Chapter 6
Feeds for Parabolic Dish Antennas
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Appendix 6B — Parabolic Dish Antenna Setup

A parabolic dish is a thing of beauty, no matter what zoning boards may say, but it isn't an antenna without a feed and mounting structure. In setting up a dish antenna, we should concentrate on what is most important. Here is my priority list:

1. The phase center of the feed must be at the focal point of the dish. *Penalty for error = tens of dB.* (see Section 6.1.4)
2. **The feed should be chosen to illuminate the reflector *f*/D efficiently.** *Penalty for error = dB.*
3. **Minimize feedline loss.** *Penalty for error = dB.*
4. **Everything else.** *Penalty for error = tenths of dB.*
5. **A robust tripod or permanent mount with accurate azimuth calibration and a bubble level for elevation.** *Penalty for error = missed contacts!*

Choosing a feed should be easy — there are a number of proven good feeds, and Chapter 6 points them out. Minimizing feedline loss can be more difficult, since *none* of the reverse feeds that attach directly to an axial waveguide provides good performance.

The most critical point is also the most difficult — getting the feed in the right place. Many of us have been led astray by trying to adjust a dish with a signal source in the backyard. Results can be very misleading unless you are out of the near field and you account for ground and other reflections. To be out of the near field, a minimum distance greater than the Rayleigh distance is required:

Rayleigh distance = $2D^2/\lambda$

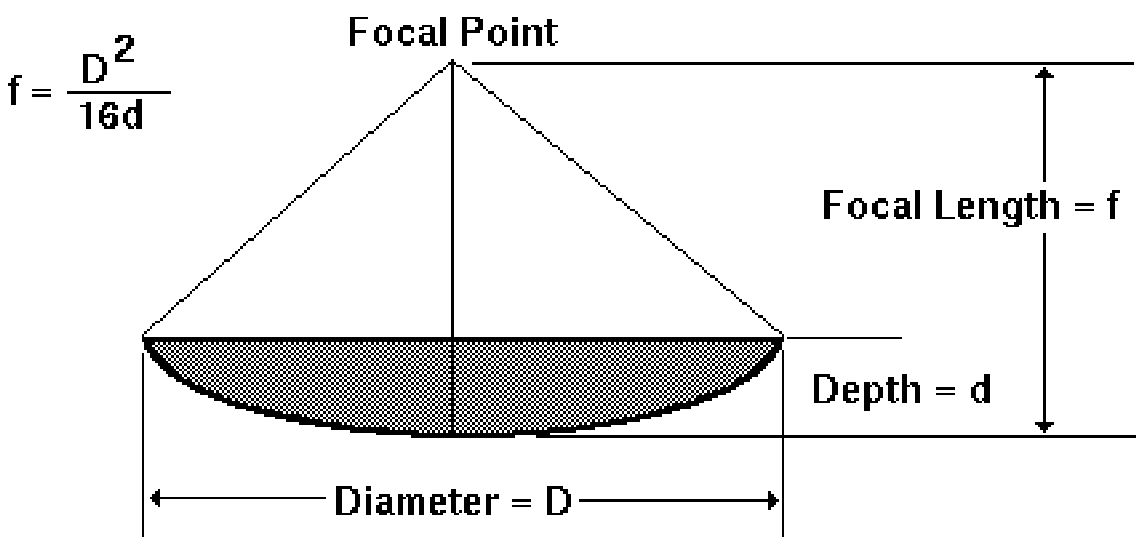
or about 50 meters for a small dish at 10 GHz.

A range length greater than the Rayleigh distance is sufficient for accurate antenna gain measurment, but not necessarily for adjustment of feed position. I recently found a paper[1] that shows that a range length of **$100 \bullet D^2/\lambda$**, or *fifty times the Rayleigh distance*, is needed to accurately locate the dish focus; on a short range, the error could as much as a half-wavelength. In Figure 6.1-8, we saw that a half-wavelength error in focal position can be fatal for a deep dish. Since the required distance at 10 GHz for even a small dish is 2500 meters, well over a mile, finding a clear area for a test range might be difficult.

A better alternative is a simple step-by-step procedure based on physical measurements and geometry — and a PC can do all the calculations for you, using the **HDL_ANT** computer program.

Conventional dishes - axial feed

1. Measure the dish diameter.
2. Measure the depth of the dish at the center — see Figure 6B-1.

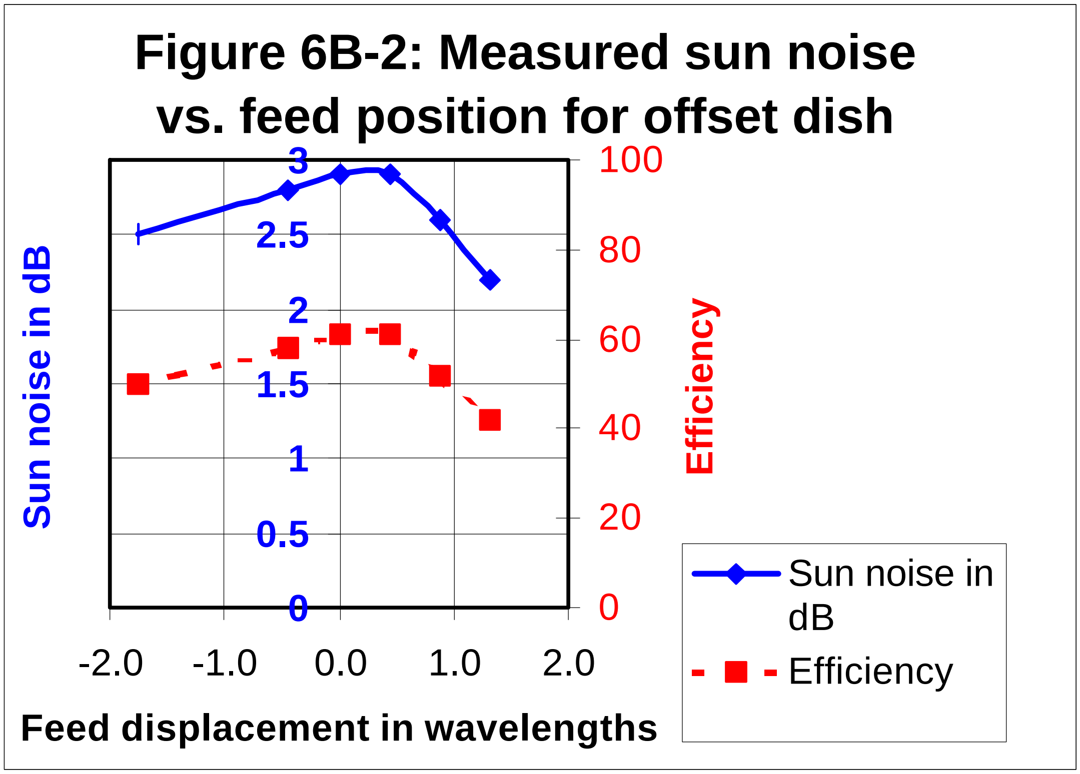


3. Calculate the focus length using the **HDL_ANT** program**.**
4. The ***f/D*** is the focal length divided by the diameter.
5. Pick a feed recommended for this ***f/D*** and note the location of the phase center. If you don't know the location of the phase center, assume it is at the center of the mouth of the horn. (Why would you not know the location of the phase center? Since just about all of the known good feeds are discussed in Chapter 6, you might reconsider your choice.)
6. Measure the VSWR of the feed and adjust if necessary.
7. Install the feed with its phase center at the focal point, using struts that are mounted so they don't distort the dish surface (K1LPS recommends a frying pan as illustrated in Figure 4-10).
8. If you can measure sun noise, continue. Otherwise jump to step # 13.
9. Measure sun noise with the dish.
10. Move feed in and out in quarter-wavelength steps. Measure sun noise at each position.
11. Draw a plot of sun noise vs. position.
12. Position feed at the best position on the plot.

13. Adjust the dish for maximum sun noise and look at the shadow of the feed (see Figure 5-8) — if all is well, it should be in the center of the reflector. If not, either the struts are uneven so that the feed is off-axis, or the parabolic surface is distorted. This does not mean the dish is unusable, only that aiming the dish by eye will not be accurate.
14. Tighten everything down.
15. Get on the air and make some contacts.

Offset-feed dishes

1. Measure longest and shortest dimensions of dish.
2. Find deepest point in dish and measure depth.
3. Measure position of deepest point from bottom edge along long axis. Measuring the depth and position of additional points will allow more accurate curve-fitting. (Even easier: most of the commonly available offset dishes are tabulated in Appendix 5A.)
4. Calculate focus position and ***f/D*** for feed horn using the **HDL_ANT** program.
5. Pick a feed recommended for this ***f/D,*** or design one using **HDL_ANT**. Note the location of the phase center.
6. Measure the VSWR of the feed and adjust if necessary.
7. Tie a knot in the middle of a piece of string, then mark the distance from the bottom edge of the dish to the focus away from the knot on one end of the string and the distance to the top edge on the other end.
8. Tape the string to the dish with the marks aligned to the top and bottom edge. The knot should be at the focal point when the string is pulled taut. See Figure 5-4.
9. Mount the feed so that the knot is at the phase center, as shown in Figure 5-5, with the feed pointed at the center of the dish.
10. If you can measure sun noise, continue. Otherwise jump to step #16.
11. Measure sun noise with the dish.
12. Move feed in and out in half-wavelength steps, along the line between the bottom edge of the dish and the calculated focal point. Measure sun noise at each position.
13. Draw a plot of sun noise vs. position. Figure 6B-2 is a plot I made for a one-meter offset dish at 10.368 GHz.
14. Position feed at the best position on the plot.
15. Adjust the dish for maximum sun noise and look at the shadow of the feed (see Figure 5-9) — if all is well, it should be centered along the bottom edge of the dish, where the string is attached.
16. Tighten everything down.
17. Get on the air and make some contacts.



Once the feed is in position, there should be no need for further adjustments. Trying to make adjustments on a mountaintop or remote location is asking for trouble. Once I have found the proper location, I make a metal bracket to hold the feed in place permanently, like the one in Figure 5-10; also, note the bubble level in the picture, to prevent elevation aiming errors. A larger dish might require multiple struts, like Figure 8-17.

A recent article in ***QEX*** showed an adjustable mount for an offset feed with *five* degrees of freedom. This range of adjustment is not only unnecessary, but probably decreases the odds of ever getting it right.

Mounting and pointing the dish antenna

A robust tripod is essential for portable work — if you can lift it with one hand, it will blow over too easily. I use the heavy surplus tripod shown in Figure 6B-3 and in Figure 10-2 on the left. For additional stability, a heavy battery may be tied under the center post. Under the rotating head is a compass rose, shown in Figure 6B-3, for accurate azimuth pointing. At each location, the azimuth indicator is calibrated by peaking on a beacon or other signal with a known heading. Once calibrated, the dish can be aimed with confidence.

A good source for the compass rose is the Oregon Rule Company[2]. They sell stick-on plastic "Graduated Dials" and "Astronomy setting circles" calibrated 0 to 360° either clockwise or counter-clockwise. On my tripod, the compass rose rotates and the pointer is fixed, so a CCW version was needed. A round plate is needed for support — an aluminum platter from inside an old 20 Mbyte hard drive is perfect for a 5-inch graduated dial.

On top of the transverter is a bubble level; if the dish is set up properly, the beam will be on the horizon when the bubble is centered.

Reference

1. W.A. Imbriale, P.G. Ingerson, and W.C. Wong, "Experimental Verification of the Analysis of Umbrella Parabolic Reflectors," *IEEE Transactions on Antennas and Propagation*, September 1973, pp. 705-708.

2. http://www.oregonruleco.com