By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

2.4-GHz Patch Antennas

This time I'm going to show you some simple-to-build 2.4-GHz patch antennas. My styrofoam wall-board designs don't work well above 1500 MHz or so, as the material is just too thick. Thus, we will be building this one "DeadBug" style.

The ground plane can be almost any sheet metal. I like to use a sheet of PC-board material, but you can use sheet aluminum, brass, copper, tin, or even steel. If you do use PC-board material, there are a few things to watch out for. With single-sided PC board make sure the copper side is toward the patch. If you're using double-sided PC board, make sure you have a good ground to the ground plane closest to the patch. The size of the ground plane somewhat affects gain, but going much more than an inch beyond the edges of the patch doesn't add much gain. As it is, the round and rectangular patches will have 9 to 9.5 dBi gain. The circular-polarized version has about 6 dBi vertical gain and 6 dBi horizontal gain for 9 dBiC (dbi circular).

The patch needs to be something to which you can solder. Sheet brass or tin works best. It doesn't have to be square, and as you notice from the photographs, none of the three featured patch antennas are square.

The first patch is round. There are few advantages to a round patch, though. It can be a bit harder to build using hand tools, and it tends to be narrower in bandwidth than a square or rectangular patch. There are some tricks such that the circle is really an oval; it's fed slightly off center and develops circular polarization. Many of the VHF and UHF patch antennas on AO-40 use this technique, but when using hand tools, this antenna is more of a novelty. I found the bottom of a Campbell's soup can was about the right size and used it to mark my circle on sheet brass. The point of attachment was found experimentally using a network analyzer.

Maximum gain is perpendicular to the patch. Looking at the example shown in photo 2, the maximum signal would be directed right at you.

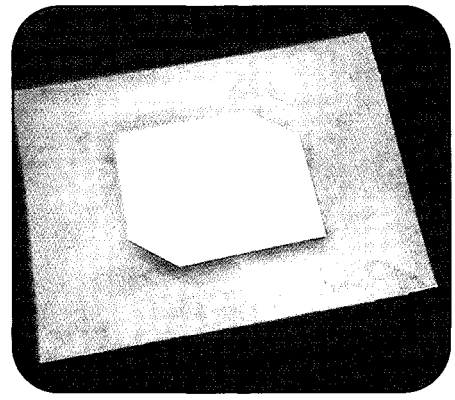

Photo 1. Some 2.4-GHz patch antennas.

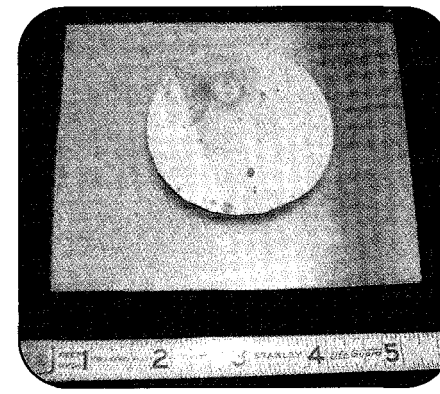

Photo 2. A circular patch.

The rectangular patch has better bandwidth than the round patch and is certainly easier to cut out. I just cut the patch from sheet hobby brass using some heavy-duty scissors. Again, the point of attachment was experimentally determined. Construction can be fun, and there are a lot of ways to do it. Using a fine soldering iron, just get in there and solder it. I found it easier to solder a blob onto the end of the coax connector, tin the back of the patch, and then just briefly heat it with a micro torch. All three of these patches are mounted 1/4 inch off the ground plane, so a 1/4-inch rod positions the patch while I'm heating it.

The –10 dB return loss or 2:1 SWR points show a bandwidth of 150 MHz or so. I feel a future column on dB return loss coming. When it comes to calculations, SWR is a very clumsy system to use. Most test equipment is calibrated in dB return loss. That's how many dB's lower the reflection is compared to the through signal. A –10 dB return loss is about a 2:1 SWR; –20 dB return loss is close to 1.2:1 SWR; –30 dB return loss is about 1.05:1 SWR; and that flirt you see with –40 dB return loss would be a 1.02:1 SWR.

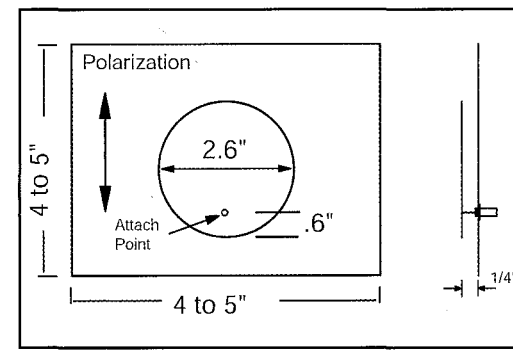

Figure 1. Circular patch dimensions.

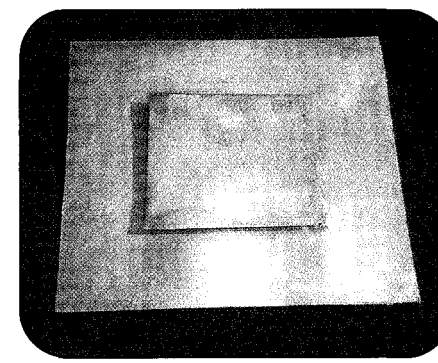

Photo 3. A 2.4-GHz rectangular patch.

Circularly-Polarized Patch

As we covered in the previous "Antennas" column in the Summer issue of *CQ VHF,* there are many ways to generate circular polarization from a patch antenna, but trimming the corners a bit is one of the easiest ways. I've tried to find some rules for the depth of those cuts, but none seem to equal my measured results. Thus, the .6 inch was determined by trim-

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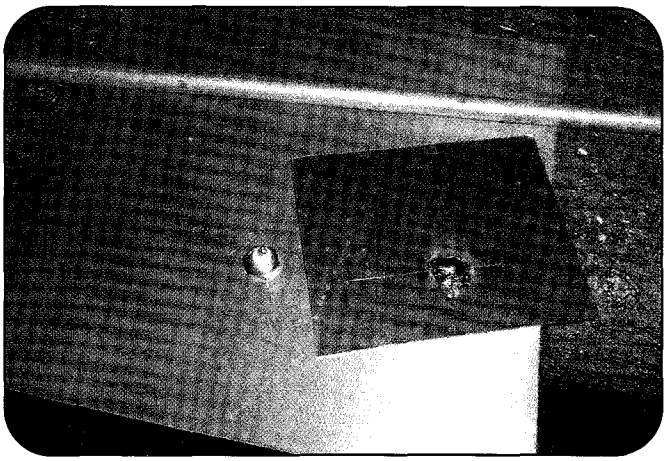


Photo 4. Construction of the patch.

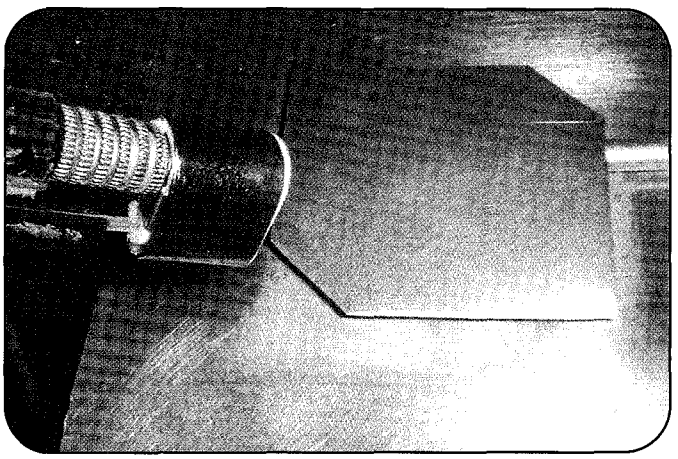


Photo 5. Construction of the patch.

ming, trimming, and trimming a little at a time until the gain didn't change as I rotated the patch 90 degrees when pointed at the source antenna.

Gain vs. Dish Diameter

First, the antenna can be mounted at the focus of a dish to give you more gain. How much more gain? Well, that depends on a lot of factors, but an 18-inch dish, which is about the smallest size you would want to use on 2.4 GHz, will give you about 15 dBi gain. A 3-foot dish would give 22 to 23 dBi of gain. Bigger? Okay, a 6-foot dish would give in the 29–30 dBi range.

Just remember that when you use a circular-polarized antenna as a dish feed, the feed is bouncing the signal off the dish. Therefore, the world is seeing a mirror image of the feed. If you want a right-hand circular-polarized dish, you need to install a left-hand feed. This feed will work great with OSCAR AO-51 or almost any S-Band bird.

Wi-Fi

This antenna also makes a good little antenna for your Wi-Fi experiments. Like the AMSAT version, it can be mounted at the focus of a dish if you are working on a really long shot. (I have heard of one lad pointing one of these at a local motel for internet access, but I can't condone such actions!)

Letters, Letters . . . We Get Letters

From Jeff we received some questions on tweaking Cheap Yagis and similar antennas.

First, make sure the coax is attached correctly. At the Central States VHF Society antenna range last July, I saw a Cheap Yagi with the coax reversed. The coax shield was to the tip of the "J" and the center conductor was to the middle of the element. This person had noticed that the coax was hot, so he put a long string of ferrite beads on the coax. This did keep RF off the coax, and the antenna performed up to spec on the antenna range. Frankly, that's not something I would have expected. However, it's a lot easier if you connect the coax per my diagrams.

Next, trim the free end of the "J" for best SWR. This is much like trimming or adjusting the driven element of any Yagi.

Last, I have my own "Yagi Tweaker," which I've shown before (see photo 10). Short pieces of Yagi element material are taped to the ends of a wood stick. Putting the tweaker near

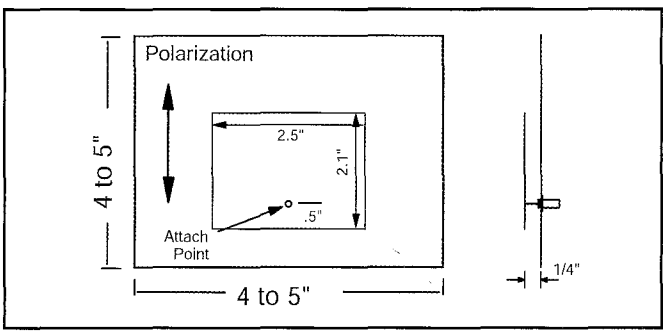


Figure 2. Rectangular patch dimensions.

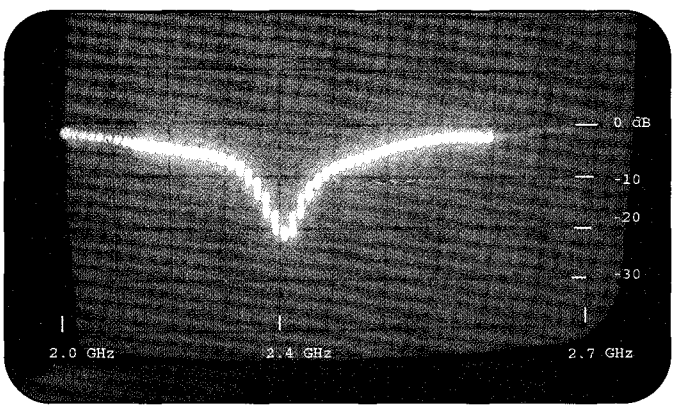


Photo 6. Rectangular patch frequency response.

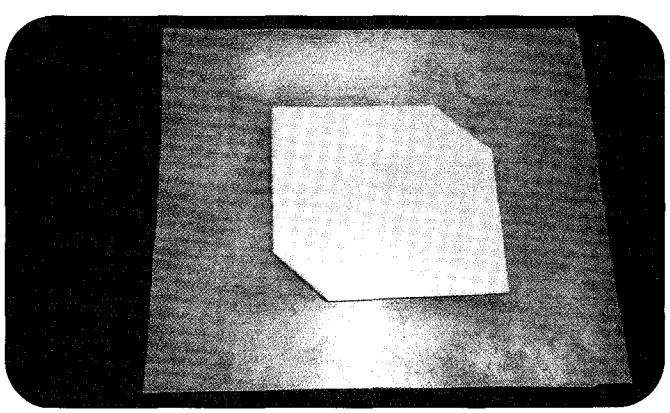


Photo 7. A 2.4-GHz circular-polarized patch.

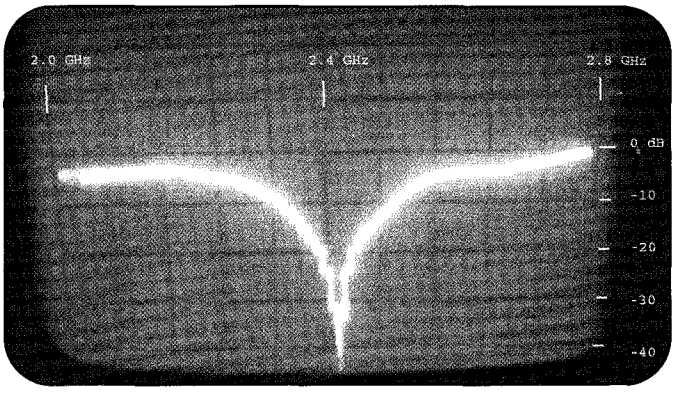


Photo 8. Circular-polarized patch frequency response.

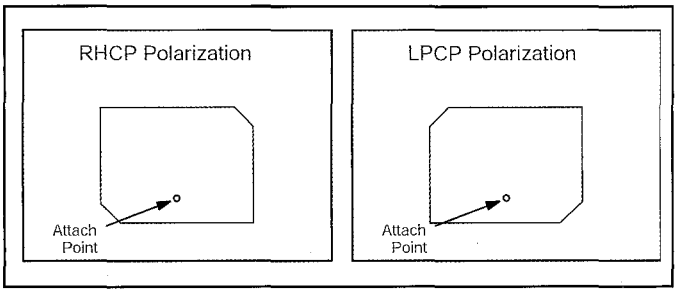


Figure 4. Left- and right-hand circular-polarized notches.

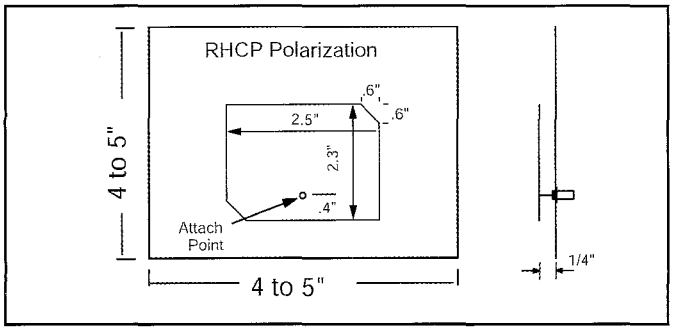


Figure 3. Circular-polarized patch dimensions.

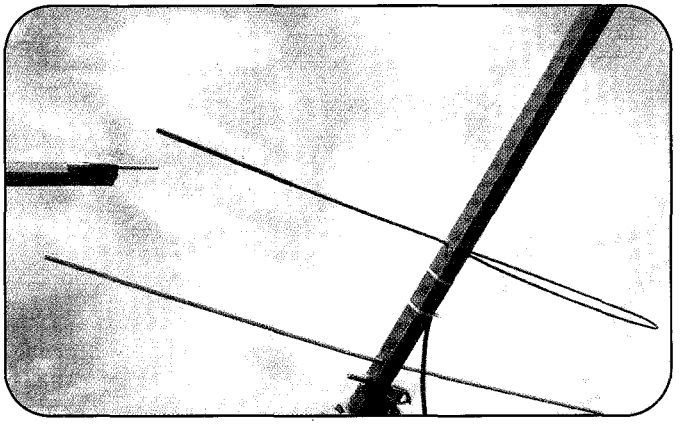


Photo 9. The author's "Yagi Tweaker."

the tips of each element quickly shows you the most sensitive elements. If the SWR starts going up as the tweaker gets near the tip of the element, then the element is too long. If the SWR dips as you get the tweaker near the tip of the element, then it's too short.

This really needs to be done on an antenna range. Retuning a Yagi for a super-flat SWR destroys its pattern, and that's not going to get you anywhere. However, a slightly long director #1 is the quickest way to kill the SWR of a Cheap Yagi.

Photography Note

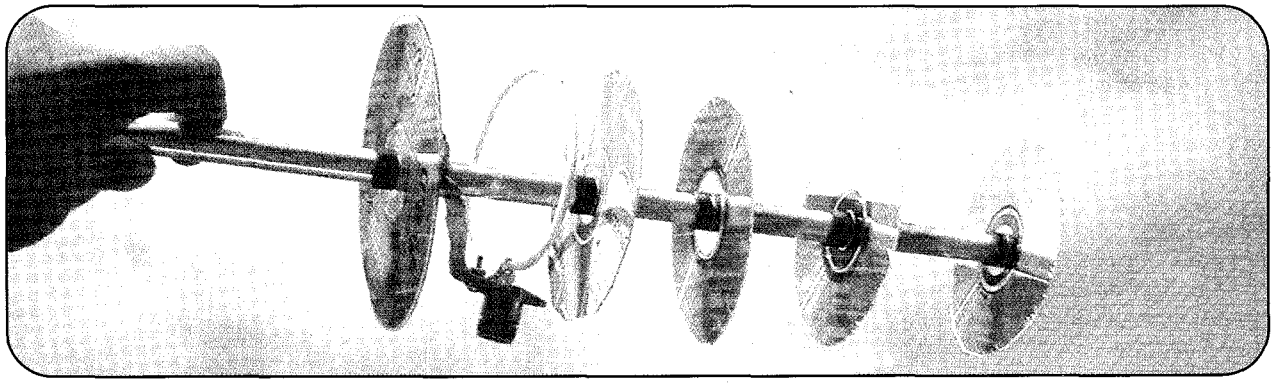
Photographing a good old analog network analyzer CRT is fun (not). Getting the sweep and the shutter to almost sync is the hardest part. It takes about ten shots to have one come out, so until I get my $100K analyzer, you'll have to suffer through my camera shortcomings.

Have fun with antennas, and we'll see what makes it out of my lab for the next "Antennas" column.

A Fun Antenna

Last July at the Central States VHF Society antenna contest, Bob, VE3BFM, showed up with this interesting 900-MHz antenna made out of AOL CDs. Not bad! It measured right at 10 dBi gain!

The design is known as a "Disk and Rod" or sometimes a "Cigar" antenna. Bob found that a straight CD resonates at about 850 MHz, so he used one as a Yagi reflector. The other CDs had been trimmed down in diameter somewhat so they could act as Yagi directors. I think I've figured out how to model one of these around a Cheap Yagi driven element, so we just might have a fun project in the near future if I can come up with an easy way of cutting down the diameter of a CD. That brings up the question of the antenna gain of music vs. data CDs . . . or maybe rap vs. easy-listening vs pop CDs. You certainly can get all the free AOL element material you need at your local post office!



A fun antenna for 902 MHz.