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A *Parasitic* Lindenblad Antenna for 70 cm

Build this easy to reproduce antenna for omnidirectional circularly polarized work.

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A Lindenblad is a type of antenna that is circularly polarized and has an omnidirectional radiation pattern. This makes it especially useful for portable or temporary satellite operation because it eliminates the need for an azimuth/elevation rotator system. It is also a good general purpose antenna for a home station because it is compatible with both the vertical antennas used on FM repeaters and the horizontally polarized ones used for SSB/CW operation.

A traditional Lindenblad antenna uses four dipole driven elements to create the radiation pattern.[1] The need to feed these four dipoles from 50 Ω coax can make design and construction challenging. Past designs have used combinations of folded dipoles, open wire lines, twinlead, ¼ wave sections, transformers and special cables in order to try to get a good match to 50 Ω. A previous *QST* article described a way to simplify the construction of a 2 meter version, but even that approach is challenging on 70 cm due to the much tighter tolerances required.[2]

Skewed Parasites

The parasitic Lindenblad antenna introduces a much simpler way to construct these antennas for 70 cm. It uses a single dipole driven element along with a circular polarizer made from parasitic elements.

Hams have been using antennas with parasitic elements for many years. The concept was pioneered by Professor Shintaro Uda of Tohuku University (Japan) who wrote the first published article in 1926.[3] Professor Hidetsugu Yagi, a colleague at the University, collaborated with him and wrote an article in English that was published in 1928. This article was so widely read that the design became commonly known as a Yagi antenna. Most ham radio beam antennas today make use of this Yagi-Uda concept.

Parasitic elements in beam antennas are always in the same plane as the driven element because their purpose is to improve the gain or front-to-back ratio of the antenna. In the parasitic Lindenblad, however, all of the antenna elements are in different planes. The driven element is a vertical dipole extending up from the mast, as shown in the photo. The parasitic elements surrounding the driven element convert the vertically polarized signal to circular polarization.

The parasitic elements are arranged in a similar manner to the driven dipoles of a traditional Lindenblad antenna. They are positioned equally around the center dipole and canted at 30° from horizontal. Because of this 30° shift, the parasitic elements absorb power from the electromagnetic field of the driven element and this causes a current to flow in them. The induced current flow causes the parasitic elements to radiate their own electromagnetic field just as if they had been driven from a feed line. Since they are arranged as a traditional Lindenblad antenna, the resulting radiation is circularly polarized.

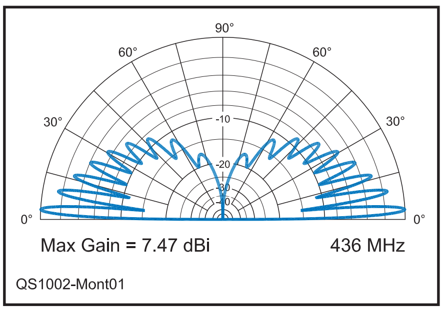

Figure 1 — *EZNEC* predicted elevation pattern of the parasitic Lindenblad. The azimuth pattern is almost perfectly circular.

Parasitic Lindenblad Performance

The overall antenna pattern is the combination of the patterns of the parasitic elements and the vertical dipole. The spacing of the parasitic elements from the driven element is designed so that they absorb and reradiate half of the total antenna power. The tuning of the parasitic elements is designed so that their vertical component cancels half of the driven element field. The resulting combination is only circularly polarized and opposite sense from the parasitic elements alone. This means that with the parasitic elements tilted as in a left-hand polarized

[1]Notes appear on page 48.

Lindenblad, the antenna pattern will be right-hand circularly polarized.

The antenna elevation pattern predicted by an *EZNEC* model is shown in Figure 1.[4] This is the right-hand circularly polarized gain with the antenna mounted 10 feet above ground. The maximum gain predicted by the model is 7.47 dBic; however, the real antenna gain will be more like 6 dBic.[5] The predicted azimuth pattern, not shown, is almost perfectly omnidirectional with less than 0.1 dB variation.

The driven element is designed to provide 50 Ω directly but it requires a balanced feed for proper operation. If the coaxial cable is connected directly to the dipole, a significant antenna current will flow over the outside of the coax shield, which will distort the radiation pattern and cause an impedance mismatch. Fortunately, it is very easy to eliminate this shield current by using a pair of inexpensive ferrite cable sleeves.

Rolling Your Own

The parasitic Lindenblad was constructed using only hand tools. Most of the construction and materials are not critical, and experienced antenna builders should feel free to substitute their own favorite techniques. The structural elements of the antenna are made of standard, UV-resistant (gray) PVC components that are cemented together. They were all found at a local hardware store. Table 1 provides a list of the required parts.

LMR-240 coaxial cable is used because of its low loss, low cost and wide availability but any small diameter 50 Ω cable may be substituted as long as the length is kept short. The cable ferrites have a 0.25 inch inner diameter so the cable needs to be smaller than this to fit inside.

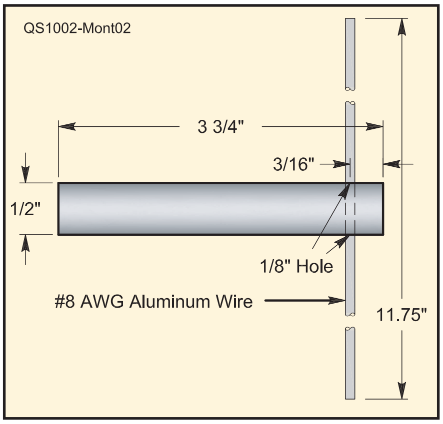

Figure 2 — Fabrication details of parasitic element.

The polarizer structure is made from four rain gutter ferrules and a conduit adapter. This structure supports the four parasitic elements made from #8 AWG aluminum ground wire.

Parasitic Element Fabrication

Start by making the four parasitic element assemblies as shown in Figure 2. Cut the ferrules to 3¾ inches in length. Drill a ⅛ inch hole through each ferrule 3/16 inches from the end. The hole should go through both ferrule walls and be centered as much as possible. Push a ground wire through the hole in the ferrule and center the wire so that it sticks out the same amount on both sides of the ferrule. Apply the adhesive liberally through the end of the ferrule to coat the wire and the inside of the ferrule wall. Set these aside for several hours until the adhesive is dry. The assembled element is shown in Figure 2.

Driven Element Fabrication

Next make the driven dipole assembly as shown in Figure 3. Gently tap the PVC insert connector into the two pieces of aluminum tubing with a hammer until they are spaced ¼ inch in the center. It may be necessary to file down the insert connector first to make it fit. Drill a hole for a #6 screw, ⅜ inch from the end of the tubing at the center insulator. Directly across the insulator, also spaced ⅜ inch from the end, drill a hole for a #8 screw.

Clean the holes in the dipole with steel wool and apply conductive grease. Carefully thread the machine screws into the holes but do not tighten them. Strip the insulation from one end of the coax and unbraid the shield, making a pair of wires. Leave about ¼ inch of insulation on the center conductor. Wrap the center conductor around the #6 screw and the shield around the #8 screw and tighten as shown in Figure 4. Attach the coaxial cable to the tubing with wire ties to hold it in place. Slip the heat-shrink tubing over the dipole connections and heat until it makes a nice tight fit.

Push the insert end of the insert to threaded PVC adapter into the end of the aluminum tubing with the coaxial cable. Drill a hole and insert and tighten a #6 screw to secure the tubing to the insert adapter. Thread the 12 inch riser onto the threaded end of the adapter. This provides an insulated section to use for fastening the antenna to a mast. Slip the cable ferrites over the open end of the coaxial cable and align them with the bottom of the driven dipole as shown in Figure 5. Fasten the ferrites and cable with wire ties.

Making The Parasitic Element Hub

To make the parasitic element hub, drill four ½ inch holes in the conduit adapter, spaced equally around the adapter with the holes ⅛ inch from the 1 inch side. The four parasitic element assemblies should fit snugly into these holes but do not attach them yet.

The parasitic element hub needs to fit over the driven dipole so that the ½ inch holes are centered on the PVC insulator. Using a file or a rotary cutting tool, create a small channel for the #6 screw in the dipole center so that the hub fits over the center part of the dipole.

After this is done, drill a hole through the top part of the hub and through the aluminum tubing for a #8 machine screw. Insert the #8 screw to hold the hub in place.

Temporarily attach the 12 inch PVC riser to a support so that the dipole is perfectly ver-

Table 1
Parts Required for Parasitic Lindenblad Antenna

Quantity	*Description*
1	Gray PVC insert connector, ½" × ½"
1	Gray PVC insert to threaded adapter, ½" to ½"
1	Threaded PVC lawn irrigation riser tube, 12" × ½"
1	PVC electrical conduit adapter, 1" to ¾"
4	Gray PVC ferrules for spacing rain gutter nails, 5" × ½"
4	Lengths of #8 AWG aluminum ground wire or ⅛" aluminum tubing, 11.75"
2	Lengths of ¾" outer diameter, 17 gauge, aluminum tubing, 6 1/16"
2	Aluminum sheet metal screws, #6 × ⅜"
2	#8 × ½" aluminum sheet metal screw
2	Fair-Rite cable ferrites. Part # 2643540002 (Mouser Electronics Stock #623-2643540002)
1	Times Microwave LMR-240 coaxial cable, 3 to 10' as needed
1	Male N connector for LMR-240 coaxial cable
1	Black plastic end cap (optional), ¾"
4	Black plastic end caps (optional), ½"
	Heat shrink tubing for ¾" cable
	Regular bodied gray PVC solvent cement for Carlon conduit
	Outdoor waterproof contact adhesive (Marine Goop)
	Conductive grease for aluminum electrical connections (Ox-Gard OX-100)
	UV resistant black wire ties

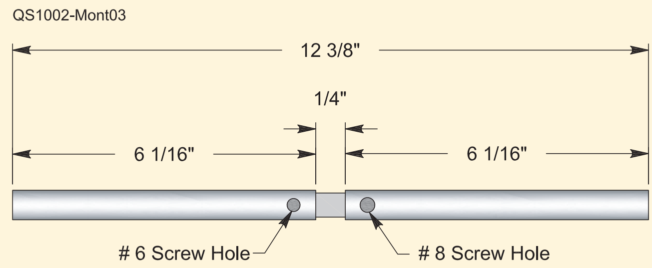

Figure 3 — Details of driven element construction.

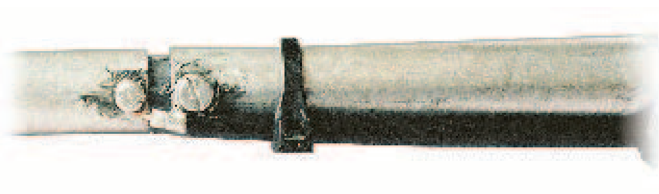

Figure 4 — View of driven element coax cable attachment.

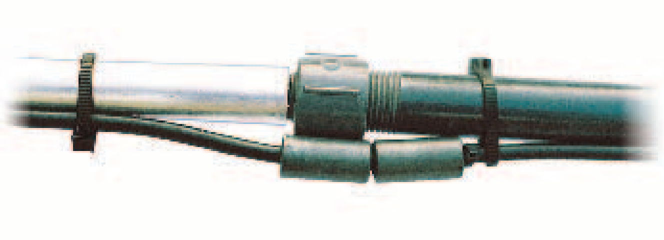

Figure 5 — Ferrite bead common mode choke at base of driven element.

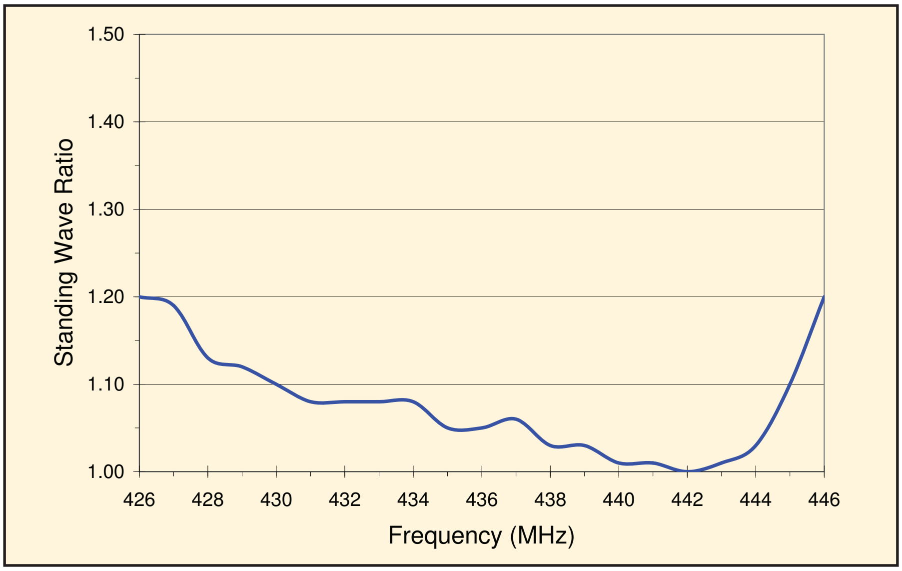

Figure 6 — Measured SWR versus frequency of the completed parasitic Lindenblad antenna.

tical. For each parasitic assembly, apply the gray PVC solvent cement around the outside of the ferrule on the end away from the aluminum wire. Carefully insert the ferrule into the ½ inch hole in the hub about ⅛ inch and quickly set the angle of the wire to 30° from horizontal by rotating the ferrule. Looking toward the hub, the left-hand side of the wire should be up. Allow the PVC cement to dry on all of the parasitic assemblies.

When it's dry, push the optional plastic end-caps onto the ferrules and the top of the dipole. Attach the connector to the end of the coax. This completes the construction of the antenna. The PVC riser allows the antenna to be attached to a mast with a pair of U bolts.

Checking it Out

The impedance match to 50 Ω was checked using an AEA-Technology 140-525 Analyzer. This device plots a graph of the standing wave ratio versus frequency and has an LCD digital readout. The antenna was connected to the analyzer through a 10 foot coax cable. The SWR was measured over a 20 MHz range centered at 436 MHz with the results shown in Figure 6.

As can be seen in the chart, the antenna provides an excellent match over the satellite sub band from 435 to 437 MHz and the SWR is very low over the entire measured 426 to 446 MHz range. The low SWR allows this antenna to be used as a general purpose antenna for 70 cm including CW, SSB, FM and repeater use. The SWR will of course vary with antenna height and ground quality, but it should easily provide the 1.5:1 or better match that most modern transmitters require in order to provide maximum power.

The parasitic Lindenblad antenna was designed to handle up to 75 W as is typical of 70 cm ham transmitters. This antenna should not be used with a high-power amplifier unless a different choke is employed, as the ferrites might get hot and damage the coax.

On the Air

The parasitic Lindenblad antenna has been used to make SSB and FM voice contacts via the AO-7, FO-29, SO-50, AO-51 and VO-52 satellites during Field Day operations. Satellite uplinks were run at 50 W output. On the downlinks, a low noise (1 dB NF) preamp mounted at the antenna was employed. The parasitic Lindenblad has performed well during ARRL Field Day, which is an excellent test of an antenna as it is probably the busiest time of the year on the satellites.

Notes

[1]G. Brown and O. Woodward Jr, "Circularly Polarized Omnidirectional Antenna," *RCA Review*, Vol 8, no. 2, Jun 1947, pp 259-269.

[2]A. Monteiro, AA2TX, "An EZ-Lindenblad Antenna for 2 Meters," *QST*, Aug 2007.

[3]*Directive Short Wave Antenna, 1924,* IEEE History Center, Rutgers University, New Brunswick, New Jersey, USA available at **www.ieee.org**.

[4]*EZNEC+ V4* antenna software by Roy Lewallen, W7EL. Available from **www.eznec.com**.

[5]Decibels compared to an isotropic circularly polarized antenna.

ARRL member Tony Monteiro, AA2TX, was first licensed in 1973 as WN2RBM. He started his engineering career as a member of the technical staff at Bell Laboratories and has served as an engineering director at a series of high-tech start-up companies. Contact him at 25 Carriage Chase Rd, North Andover, MA 01845 or at **aa2tx@amsat.org**.