Design Steps

$$V_{out} = V_{dd} \times \frac{R_1}{R_{NTC} + R_1} \times \frac{(R_2||R_3) + R_4}{(R_2||R_3)} - \left(\frac{R_4}{R_3} \times V_{dd}\right)$$

1. Calculate the value of R_1 to produce a linear output voltage. Use the minimum and maximum values of the NTC to obtain a range of values for R_1.

$$R_{NTCMax} = R_{NTC\ @\ 25C} = 2.252\ \ k\Omega, \quad R_{NTCMin} = R_{NTC\ @\ 50C} = 819.7\ \ \Omega$$

$$R_1 = \sqrt{R_{NTC\ @\ 25C} \times R_{NTC\ @\ 50C}} = \sqrt{2.252\ \ k\Omega \times 819.7\ \ \Omega} = 1.359\ \ k\Omega \approx 1.37\ \ k\Omega$$

2. Calculate the input voltage range.

$$V_{inMin} = V_{dd} \times \frac{R_1}{R_{NTCMax} + R_1} = 3.3\ \ V \times \frac{1.37\ \ k\Omega}{2.252\ \ k\Omega + 1.37\ \ k\Omega} = 1.248\ \ V$$

$$V_{inMax} = V_{dd} \times \frac{R_1}{R_{NTCMin} + R_1} = 3.3\ \ V \times \frac{1.37\ \ k\Omega}{819.7\ \ \Omega + 1.37\ \ k\Omega} = 2.065\ \ V$$

3. Calculate the gain required to produce the maximum output swing.

$$G_{ideal} = \frac{V_{outMax} - V_{outMin}}{V_{inMax} - V_{inMin}} = \frac{3.25\ \ V - 0.05\ \ V}{2.065\ \ V - 1.248\ \ V} = 3.917\frac{V}{V}$$

4. Solve for the parallel combination of R_2 and R_3 using the ideal gain. Select R_4= 1.5 kΩ (Standard Value).

$$(R_2||R_3)_{ideal} = \frac{R_4}{G_{ideal} - 1} = \frac{1.5\ \ k\Omega}{3.917\ \ {}^{V}\!/_{V} - 1} = 514.226\ \ \Omega$$

5. Calculate R_2 and R_3 based off of the transfer function and gain.

$$R_3 = \frac{R_4 \times V_{dd}}{V_{inMax} \times G_{ideal} - V_{outMax}} = \frac{1.5\ \ k\Omega \times 3.3\ \ V}{2.065\ \ V \times 3.917\ \ {}^{V}\!/_{V} - 3.25\ \ V} = 1023.02\ \ \Omega$$

$$R_2 = \frac{(R_2||R_3)_{ideal} \times R_3}{R_3 - (R_2||R_3)_{ideal}} = \frac{514.226\ \ \Omega\ \ \times 1023.02\ \ \Omega}{1023.02\ \ \Omega - 514.226\ \ \Omega} = 1033.941\ \ \Omega$$

6. Calculate the actual gain with the standard values of R_2 (1.02 kΩ) and R_3 (1.02 kΩ).

$$G_{actual} = \frac{(R_2||R_3) + R_4}{(R_2||R_3)} = \frac{510\ \ \Omega\ \ + 1.5\ \ k\Omega}{510\ \ \Omega} = \ \ 3.941\frac{V}{V}$$

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