Determine the junction resistance/Voltage bias ratio I nd that the resistance of the junctions can increase a few s over their room temperature values when cooled to dilution temperatures. As such, if youre really gungho about having a 50 junction, youll do best to start with something like 48 or 49. Since the goal for these devices is an accurate assessment of the noise temperature, getting closeto 50 is important, but how close is close? If your source impedance (junction impedance) is 41 , then the fraction of noise power that can propagate out is

$$\eta = 1|\Gamma|^2 = 0.99$$

so youll only end up with a 1

This is the number that youll use for your t. Its important to get this right since the noise temperatures that you will infer will scale with your measurement of the junction voltage through k_B. Figure 0.1: Bias resistor conguration for determining the ratio between the applied bias VB and the junction bias VJ. If you use a current source in place of VB you can determine the resistance and convince yourself that your reection loss will probably be good enough.

¡h3¿How do you set the bias resistance values? ¡/h3¿

If youre after noise temperature and your SNTJ is cold enough to be well into the quantum regime, then youll be happy if you have something like 10hf/e, that is, something that well exceeds the corners on the quantum noise at bottom. If youre at 6GHz, then this turns out to be something like 25V. Since I like to have my bias sources scaled so that they swing about 1V for the range of interest, this means a divider ratio of something like 1:40,000. If you dont use any room temperature dividers, you can use a single bias resistor value of 2 M. I usually end up using a divider at room temperature and using something like 100k so that I can measure temperature at higher temperatures as a sanity check.

Although you can,in principle, demodulate the output of your amp chain using a diode rectifier, youll have to play games setting the ltering of the room temperature mixer output and youll have to think about one more thing. I think that its far easier to demodulate the output of the SNTJ at a given frequency by using a standard spectrum analyzer in a triggered, zero span acquisition at the frequency that you care to measure. I use the Agilent E4407B for this purpose. Make sure to set it to sample each bin and not pull the max/min at each point. The E4407B also lets you set the display to linear Watts. Open up the resolution bandwidth as wide as you need to, usually less than 10 MHz on a typical instrument. This will yield the noise curve integrated over this bandwidth, so if youre interested in getting the noise over a narrower bandwidth then you can crank it down, but be prepared to wait longer. Anyhow, with the trace averaging in the instrument you can accumulate averaged shot noise mustache traces quickly and easily by syncing a triangle sweep on the bias. Output the data however you like and perform your t using the scaling ratio VJ/VB that you found with your 3 probe measurement above. Since these automated spectrum analyzers do a lot under the hood, you have to make sure that however it congures its own internal attenuators to level its incoming signals, that its noise oor is dominated by your amplification chain. Set up your bias sweep so that you can see a good noise mustache, sweeping out something like 10 $k_B T$ and setting the power scale on your analyzer so that the max noise fills out the y-scale. If you shut off your cryogenic HEMT, then the noise power shown on the analyzer should be very close to zero. This is an indication that the cryogenic HEMT is dominating your system noise. If it doesnt reach zero, then you have other stuff later in the chain that is contributing significant noise and you have some troubleshooting to do.

1 Cold Measurement of Quantum Noise

2 Plotting and Understanding Data by Eye

3 Data Fit and Analysis

4 Drawing Conclusions, Using what you Learned

5 Sharing Data with Amplifier Noise Community