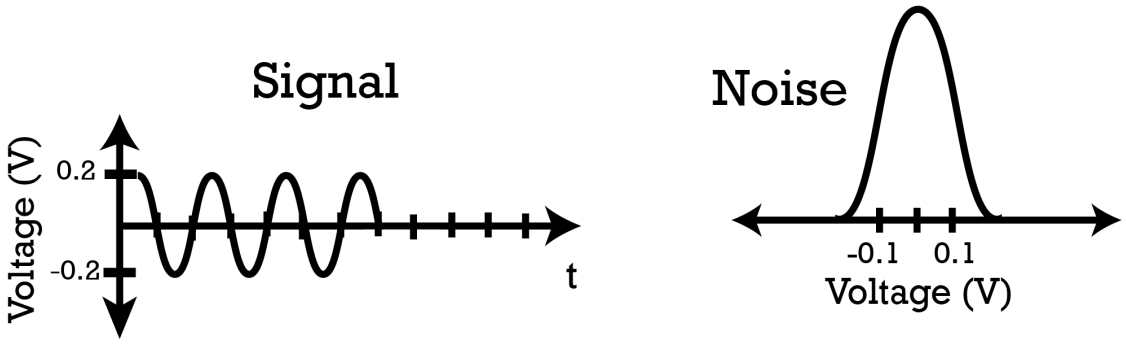
Problems for Week 5: Noise

1) Assume that your receiver has a noise floor of -90 dBm (with reference to output), a transmit power of 6 kW, a survey height of 500 m, a center frequency of 60 MHz, a surface resolution of 200m, an antenna gain of 10 dB, and two-way in-ice losses of 10 dB/km.
    a. Estimate the signal to noise ratio for a reflection from the ice surface.
    b. Estimate the SNR for a bed reflection from a lake beneath 4 km of ice.
    c. Estimate the SNR for a reflection from the sea surface.

2) Assume that your signal is a sine pulse (sketched below) to be measured in the presence of Gaussian random noise (with a voltage distribution sketched below) on a 50Ω co-axial cable.

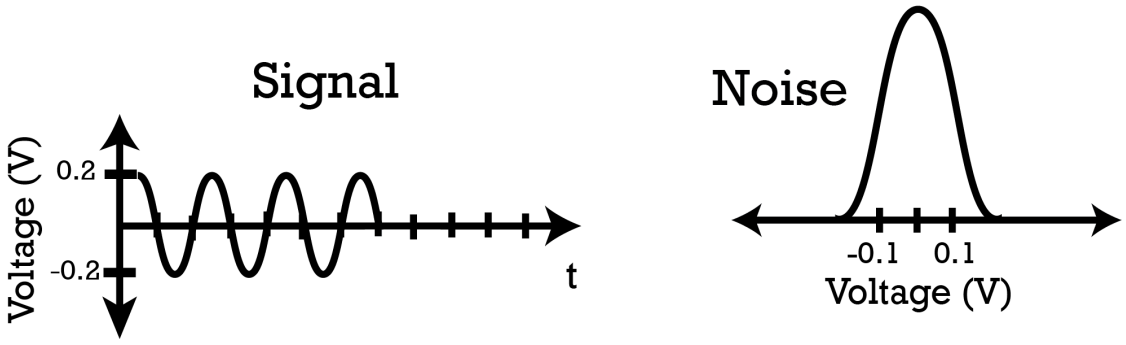


    a. What is the rms voltage of the signal?
    b. What is the rms voltage of the noise?
    c. What is the power of the signal?
    d. What is the power of the noise?
    e. What is the SNR?

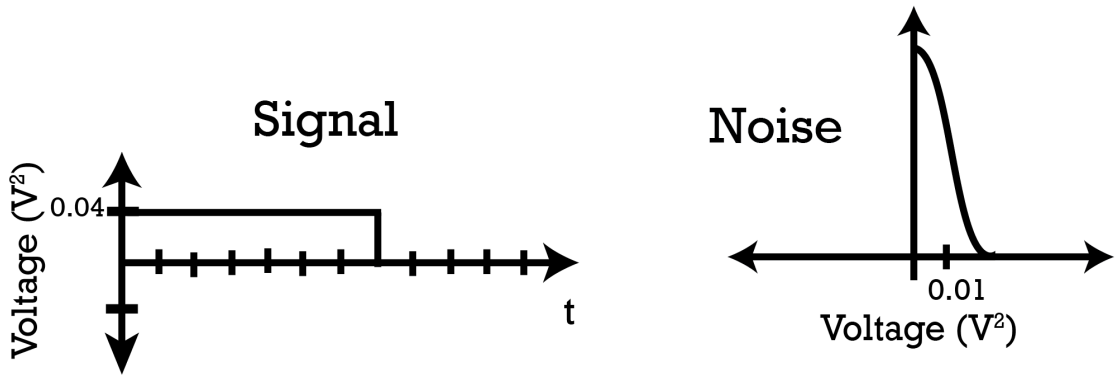
    Assume two measurements of the signal and noise are coherently summed.
    f. Sketch the resulting signal time series and noise voltage distribution.
    g. What is the new power of the signal?
    h. What is the new power of the noise?
    i. What is the new SNR?

3) Assume that you are acquiring airborne ice penetrating radar data from a survey height of 500 m above ice with a depth-averaged attenuation rate of 10 dB/km. If the surface is full of isotropic scatters and the surface return from nadir is measured to be 0 dBm, sketch the expected signal-to-clutter ratio for bed echoes as a function of ice thickness.

4) Assume that your signal is a sine pulse (sketched below) to be measured in the presence of speckle noise (with a voltage distribution sketched below).



The magnitude squared of the signal and speckle are also sketched below.



Assume two measurements of the signal and noise are coherently summed.

a. Sketch the resulting signal, magnitude squared of the signal, speckle, and magnitude squared of the speckle.
b. What is the ratio of the SNR for the resulting signal to the original?

Assume two measurements of the signal and noise are incoherently summed.

c. Sketch the resulting magnitude squared of the signal and magnitude squared of the speckle.
d. What is the ratio of the SNR for the resulting signal to the original?

5) Sketch a radargram for an ice sheet with a flat ice surface and a sloping bed (from 200 m to 2000 m deep) and showing the effect of:

a. No Noise
b. Surface Clutter
c. Speckle
d. Receiver Thermal Noise Floor
e. All of the above (clutter, speckle, floor) with coherent summation
f. All of the above (clutter, speckle, floor) with incoherent summation