About this Article

This material was included with the downloadable supplemental content accompanying the *ARRL Antenna Book*.

You may print a copy of this material for personal use. Any other use of the information requires permission from the ARRL.

Copyright/Reprint Notice

In general, all ARRL content is copyrighted. ARRL articles, pages, or documents – printed and online – are not in the public domain. Therefore, they may not be freely distributed or copied. Additionally, no part of this document may be copied, sold to third parties, or otherwise commercially exploited without the explicit prior written consent of the ARRL. You cannot post this document to a website or otherwise distribute it to other through any electronic medium.

For permission to quote or reprint material from ARRL, send a request including the issue date, a description of the material requested, and a description of where you intend to use the reprinted material to the ARRL Editorial and Production staff at: **permission@arrl.org**.

"Cat Whiskers"
The Broadband Multi-Loop Antenna

Contact challenging DX with a broadband, bidirectional antenna covering 14 – 30 MHz.

Jacek Pawlowski, SP3L*

This easy-to-build, lightweight antenna covers five Amateur Radio bands, requires no tuning, and is forgiving of small construction measurement errors. As you can see in the photo, it is comprised of both solid and wire elements. It derives its nickname from the way the wire elements fan out like cat whiskers.

***Second-place winner in the 2017 *QST* Antenna Design Competition, 80 Through 10 Meters category**

Whiskers and Spreaders

The antenna's overall dimensions are 7.4 × 4.5 meters (see Figure 1). There are four wires ("whiskers") going to the left-hand side and another four wires to the right of the feed point in the center. The top and bottom whiskers are attached to spreaders made of fiberglass fishing rods. The remote ends of the whiskers are soldered to a rectangular wire frame, creating a number of loops.

All wires in the prototype antenna are #17 AWG tinned copper, which suits up to 200 W or so of RF power. You should increase wire diameter if a higher power rating is required.

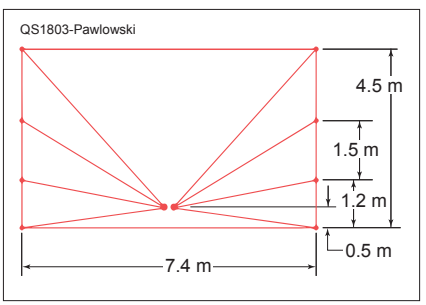

Figure 1 — Cat Whiskers broadband, bidirectional antenna dimensions (in meters).

Converting from Metric to US Standard

1 meter = 3.281 feet

1 millimeter = 0.0391 inches

The upper spreaders are tilted up by 47 degrees and the lower ones are tilted down by 8 degrees. The upper ones are 5.4 meters long and the lower ones are 3.7 meters long. They are made of 8- and 6-meter fiberglass fishing rods, respectively. The two thinnest segments were removed from each rod and the remaining segments were extended and glued together. The rods were then cut to size. The cross bracket is made of a 400 × 400 × 4 millimeter steel plate. Basic dimensions of the bracket are shown in Figures 2 and 3. The thicker ends of the fishing rods were slipped into 40-millimeter diameter aluminum tubes and attached to the cross bracket with U-clamps. The vertical 50-millimeter diameter aluminum tube is well suited for the applied rotator. Figure 4 shows how the cross bracket looks in the prototype antenna.

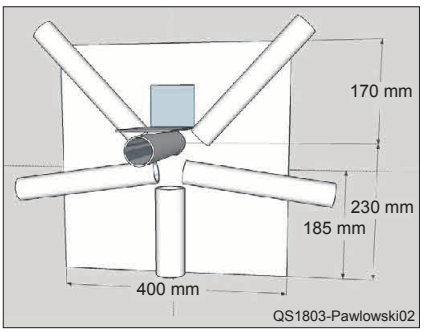

Figure 2 — Cross bracket side (front).

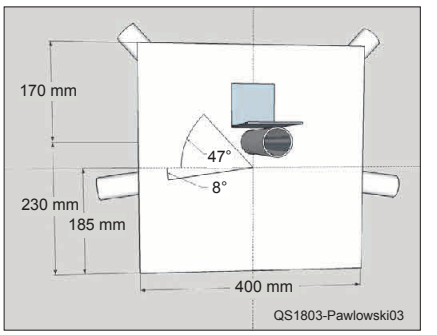

Figure 3 — Cross bracket side (back).

Figure 4 — Prototype antenna supported by trimmed cross bracket mounted atop a Yaesu G-450C rotator. A plastic box containing the 6:1 balun is mounted behind the cross bracket.

Adding a Boom

An additional tube can be added perpendicular to the antenna plane to form a boom. This boom is useful for two purposes. Ropes from the spreader ends to the boom ends will stiffen the whole construction and make it more resistant to strong winds. Adding a longer boom and some V-shaped wire reflectors and directors will turn the antenna into something similar to the Spiderbeam antenna. That's the intended evolution of this project. The very first Cat Whiskers implementation had no boom and the upper spreaders trembled in strong winds. Based on this observation, a fiberglass or aluminum boom with ropes are advisable additions.

Raising the Antenna

The prototype antenna weighs 17.6 pounds. Figure 4 shows a light Yaesu G-450C rotator that is used to aim the antenna, which adds another 3.5 kilograms to the antenna weight. The Cat Whiskers antenna was initially installed on a crank-up segmented aluminum mast, which made hoisting it quite simple. When the mast was still only 3 meters high, the rotator was attached, and then the antenna was lifted up and attached on top of it. Finally, segment after segment was added at the bottom of the mast and cranked up. The antenna ended up 11 meters above ground level. A small team of fellow hams was needed to secure the mast with guy ropes as it was being moved up.

Electrical Design and Performance

The wide bandwidth of the Cat Whiskers antenna was achieved through innovative multi-loop topology. During computer modeling, the antenna dimensions were chosen for minimum impedance variation. As a result, the antenna's impedance varies from 137 Ω to 640 Ω over the whole 14 – 30 MHz range (see Figure 5), with attendant SWR changes of 1.83:1 to 2.56:1 when calculated directly at the feed point without a feeder (see Figure 6). The SWR is calculated for a 300 Ω source because a 6:1 balun is assumed to be connected between the antenna and the coax feed line.

The balun for the prototype antenna was built with three transformers, as shown in Figure 7. T1 is an unun

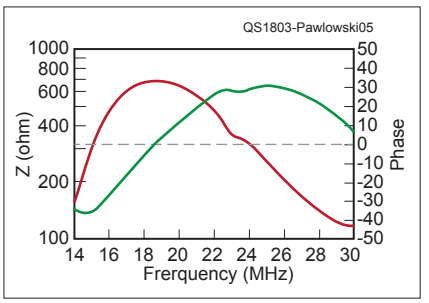

Figure 5 — Feed-point impedance (green) and phase (red) from 14 to 30 MHz.

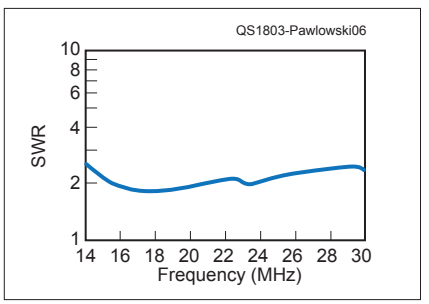

Figure 6 — Feed-point SWR simulated in free space from 14 to 30 MHz.

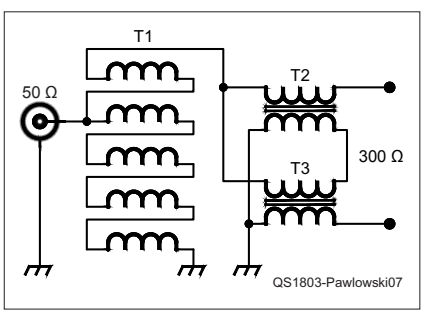

Figure 7 — Schematic of 6:1 balun.

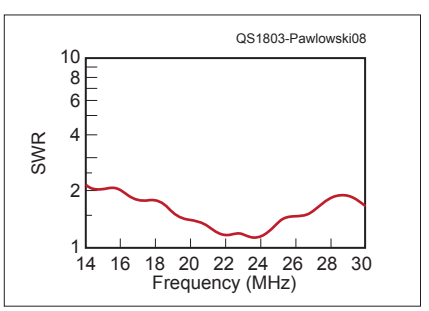

Figure 8 — Real SWR measured at the transceiver input with a 6:1 balun at the antenna fed by 40 meters of RF-7 coaxial cable.

transforming 50 Ω to 75 Ω. Its winding has 10 turns of five enameled #20 AWG wires. Transformers T2 and T3 form a Guanella 4:1 balun and ideally should be wound with a pair of wires having a characteristic impedance of 150 Ω. Stranded wires with thick high-voltage isolation were used to construct the transformers. This thicker-than-normal insulation creates wider separation between the wires, which increases their characteristic impedance to something close to 150 Ω.

The T2 and T3 windings also have 10 turns. Three FT140-61 cores were used. If your transmitter delivers more than approximately 200 W, bigger cores should be used, such as the FT240-61. The balun may look a little overdesigned, but I wanted to take every precaution to block common-mode current flowing in the coax. Such common-mode current would distort SWR measurements and lead to false conclusions.

When a coax is connected to the balun, the SWR is reduced because real-world coax is not a lossless transmission line. For example, if you connect 30 meters of a rather lossy cable such as RG-58, the SWR measured at the transceiver end would be below 1.85:1 over the 14 – 30 MHz range.

In the prototype installation, RF-7 coaxial cable was used (similar in performance to RG-213, but somewhat thinner). The SWR measured in the shack varied from 1.14:1 to 2.18:1 over the whole frequency range (see Figure 8). This was a really delightful result.

The well-known T2FD antenna has similar SWR performance, but to work properly, the T2FD must dissipate quite a lot of RF energy in a resistor. Due to the energy dispersion, it has significantly less gain than a half-wave dipole. As for the

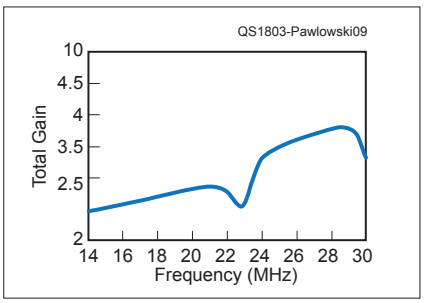

Figure 9 — Free space gain from 14 to 30 MHz.

List of Materials

(2) Fiberglass fishing rods, 8 meters long

(2) Fiberglass fishing rods, 6 meters long

(5) Al tubes ½ meter in length, 40-millimeter OD

(1) Al tubes ½ meter in length, 50-millimeter OD

(1) Steel plate 400 × 400 × 4 millimeter

(8) **U**-clamps for 40-millimeter tubing

(2) **U**-clamps for 50-millimeter tubing

(58 meters) Tinned #17 AWG stranded wire

(50) Plastic cable ties, UV resistant

(4 meters) Scotch tape

(1) Plastic box for the balun

(2) Plastic clamps to mount balun box

(3) FT140-61 cores

(2 meters) #24 AWG enameled wire

(2 meters) High-voltage #20 AWG stranded copper wire

(1) SO-239 connector

(2) M5 bolts

(4) M5 nuts

(8) M5 large-diameter washers