Average Noise Power for a Low Noise Amplifier

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Measurement Setup

The average noise power from a low noise amplifier was measured. The amplifier is a Miteq-00500100-10-10 low noise amplifier. The band of the amplifier is from 500MHz to 1.0 GHz. The advertised noise figure is 1.0 dB.

To measure the average noise power, the amplifier input was terminated with a 50Ω termination at room temperature. The output of the amplifier was connected to an Agilent E4445A Series spectrum analyzer. The frequency of the spectrum analyzer was set to 1 GHz with a span of 0 GHz. The resolution bandwidth of the analyzer was set to 100kHz which is in the range of the 21 cm experiment. The video bandwidth was kept at 3 MHz. The sweep speed was set at 20 mS. The noise power was measured and recorded with a Java 6 application that interfaced to the spectrum analyzer via a Prologix GPIB-USB 3.x controller[1]. The Java application used the RXTX JAVA Communication API[2]. The marker power at1 GHz was read out every 0.5 seconds.

The measurements were made over a sustained period of 36 Hours in which 262,144 (4^9) measurements were recorded. The average power was 28.9×10^{-12} Watts (-75.39dBm). The gain of the amplifier at 1 GHz was measured with a network analyzer to be 47.18 dB. Subtracting this gain and using a resolution bandwidth of 100kHz, the effective average noise temperature at the input of the amplifier is 407.15K. This gives a room temperature noise figure of 1.43dB (at 1 GHz).

The noise power data was histogrammed into bins of -84.5dBm which is equivalent to 50 Kelvin bins. The distribution is matched extremely well to an exponential distribution with a mean of -75.39dBm (407.15K). The histogram is shown in Figure 1.

Next the data was broken into a number of segments. The mean of each segment was computed. Then the standard deviation of the segment means was determined. The data is shown in Table 1 and in Figure 2. Figure 2 also plots the standard deviation of the entire data set divided by the square root of the number of points in the segments. (Since the data set is an exponential distribution, the standard deviation of the entire data set is equal to the mean of the data set.)

[1] http://prologix.googlepages.com/home
[2] http://www.jcontrol.org/download/rxtx_en.html

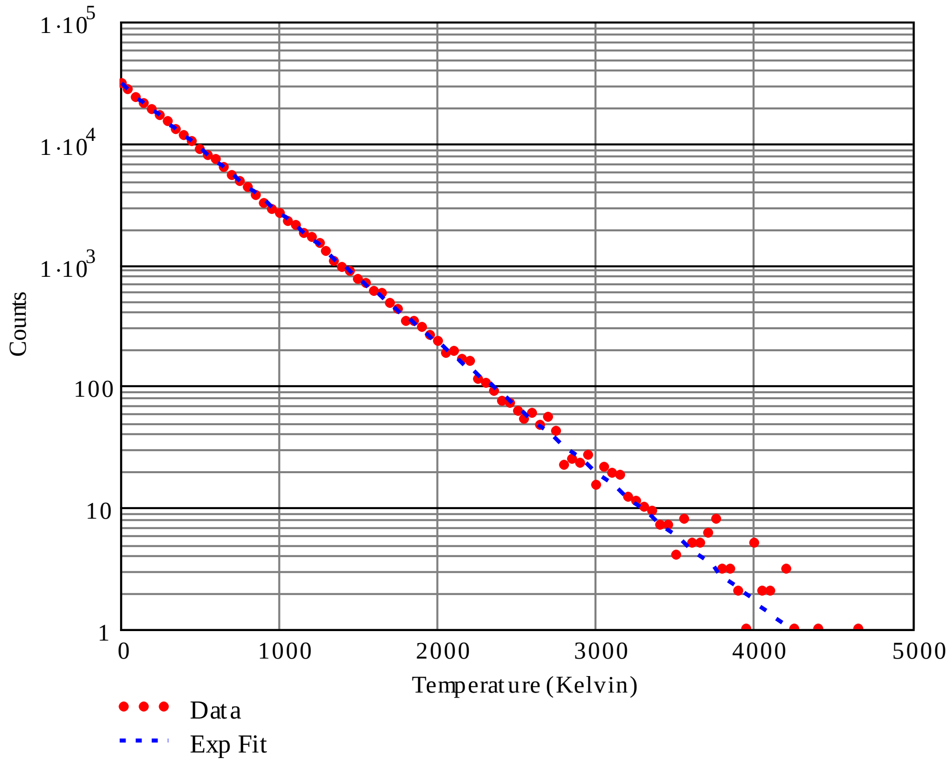

Figure 1. Histogram of noise power data. The bin width is 50K. The mean value of the measured data is 407.15K. The blue dotted line is an exponential distribution with a mean of 407.15 K.

Number of Segments	Number of Points in Segment	Standard Deviation of Segment Mean (Kelvin)
4	65536	2.1
16	16384	3.8
64	4096	6.3
256	1024	12.3
1024	256	25.3
4096	64	50.4
16384	16	103.3
65536	4	205.8

Table 1. Standard deviation of segment mean.

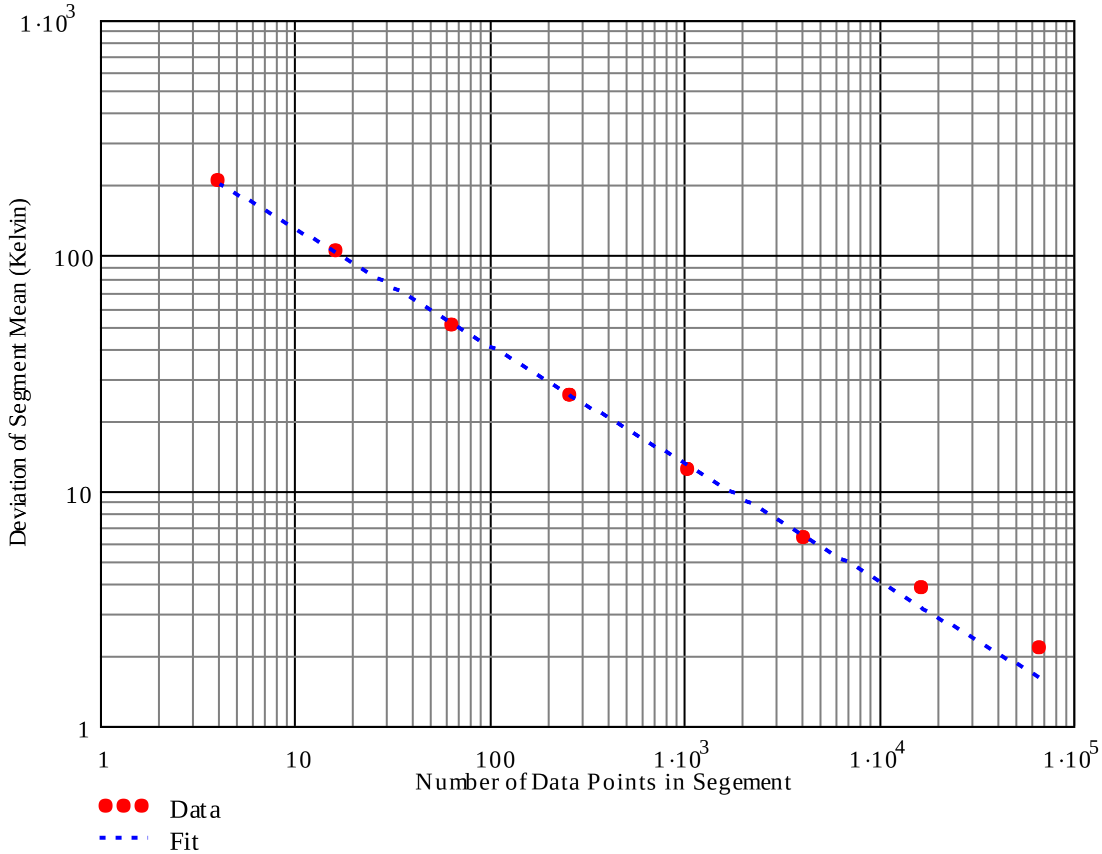

Figure 2. Deviation of segment mean versus number of points in segment. The fit is the standard deviation of the entire data set divided by the square root of the number of points in the segments.