Noise 1

Exercises

TI Precision Labs – Op Amps

1. Two noise sources are in series (20mV rms, and 30mV rms). What is the total noise?

2. What is the thermal noise voltage spectral density for a 10kΩ resistor at 25C and at 125C?

3. What resistance would be required to generate 1nV/rtHz (T = 25C)?

4. What is the rms voltage for a 10mVpp noise signal?

Noise 1

Solutions

TI Precision Labs – Op Amps

1. Two noise sources are in series (20mV rms, and 30mV rms). What is the total noise?

$$e_{n\_total} = \sqrt{e_{n1}^2 + e_{n2}^2} = \sqrt{(20\text{mV})^2 + (30\text{mV})^2} = 36\text{mVrms}$$

2. What is the thermal noise voltage spectral density for a 10kΩ resistor at 25C and at 125C?

$T_n = 273 + 25$

$$e_{n\_r} = \sqrt{4k_n \cdot T_n \cdot R_n} = \sqrt{4\left(1.38 \cdot 10^{-23}\,\frac{\text{J}}{\text{K}}\right) \cdot (298\text{K}) \cdot (10\text{k}\Omega)} = 12.8\,\frac{\text{nV}}{\sqrt{\text{Hz}}}$$

$T_n = 273 + 125$

$$e_{n\_r} = \sqrt{4k_n \cdot T_n \cdot R_n} = \sqrt{4\left(1.38 \cdot 10^{-23}\,\frac{\text{J}}{\text{K}}\right) \cdot (398\text{K}) \cdot (10\text{k}\Omega)} = 14.8\,\frac{\text{nV}}{\sqrt{\text{Hz}}}$$

3. What resistance would be required to generate 1nV/rtHz?

$$R_n = \frac{e_{n\_r}^{2}}{4 \cdot T_n \cdot k_n} = \frac{\left(1 \frac{nV}{\sqrt{Hz}}\right)^2}{4 \cdot (298K) \cdot \left(1.38 \cdot 10^{-23} \frac{J}{K}\right)} = 60.8\Omega$$

4. **What is the rms voltage for a 10mVpp noise signal?** Note: peak-to-peak translation to rms is always a statistical approximation. Remember that the noise is a Gaussian signal, so there is always a finite probability that a noise measurement will be on the far tail of the curve. The calculation below assumes that +/-3 standard deviations is sufficient for a peak-to-peak approximation.

$$\frac{10mVpp}{6} = 1.667mVrms$$