AMPLIFIER NOISE PERFORMANCE

Lab #11

In this laboratory session, the noise characteristics of your amplifier will be measured and analyzed, using an Agilent N8975A noise figure analyzer. The measured data will be used to analyze several different receiver system configurations, and the results compared to expectations from theory.

Noise Figure Characterization

1.) Calibrate the Agilent N8975A by using its associated noise source at the input of the analyzer. As these are precision connectors, be especially careful to use correct connection techqniue. You should choose start and stop frequencies, and the number of points to cover a 200 MHz wide frequency range in 10 MHz steps centered on your amplifier's operating frequency. Also, be sure to select an averaging factor of 64-128 in order to provide adequate smoothing.

2.) To measure your amplifier, connect the noise source to the input of your circuit and the output of your amplifier to the input of the noise figure meter. You'll need to use a male-male adapter for this connection (please do not remove the gold adapter from the instrument front panel). Measure and record in your lab notebook the available gain, G_A, and noise figure, NF, of your amplifier over the frequency range. To download the data from the instrument, run the program "n8975aread <filename>" from the terminal of a lab computer. This will initiate a measurement, and generate a file with the gain and noise figure tabulated. Plot these results and include them in your notebook.

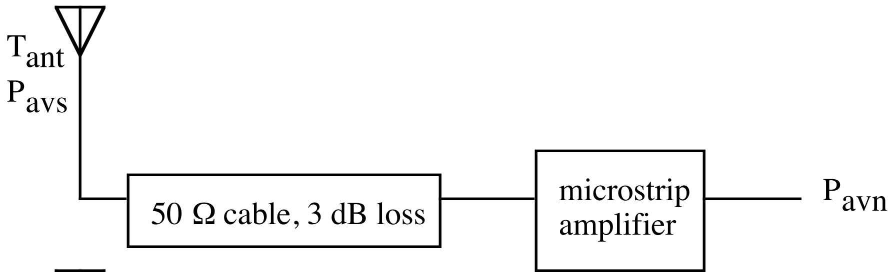
3.) If you designed a low-noise amplifier, how does this compare to the expected value? If you designed a high-gain amplifier, how much of an increase in noise figure resulted from this choice?

System Analysis Using Measured Noise Figure

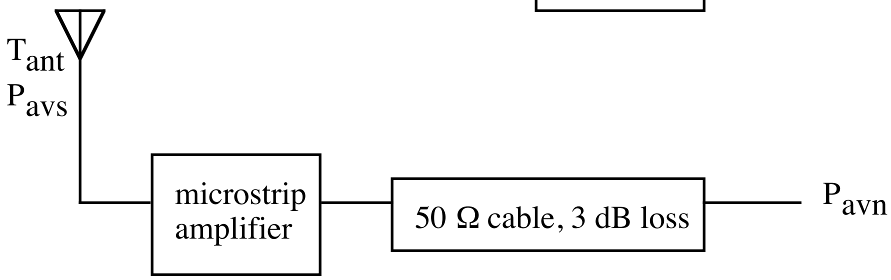
1.) Two possible system architectures shown in the figure below for implementing a wireless radio link. As can be seen from an analysis of the two systems, the overall gain of both systems is the same. The system's designer has specified a maximum noise temperature of 350 K in order to adequately receive the signal. Will your amplifier perform satisfactorily in either of these configurations? In order to achieve this noise goal, find the maximum antenna noise temperature that will work for each design. Which design is preferable for low noise performance? Why?

2.) Another quantity that is of great importance in practical wireless communication systems is dynamic range. Dynamic range indicates the range of signals that the system can properly handle, and is limited at low powers by the noise performance of the system and at high powers by non-linear effects, and can be expressed as $DR = 10\log(\frac{P_{max}}{P_{min}})$. For both systems shown below, compute the dynamic range if the largest acceptable signal, P_{max}, is one that causes 1 dB of gain compression in the amplifier, and the smallest signal, P_{min}, is that which causes a signal-to-noise ratio of 1 (also known as the minimum detectable signal, or MDS) at the output of the system. In terms of dynamic range, which system is preferable? Explain the origin of any differences between the two systems for dynamic range and noise performance in terms of physical and/or operational concepts of the components.

a.)


T_{ant}
P_{avs}
50 Ω cable, 3 dB loss
microstrip amplifier
P_{avn}

b.)


T_{ant}
P_{avs}
microstrip amplifier
50 Ω cable, 3 dB loss
P_{avn}