**Chapter 10**

# ANTENNA MEASUREMENT USING SUN NOISE

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## Introduction

Even a modest 10 GHz system is capable of detecting sun noise, which is an excellent way of ensuring both antenna and receiver performance. Since the actual solar flux at any time is available, it may be used to make reasonably accurate measurements of antenna performance without the need for accurate standard gain antennas. Another advantage is that almost all errors cause pessimistic results, so we are not likely to be deluded into thinking that an antenna works better than it really does.

## Sun Noise Measurement

I use the **NOISE** program [1] by Mel, WR0I, to estimate expected sun noise based on the WWV solar flux. For a 2 foot dish with 60% efficiency and a receiver noise figure of about 2.5 dB (modified TVRO LNB), the program predicted 2.4 dB of sun noise. I measured 2.5 dB of sun noise on my 25 inch dish, and 2.0 dB with the 18 inch offset-fed RCA dish. However, I also measured 2.2 dB of sun noise on a 30 inch dish with a fancy "shepherd's crook" feed arrangement using copper water pipe as circular waveguide. The last measurement quickly highlighted the need for further adjustment of the feed arrangement.

A good system for measuring sun noise was described by Charlie, G3WDG [2]. He built a 144 Mhz amplifier with moderate bandwidth using MMICs and helical filters which amplifies the transverter output to drive a surplus RF power meter. The newer solid-state power meters are stable enough to detect and display small changes in noise level, and the response is slow enough to smooth out flicker. Since my 10 GHz system has an IF output at 432 Mhz, duplicating Charlie's amplifier would not work. In the junk box I found some surplus broadband amplifiers and a couple of interdigital filters, and combined these to provide high gain with a few Mhz bandwidth, arranged as shown in Figure 10-1. I found that roughly 60 dB of gain after the transverter was required to get a reasonable level on the power meter, while the G3WDG system has somewhat narrower bandwidth so more gain is required.

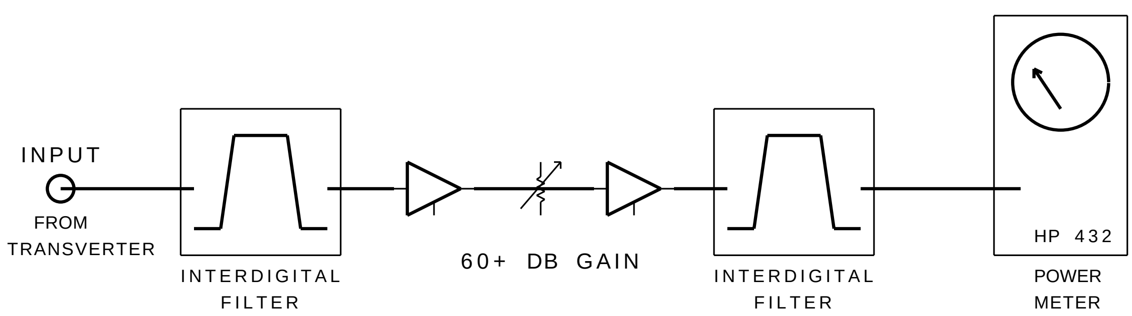


Figure 10-1. Indicator For Sun Noise

Operation is simple, as shown in Figure 10-2 — point the dish at the sun, peak the noise, then move to clear sky and note the difference in output. Several precautions are necessary:

1. Peak noise power must not exceed the level that any amplifier stage can handle without gain compression. Amplifiers with broadband noise output suffer gain compression at levels lower than found with signals, so be sure the amplifier compression point is at least 12 dB higher than the indicated average noise power.
2. Make sure no stray signals appear within the filter passband.
3. Foliage and other obstructions add thermal noise which obscure the cold sky reading.
4. Low noise amplifiers are typically very sensitive to input mismatch, so the antenna must present a low VSWR to the preamp.
5. If the preamp is at the near the feed, don't let it heat up too much or the noise temperature can change. (Total solar radiation is about one kilowatt per square meter — several hundred watts even on a small dish.)

A noise figure meter could also be used as the indicator for the sun noise measurement, but a calibrated attenuator would be needed to determine the **Y-factor**. Using different equipment gives us an independent check of noise figure, so that we may have more confidence in our measurements.

## Noise Figure Measurement

The **NOISE** program requires the receiver noise temperate in order to calculate the antenna performance. Fortunately, we can use the same sun noise technique to measure noise figure or temperature by measurement of sky noise and ground noise[3]. Sky noise is very low, around 6 K at 10 GHz, for instance, and ground noise is due to the ground temperature, around 290 K, so the difference is nearly 290 K. At microwave frequencies we can use a manageable antenna that is sharp enough that almost no ground noise is received, even in sidelobes, when the antenna is pointed at a high elevation. A long horn would be a good antenna choice.

The antenna is pointed alternately at clear sky overhead, away from the sun or any obstruction, and at the ground. The difference in noise output is the **Y-factor**; since we know both noise temperatures, the receiver noise temperature is calculated using the $\mathbf{Y}_{(ratio)}$:

$$T_e = (\mathbf{T}_{hot} - \mathbf{Y}\mathbf{T}_{cold}) / (\mathbf{Y}-1)$$

The latest version of my microwave antenna program, **HDLANT,** will make this calculation. Since the measured **Y-factor** will be relatively small, this measurement will only be accurate for relatively low noise figures. On the other hand, they are the most difficult to measure accurately using other techniques.

Figure 10-2

W2IMU[4] suggested that the same technique could be used for a large dish at lower frequencies. With the dish pointing at clear sky, the feedhorn is pointing at the reflector which shields it from the ground noise so it only sees the sky noise. If the feedhorn is then removed and pointed at the ground, it will then see the ground noise.

## Summary

Sun noise measurements are fine for checking system performance, but less satisfactory for alignment. Any adjustment may change both sun and sky reading, so it is necessary to compare the two after each adjustment, and the resulting differences may be small. Make one adjustment at a time, keep careful notes, and look for reproducible improvements. The process is tedious but careful work pays off.

## References


1. M.B. Graves, WR0I, "Estimating Sun Noise at Various Frequencies, Based on the 10.5 cm Flux Reported by WWV," *Proceedings of Microwave Update '94,* ARRL, 1994, pp. 125-131. (**NOISE** program may be downloaded from:
   ***http://www.tiac/net/wade/mel.zip***

2. C. Suckling, G3WDG, "144MHz wideband noise amplifier," ***DUBUS***, 2/1995, pp. 5-8.

3. H. Fasching, OE5JFL, "Noise Figure Measurement using Standard Antennas," *DUBUS Technik 4*, ***DUBUS***, 1995, pp. 23-25.

4. R. Turrin, W2IMU, "Method for Estimating Receiver Noise Temperature," *Crawford Hill Technical Note #20*, September 1986.