Determination of Boltzmann’s Constant Using Johnson Noise

OUTLINE

Part I Qualitative

1. Read Section 1.0

2. Plug in power connections. See section 1.1.

3. Connect preamp to oscilloscope. Set R(in) and R (F). See Fig. 1.1a and instructions above it. Observe signal on oscilloscope.

4. Connect preamp to HLE. See instructions below Fig. 1.1b. See figure 1.1c. Set corner frequency knobs.

5. Set gain according to instructions below Fig. 1.1c. Connect output to oscilloscope and view signal produced by Johnson Noise.

6. Change R(in) from 100,000 to 10,000 Ohms and observe effect on signal. The amplitude of the noise is proportional to R(in) value.

Part II Quantitative

1. Connect additional parts as shown in Fig. 1.2a. Adjust according to instructions on p 1-7. Not shown in figure: Connect BNC cable between Monitor jack and Ch. 2 of oscilloscope. Select XY mode on oscilloscope and observe signal. How XY mode is selected depends on the oscilloscope model.

2. Observe reading on built in analog voltmeter. See instructions at top of p 1-8. Connect DMM as shown in fig. 1.2c. Observe fluctuations in DMM voltage reading.

3. Read section 1.3 (p1-9 &1-10). Take data like that in table on p 1-11. Take several values of each voltage and average. Use the formula to get value of amplifier noise using low value resistors. Use this to subtract amplifier noise from total noise voltage.

4. Get < V2(J)> using R(in) values from 10 Ohm to 100K Ohm. Use gain in table (p1-11) except reduce gain to 150 for 100K.

5. Plot < V2(J)> versus R. It should be linear.

6. Read page 1-16. Plot < V2(J)> / bandwidth. Use the value of bandwidth from table 1.5 for your corner frequencies.

7. Determine slope of the line using Excel or other line fit program. Use it to find value of Boltzmann’s constant. You will need to measure room temperature.

8. Compare your value of k with value given on page 1-17.