Small Offset Stress Dish for Portable 1296 EME by Al – K2UYH

Abstract: This paper describes an offset dish and mount that was designed for portable EME operation on 23 cm. The antenna and mount can be disassembled into a relatively small lightweight package that can be carried as luggage on an airplane, yet is equivalent in performance to about an 8' diameter parabolic dish.

Introduction: The development of JT44/65 has generated considerable interest in portable and mini dxpedition activity on 1296 EME [1,2,3]. Most of these dxpedition stations have used single long yagi antennas because of their small size and low weight. Unfortunately on 1296, single yagis have insufficient gain to allow CW contacts with all but the largest stations. CW remained the preferred, if not the exclusive, mode of many EME operators. Even using JT44/65, QSOs are not possible with the smaller 1296 stations. Consequently a small, but higher gain antenna should be of great interest for portable 23 cm EME operation.

One problem with yagi antennas is that most are linearly polarized, while almost all *regular* 23 cm EME stations use circular polarization. It is possible to produce a circularly polarized yagi, and this would help. The use of circular polarization would provide an effective gain increase of 3 dB, but even more gain is desirable.

Dish antennas can be feed circularly polarized and provide lots of gain, but they also provide considerable additional weight and size, along with the gain. Stress dish designs can solve the problem of weight. For small size dishes, feed blockage becomes a problem. At 1296, particularly for dish diameters of 8' and less, feed blockage starts to significantly reduce antenna efficiency. The offset dish concept eliminates the feed blockage problem. It allows relatively small dishes to provide high gain efficiency. It thus seems that a circularly feed, offset stress dish would be an ideal antenna for portable 1296 EME operation. This paper describes the design just such an antenna.

Figure 1. 7.5' offset dish on polar mount

Offset Dishes: Offset set dishes are just a portion of a parabola of revolution (conventional parabolic dish) [4]. The antenna described in this paper uses slightly less than a quarter of a conventional dish reflector. By using only part of a normal *full* dish as the reflector, the feed antenna can be moved away from the center of the reflector, where most of the RF energy is located. The feed can be located to one side of the reflector, where little or no RF energy is present – as shown in Figure 2. The feed must still be located at the focal point of the parabolic curve. The feed must also have higher gain, since it should *ideally* only illuminate the reflector area. (As noted, the offset dish is only a *faction* of the full dish. Hence the feed antenna must have higher gain to produce a smaller beam). Likewise, a deeper dish (smaller equivalent f/d ratio) should be used for the offset reflector to keep the feed antenna to a reasonable size.

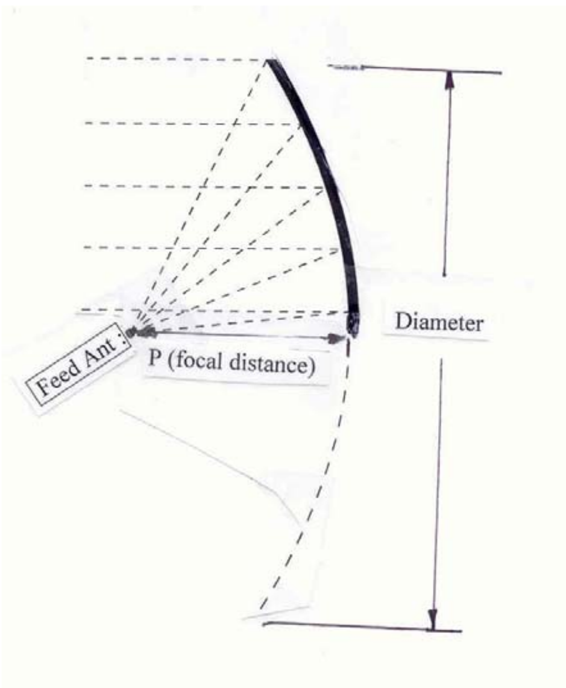

Figure 2. The feed is located to one side of the reflector

The offset dish besides having greater efficiency than a convention dish antenna has an added advantage for EME. It can be mounted with its center gravity very close to the ground and still fully track the moon. This allows a relatively small mount to be used and makes a polar mount an attractive choice with an offset dish.

Dish Construction: It was decided as compromise between portability and gain to construct a reflector with a radius of 7.5'. This would correspond to a conventional dish of 15' in diameter. In the case of our offset dish, only a quarter of a conventional dish's surface is used. This surface was produced from five 7.5' lengths of ½" x ¾" wood molding stock – readily available at the local Home Depot. These *struts* were attached to a 1' radius wedge shaped (quarter of a circle) piece of ½" plywood with two bolts. A 3' overlap was used. It would have been preferable to make channels into which the wood struts could be inserted for attachment. I used this method of attachment for the 70 cm 20' portable stress dish I produced more than 20 years ago [5]. This arrangement is stronger and makes assembly and disassembly quicker – but with only five struts, the added time was not considered significant.

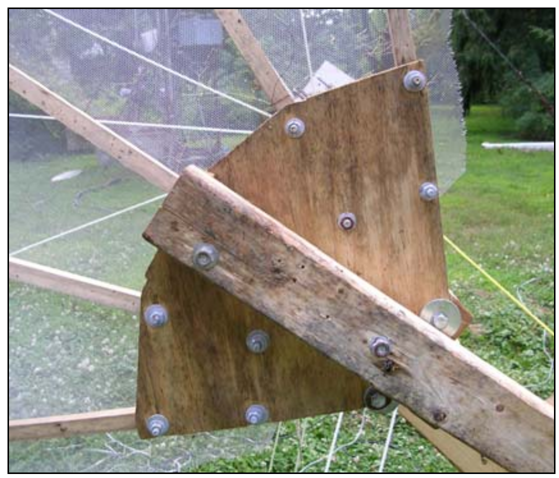

Figure 3. The *struts* are attached to a square plywood center with two bolts

A rim around the outside of the reflector was made with 3.5' length of ½" x ½" wood modeling stock with two small (8-32) bolts as shown in Figure 4. The 3.5' length was chosen to produce a reflector with an equivalent (full reflector) f/d ratio of about 0.3. This corresponds to a feed beamwidth of about 90°. (This beamwidth matches reasonably well a dual dipole feed). Making the reflector deeper using the relation:

$$X^2 = 4PY$$

where X is radius of the reflector, Y is the height and P is the focal distance, will allow a wider beam feed to be used. The dish's focal distance is about 4.5'.

Figure 4. An outside rim is formed from 3.5' length of ½" x ½" modeling strips

The dish's focal length is about 4.5' long. A 3.5' length of 2" x 3" lumber was used for the main feed support. This piece was attached to the plywood center section using a small wood block. Nylon ropes were run from the feed support to eye bolts at the ends of each strut. The length of these lines was adjusted so that the radius (X distance) of each strut was 7.5'. It was discovered that the pull of struts was bending the feed support (and plywood center section). To counter this effect, a second 3' length of 2" x 3" was added in the direction opposite to the struts and at a right angle to the feed support. The feed support was guyed to this add support to correct its bending as shown in Figure 5. The feed support was also used for attaching the dish to the mount.

<u>Feed Antenna:</u> Orthogonal dual dipoles with a quadrature hybrid to produced circular polarization were used as the feed antenna. Dual dipoles were chosen because

Figure 5. The dish is attached to the feed support by a 2" x 2" block

of their relative small size. (An IMU horn would be an excellent choice for a feed antenna, but would add significantly to the feed's size and weight). The feed was attached to about a 1' length of 2" x 2". This was attached to a second approximately 1.5' length of 2" x 2" using a single 3/8" bolt, which was in turn attached to the feed support by another single 3/8" bolt. Extra mounting holes were drill in the feed support to allow the position of the feed to raised or lowered. This arrangement provided several degrees of freedom in adjusting the position of the feed for optimum performance. Feed mounting details are shown in Figure 6.

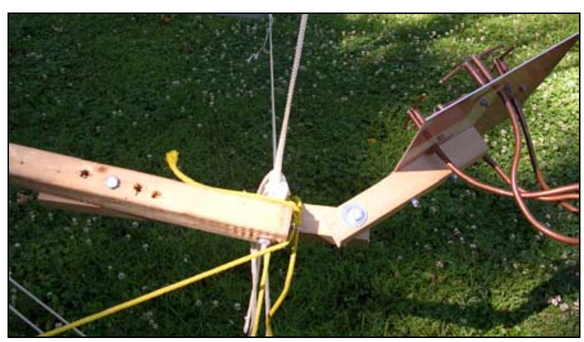

Figure 6. The feed is mounted using several supports to allow optimum positioning

<u>Polar Mount:</u> The offset dish can easily be mounted with a conventional El-Az mount, but also lends itself to polar mounting. Polar mounts have two axis of rotation. The main axis is the polar axis, which is aligned with the North Star. This axis is elevated to angle equal to the latitude and pointed to true north. The moon can usually be tracked for many hours by changing only the polar axis. This can be advantageous when manually tracking the moon as is common for portable operation. The other axis is declination. For amateur sized dishes, the declination needs to be set only once a day. It was decided to use a polar mount.

The polar mount was constructed from six 4' lengths of 2" x 3" lumber. The centers of two of these lengths were attached to a third length to form a base as shown in Figure 7.

Figure 7. The base of the polar mount is made from six 4' length of 2" x 3" lumber

Bolts and nuts were used to attach the lumber. A hinge was secured to one end of the third length, and the end of a fourth length attached to the other side of the hinge. Two additional lengths were attached on opposite sides to the other end of the base (third length) using a single long 3/8" bolt. These two lengths can be moved up and down. The fourth length is positioned between these two lengths. It can be secured at any desired angle (90° - latitude) by bolting the open ends of the two lengths together as shown in Figure 7.

A 1" long, 1" diameter, pipe nipple was used for the polar axis. This nipple was attached to a short (about 1.5') length of 2" x 3" using a pipe flange, and this short length attached to the dish's feed support with a single 3/8" bolt. The angle between the short length and the feed support is the declination angle of the mount and can be set using the 3/8" bolt. The rotation of the pipe flange on the nipple is used for the polar rotation. A second pipe flange was used to attach the other end of the nipple to the polar mount. This second pipe flange is attached near the top to one of the two parallel members of the polar mount as shown in Figures 7 and 8.

Figure 8. 1" diameter pipe nipple is used for the polar axis

One of the limitations of this polar mounting arrangement is that the dish cannot rotate through zenith. The mount blocks the dish. The solution to this problem is to unbolt the dish and flip it 180°. This switch takes only a minute or two and allows horizon-to-horizon moon track except the right near zenith.

Covering: The dish is covered with Aluminum screening. This material is available in the US in 3' width by 25' long rolls, which is sufficient to cover the dish, for relatively low cost. The screening was first rolled over the top of the stressed dish and cut to the required size. The remaining screening was flipped over to match the cut end with the shape of the dish, and rolled over the center portion of the dish. This process was repeated a third time for the bottom section – see Figure 9. One of the extra corner pieces from the top was used to cover the small remaining area at the bottom (vertex) of the reflector. The screening is attached to the struts using small gage (~ #24) wire. The wire is run through the mesh and around the struts and then wrapped (tied) together. The process of attaching the mesh takes only a few minutes. The Aluminum mesh can be removed and rolled around the 4' 2" x 3" members from the mount during transport/shipping.

Figure 9. Aluminum screening is tie to the struts using wire

Testing: The offset dish was originally constructed in a single weekend for use on a very hastily planned dxpedition to Bermuda. As events turned out, the power amplifier to be used failed two days before departure and plans for 23 cm operation had to be cancelled. I did test the dish for sun noise. The dish appeared to work as planned and yielded > 8 dB of sun noise. This was > 3 dB more than a 15' loop yagi that was to be our backup antenna.

Conclusion: The offset dish described in this paper is not considered a final design. It is intended to be a starting point that can be modified and tailored using available materials to specific station needs. It does offer a relatively inexpensive and simple way of obtaining an antenna for potable EME operation on 1296. It provides performance equivalent to about an 8' diameter parabolic dish, yet can be disassembled into a small lightweight package.

References:

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