + \lambda V_{DS,1})}$$

$A_v \geq 25$, $g_{mn} \geq 1mS$.

We can start with $r_{on} = r_{op}$ so that $r_{on} \| r_{op} = \frac{1}{2} r_{on}$.

Thus, $A_v = \frac{1}{2} g_{mn} r_{on}$

Obtaining r_{on}, we get $r_{on} = \frac{2A_v}{g_{mn}} = 50k\Omega = r_{op}$.

Since $r_{on} = 50k\Omega$ and $g_{mn} \geq 1mS$,

$g_{mn} r_{on} \geq 50$, and the minimum $g_{mn} r_{on} = 50$

We know that $A_v = g_{mn}(r_{on} \| r_{op})$

Thus, $\frac{1}{g_{mn} r_{op}} = \frac{1}{A_v} - \frac{1}{g_{mn} r_{on}}$

Solving for r_{op} we get $r_{op} = 65.064k\Omega \approx 65k\Omega$

$k_{multiplier} = \frac{1mS}{8uS} = 125$

$W_N = 62.5um$, $I_{DN} = 101.7uA$