

Effects of Electrical Noise on Biomedical Electronics

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- The electrical noise coming out of a circuit can be measured using a SA, as seen in Fig.
- If the noise coming out of a CUT is lower than the noise floor of the SA, a low-noise amplifier (LNA) is inserted between the CUT and SA to help with the noise measurement
- We generally plot PSD versus frequency to ultimately characterize the power in a signal or the signal's RMS value.

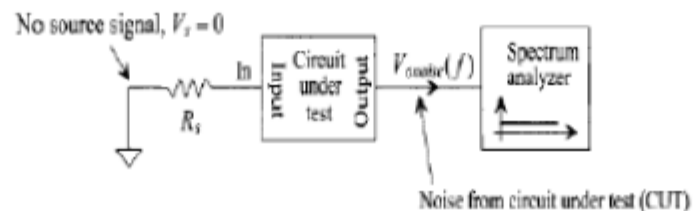


Figure 8.6 Circuit used for noise measurement.

Calculating and Modeling Circuit Noise

- If this noise signal's PSD is called $V_{noise}^2(f)$ (units, V^2/Hz), we can determine its RMS value

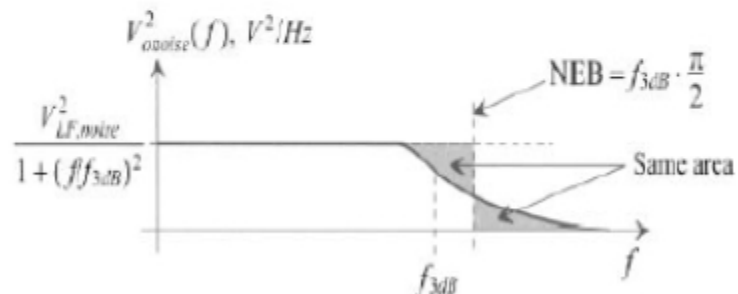
$$V_{RMS} = \sqrt{\int_{f_L}^{f_H} V_{noise}^2(f) \cdot df} \quad \text{Volts}$$

- If the noise PSD is flat

$$V_{RMS} = \sqrt{(f_H - f_L) \cdot V_{noise}^2(f)}$$

Noise Equivalent Bandwidth

- In real circuits the signals, and noise, are bandlimited
- This bandlimiting can be the result of intentionally added or parasitic capacitances present in the circuit.
- Figure shows a noise spectrum if the CUT shows a simple single-pole roll-off.



Signal-to-Noise Ratio

· Definition: $SNR = \frac{\text{desired signal power, } P_s}{\text{undesired signal power (noise), } P_{noise}}$

· Using dB: $SNR = 10 \log \frac{P_s}{P_{noise}}$