Answer on Question #54800, Engineering, Electrical Engineering

Noise voltage from a 50 Ohm resistor obtained after amplification by an amplifier with 60 dB voltage gain in 100 mV at 27 degree centigrade. Calculate the bandwidth of the amplifier. What will be the noise voltage if the temperature is increased to 57 degree centigrade?

Solution

Formula for the RMS noise voltage:

$$V_n = \sqrt{4k_B T \Delta f R} \tag{1}$$

where $k_B = 1.38 \cdot 10^{-23} J/K$ is the Boltzmann constant; $T = 273.15 + t\left[inC°\right]$ is the absolute temperature in kelvin; $\Delta f = f_{\max} - f_{\min}$ is the bandwidth; R is the resistance of the circuit element.

From (1)

$$\Delta f = \frac{V_{n1}{}^2}{4k_B TR} = \frac{\left(100 \cdot 10^{-6}\right)^2 V^2}{4 \cdot 1.38 \cdot 10^{-23} J/K \cdot \left(273.15 + 27\right) K \cdot 50 Ohm} = 1.2 \cdot 10^{17} Hz \tag{2}$$

The noise voltage if the temperature is increased to 57 degree centigrade

$$V_{n2} = \sqrt{4k_B T_2 \Delta f R} = \sqrt{4k_B T_2 \Delta f R} \cdot \sqrt{\frac{T_1}{T_1}} = \sqrt{4k_B T_1 \Delta f R} \cdot \sqrt{\frac{T_2}{T_1}} = V_{n1} \cdot \sqrt{\frac{T_2}{T_1}} = 100mV \cdot \sqrt{\frac{273.15+57}{273.15+27}} = 105mV$$

Answer: $\Delta f = \frac{V_{n1}{}^2}{4k_B TR} = 1.2 \cdot 10^{17} Hz$; $V_{n2} = \sqrt{4k_B T_2 \Delta f R} = V_{n1} \cdot \sqrt{\frac{T_2}{T_1}} = 105mV$.