CONFIRMATION OF Man. Ka BAND LNB FOR NOISE FIGURE

Due to the large discrepancy between the manufacturer provided, and Cont. measured, noise figure for the Man. LNB, EOZ offered to test the LNB in its own laboratory.

The NF measured at Cont. utilizing the Y factor method and a spectrum analyzer resulted in an almost 4 dB difference between the manufacturer's data and the measured data. The test was performed on two different LNBs, providing essentially the same results.

EOZ was provided with one of the two LNBs that was tested, and the one provided to EOZ was Man. model 8201 S/N 51705.

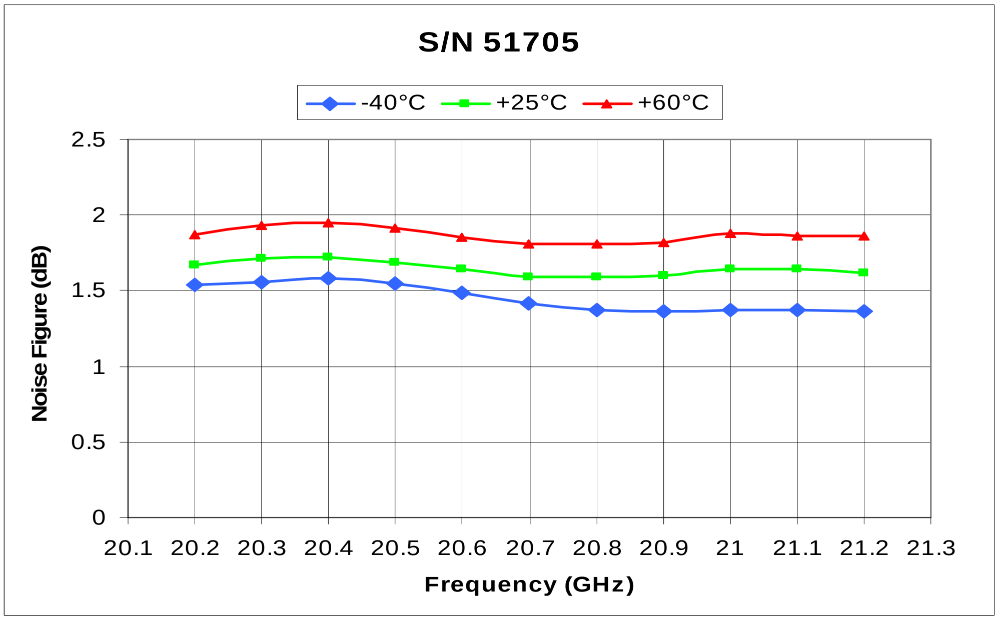

FIGURE 1. Man. PROVIDED DATA OF LNB NF

Figure 1 above shows that at ambient (25 degrees C), and at the center of the band (20.7 GHz), Man. measured approximately 1.6 dB for S/N 51705 LNB. All of EOZ's measurements were at room ambient and at 20.7 GHz (the center of the receive band). There was no attempt to keep the LNB itself at room ambient since at 15 volts it drew almost 0.5 amps, so was dissipating close to 7.5 watts slowly warming it up.

In the EOZ test setup (for the Y method using a spectrum analyzer), a Mini Circuits ZFBT-4R2G bias-T was utilized on the LNB's L band output in order to be able to feed it the DC power it required and be able to extract the L band RF output and input the required 10 MHz RF reference.

A Weinschel Engineering model 1515 resistive power splitter was used to separate the L band output and the 10 MHz input from the LNB. A laboratory Rubidium standard was used as the 10 MHz frequency reference with + 7 dBm into one port of the power splitter. Figure 2. shows the typical measurement setup at EOZ.

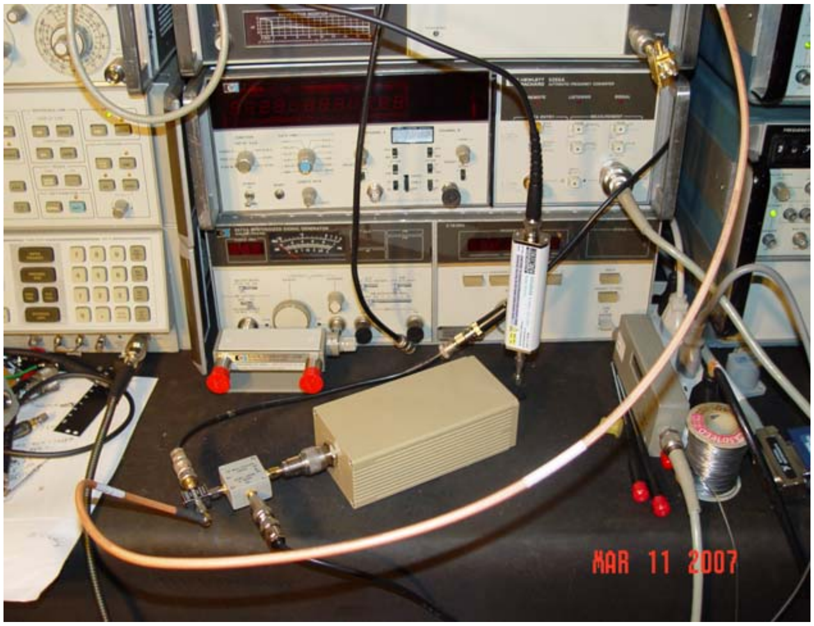

FIGURE 2. TYPICAL TEST SETUP AT EOZ WITH Cont.'S MICRONETICS NOISE SOURCE AND Man. LNB

EOZ was also provided with the Micronetics noise source used at Cont. as initial measurements using the EOZ HP noise diode was in agreement the Man. measurements. Both HP (Agilent) and Micronetics noise diodes were powered by a precision HP 6114A power supply set to 28.00 volts for the Y factor measurements.

The Excess Noise Ratio (ENR) of each noise source is only calibrated in 1 GHz increments in the range of interest, therefore some minor extrapolation was executed in order to come up with the ENR at 20.7 GHz for each source.

The following graphs (Figures 3 through 5) show the trend and the extrapolated ENR for each source. These extrapolated values were used to calculate the NF of the LNB using the Y factor method and a spectrum analyzer to obtain both the cold and hot power outputs of the LNB. Cold power is measured with the DC 28 volts to the noise diode shut off, and hot power is measured with the 28 volts applied to the noise diode. The equation used to calculate Noise Figure (NF) is as follows:

$$NF = ENR(dB) - 10 * \log (Y-1)$$

Y is simply the ratio between the hot and cold power outputs of an amplifier, or in this case the LNB. ENR is the Excess Noise Ratio, or the additional noise power above kT (typically considered -174 dBm/Hz), where k is Boltzman's constant and T is the temperature in Kelvin (typically 290 degrees at room ambient). For example, an ENR of 10 dB would mean that the noise source would be generating – 164 dBm/Hz when powered on.

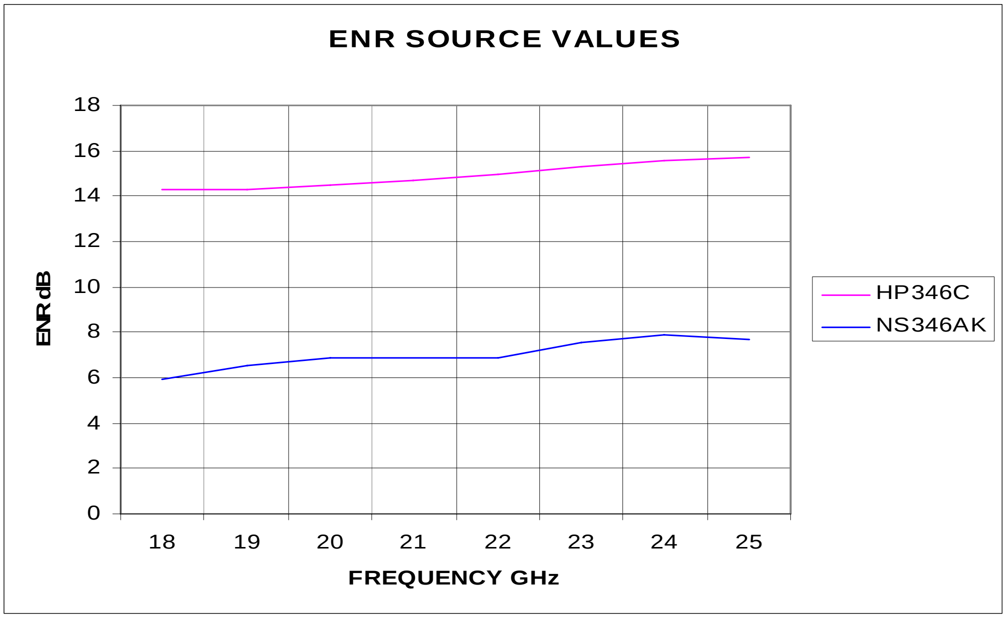

FIGURE 3. – ENR VALUES FOR THE TWO SOURCES USED

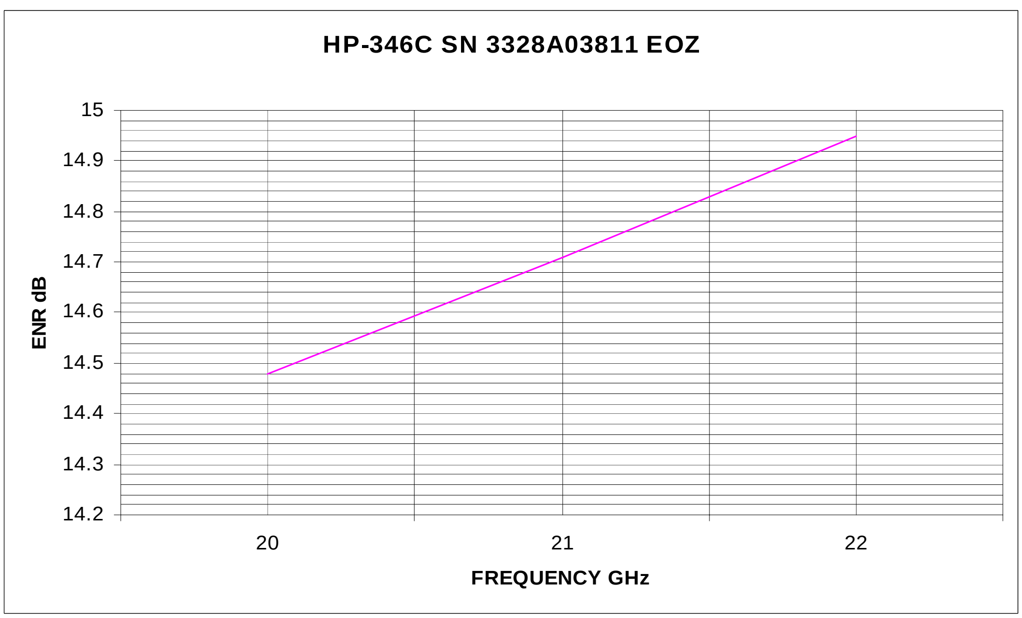

FIGURE 4. SHOWS EXTRAPOLATED ENR AT 20.7 GHz TO BE 14.64 dB

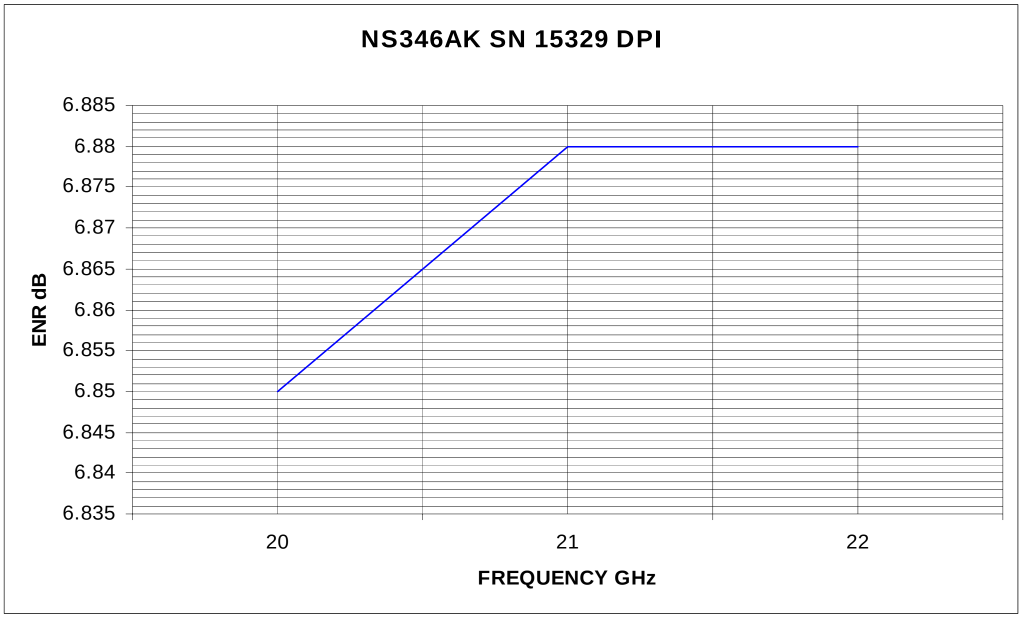

FIGURE 5. SHOWS EXTRAPOLATED ENR AT 20.7 GHz TO BE 6.871 dB

The ENR numbers from Figure 4, and Figure 5, were used to calculate the LNB's NF utilizing the Y factor method with a spectrum analyzer measuring the hot and cold power output of the LNB.

It should be mentioned, that the same test setup was utilized when EOZ's HP 8970B noise figure meter was used with the exception that the noise source was powered by the HP 8970B and the output of the LNB was connected to the HP 8970B rather than the spectrum analyzer.

The first measurements were made using the EOZ HP noise source and the EOZ HP 8566A spectrum analyzer. Figures 6 and 7 below show the noise power measured first cold and then hot respectively. The cold power was measured as – 77.54 dBm, and the hot power was measured as – 64.5 dBm. The "max hold" function was used on the spectrum analyzer to further smooth the data, as absolute values were not as significant as the ratio between the two. Using these numbers then, with an ENR of 14.64 dB, yielded the following NF:

NF = 14.64 – 10*log (10^((77.54 – 64.5)/10) – 1)

NF = 14.64 – 10*log(10^1.304 – 1)

NF = 14.64 – 12.82

NF = 1.82 dB

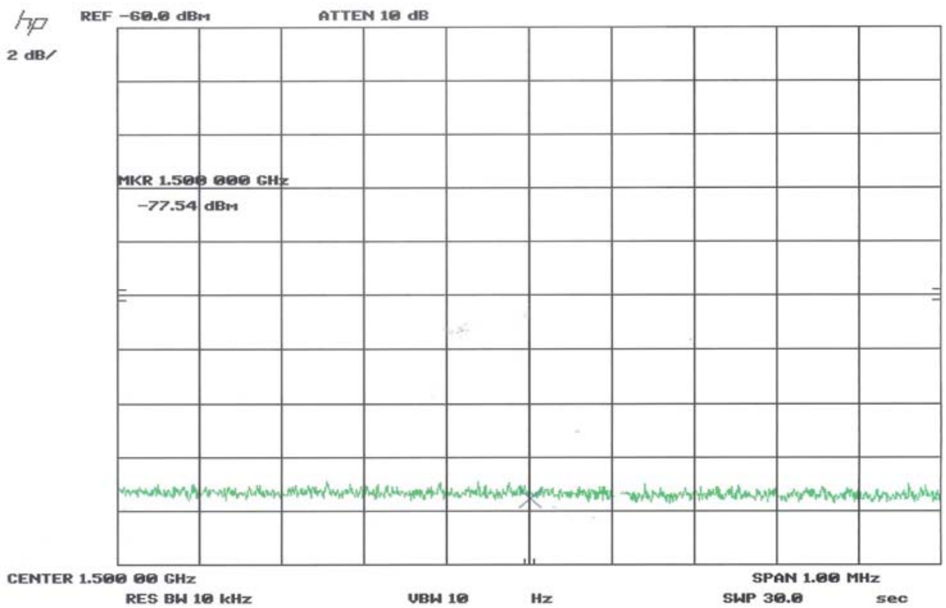

FIGURE 6. COLD NOISE POWER DENSITY OF – 117.54 dBm/Hz WITH HP SOURCE

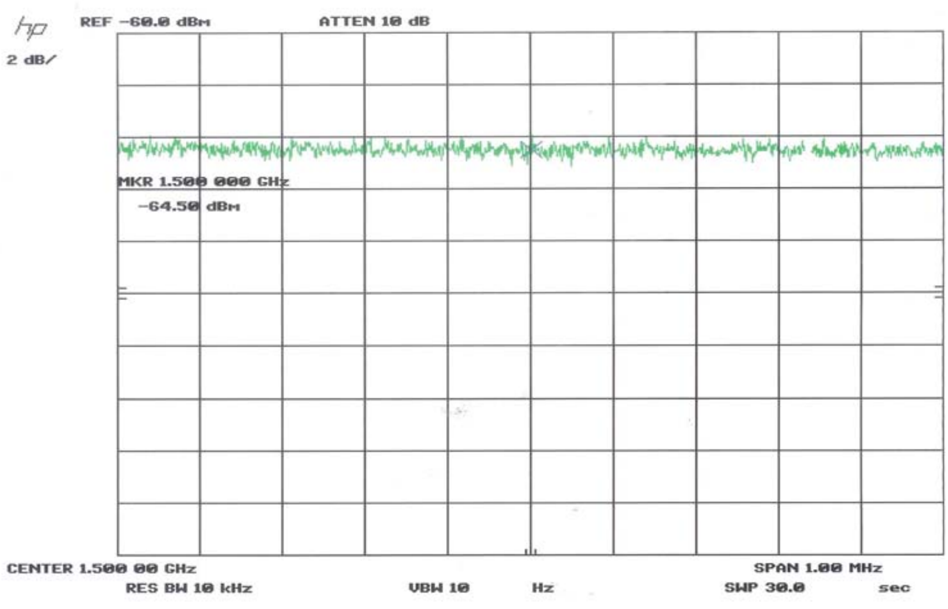

FIGURE 7. HOT NOISE POWER DENSITY OF – 104.50 dBm/Hz WITH HP SOURCE

It is interesting to note, that the cold noise power density is almost exactly kT (- 174 dBm) plus the LNB gain claimed by Man. at 20.7 GHz, at ambient, of 62.6 dB, plus the NF of about1.8 dB, minus the insertion loss of 6 db of the splitter plus the correction factor of about 2.5 dB for the spectrum analyzer. For a measurement at around 21 GHz this is extremely close (- 117.54 dBm/Hz from spectrum analyzer, and, – 118.1 dBm/Hz calculated).

The LNB's noise figure was then also measured with the HP 8970B noise figure meter, using the HP noise source. Below is a picture of the noise figure meter reading. Realize that all measurements made are at 1.5 GHz as that is where the LNB downconverts 20.7 GHz to.

FIGURE 8. NOISE FIGURE METER READING WITH HP SOURCE

The exact same set of measurements were taken with the Cont. Micronetics noise source. Figures 9 and 10 below show the spectrum analyzer plots for the cold and the hot power spectrum densities measured. The cold power was measured as – 77.40 dBm, and the hot power was measured as – 71.18 dBm. The "max hold" function was again used on the spectrum analyzer to further smooth the data, as absolute values were not as significant as the ratio between the two. Using these numbers then, with an ENR of 6.871 dB yielded the following NF:

NF = 6.871 – 10*log (10^((77.40 – 71.18)/10) – 1)

NF = 6.871 – 10*log(10^0.622 – 1)

NF = 6.871 – 5.04

NF = 1.83 dB

The Y method, utilizing the spectrum analyzer, resulted in essentially the same NF being measured with the HP or the Micronetics noise source.

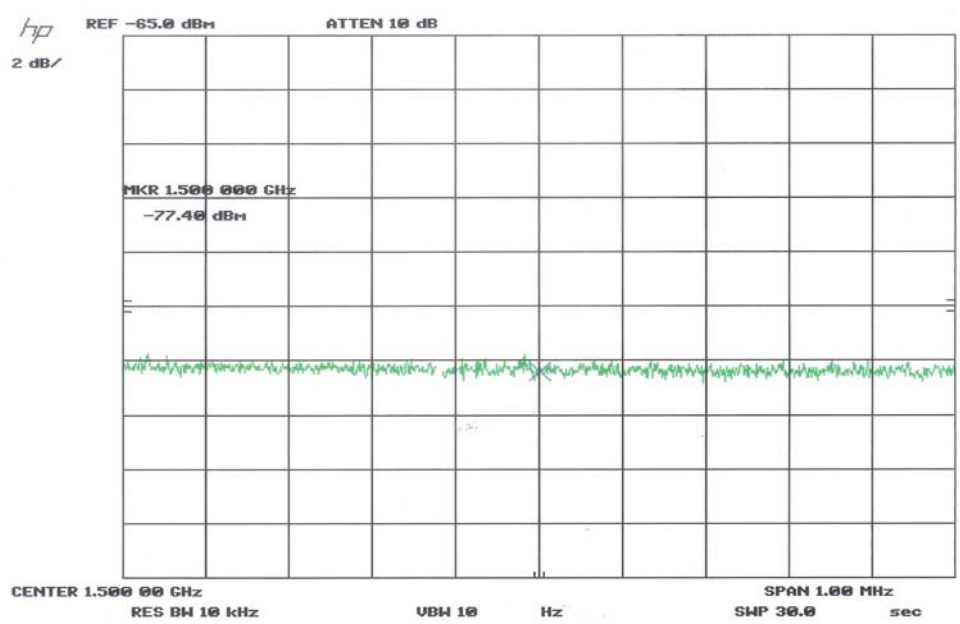

FIGURE 9. COLD NOISE POWER DENSITY OF – 117.40 dBm/Hz WITH MICRONETICS SOURCE

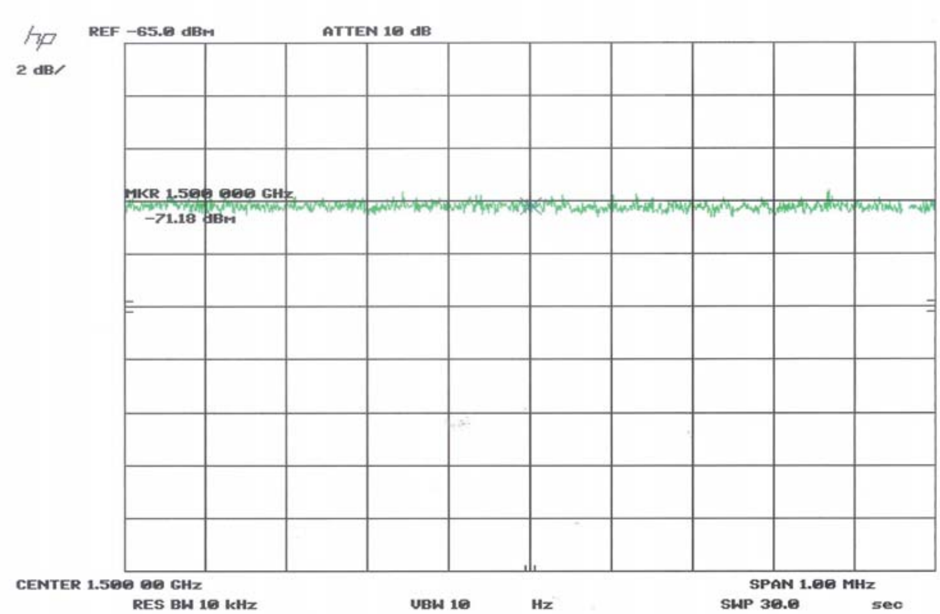

FIGURE 10. HOT NOISE POWER DENSITY OF – 111.18 dBm/Hz WITH MICRONETICS SOURCE

FIGURE 11. NOISE FIGURE METER READING WITH MICRONETICS SOURCE

For the Micronetics source, the noise figure meter read slightly higher than the Y factor measurement utilizing the spectrum analyzer. The 0.16 dB higher NF measurement is certainly within measurement uncertainty capabilities of the EOZ laboratory that was utilized for these measurements.

These measurements were repeated for weeks at random times, and at different LNB case temperatures. The data provided above is representative of the other measurements, and all combinations of noise sources, measurement techniques, temperatures and other variables consistently yielded NF values between about 1.75 dB and 2.00 dB.

Since the Man. provided data is strictly that of the LNB, the SMA to WR-42 waveguide adaptor's insertion loss also needs to be taken into account. This adaptor was provided by Cont. and they claimed an average insertion loss of about 0.2 dB for the adaptor. EOZ did attempt to verify the insertion loss of the adaptor but the results were not consistent enough from measurement to measurement to be conclusive. Consequently the 0.2 dB number will be used for adaptor loss. Given that, the LNB's actual NF then, as measured at EOZ, was between 1.55 dB and 1.8 dB. These results then are in total agreement with the Man. provided data.

The reason for the large discrepancy between the Cont. measured data and the actual NF is not clear.