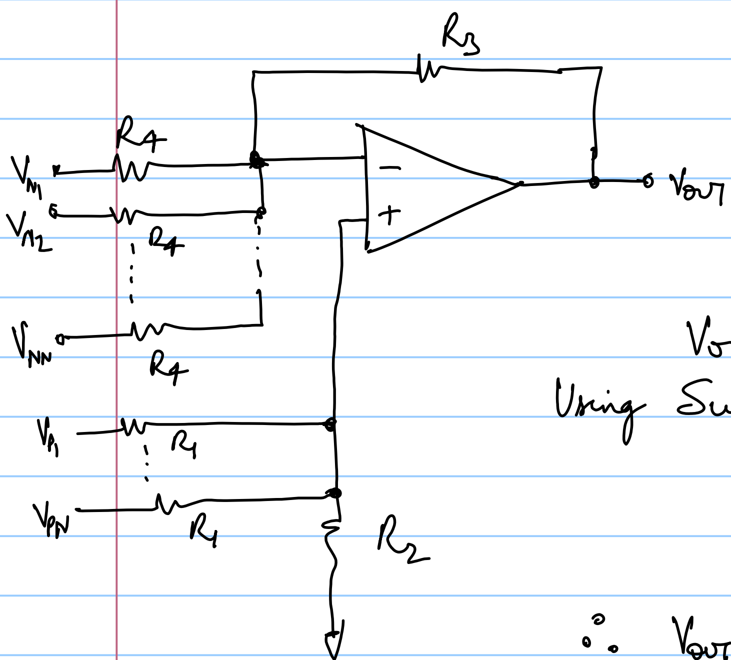
N Input Differential Amplifier

Note Title 12/9/2010



If we want the transfer function:

$$V_{OUT} = K\left(\sum_{i}^{N} V_{P_i} - \sum_{i}^{N} V_{N_i}\right)$$

Using Superposition we have:

$$\frac{V_{N_1}}{R_4} = -\frac{V_{OUT}}{R_3}$$

$$\therefore \; V_{OUT} = -\frac{R_3}{R_4}\sum_{i}^{N} V_{N_i}$$

Setting $\frac{R_3}{R_4}$ gives us the part of the desired expression:

Using Superposition on V_{P_i}'s we have:

$$V_{P_i}\,\frac{R_2 \,\|\, \frac{R_1}{(N-1)}}{R_2 \,\|\, \frac{R_1}{(N-1)} + R_1}\left(\frac{N R_3}{R_4} + 1\right) = V_{OUT}$$

$\therefore$ we need

$$\frac{R_2 \,\|\, \frac{R_1}{(N-1)}}{R_2 \,\|\, \frac{R_1}{(N-1)} + R_1}\left(N K + 1\right) = K$$

$$\Rightarrow \frac{\frac{R_1 R_2}{N-1}\cancel{\left(\frac{R_1}{N-1} + R_2\right)}}{\cancel{\left(\frac{R_1}{N-1} + R_2\right)}\left(\frac{R_1 R_2}{N-1} + R_1\left(\frac{R_1}{N-1} + R_2\right)\right)}(NK+1) = K$$

$$\Rightarrow \frac{R_1 R_2}{R_1 R_2 + R_1^2 + R_1 R_2 (N-1)}(NK+1) = K$$

$$\Rightarrow \quad R_1 \cancel{R_2 NK} + R_1 R_2 = \cancel{R_1 R_2 K} + R_1^2 K + \cancel{R_1 R_2 NK} \cancel{- R_1 R_2 K}$$

$$R_2 = R_1 K$$

or $$\boxed{\frac{R_2}{R_1} = K}$$