May 2003 *QST* - Copyright © 2009 American Radio Relay League, Inc. - All Rights Reserved

By Bob Patterson, K5DZE

A VHF/UHF Discone Antenna

A practical antenna for 144, 222 and 440 MHz and everything in between!

Amateur Radio will surely become more involved in Homeland Security communications. That will mean that the need for multiband operations on VHF and UHF will be more than a desired option; it will be a requirement. Likewise, we will likely have a need to monitor radio communications of other services that operate between and above our VHF/UHF frequencies. Amateurs could also be called upon to provide technical support to emergency services if they catastrophically lose all outside antennas. All of these situations make the Discone antenna a reliable design and a great option for Homeland Security as well as general amateur use.

This antenna design is not original with me. The original version appeared in a December 1978 *QST* article written by David Geiser, WA2ANU (now W5IXM)[1] [The earliest professional reference to the Discone appears in a 1946 paper by A. G. Kandonian, then of Federal Telephone and Radio Laboratories. Mr Kandonian appears to be the first to have coupled a disc with a cone.[2] The earliest published amateur reference is a 1949 *CQ* article by J. M. Boyer, W6UYH.[3]—*Ed.*]

I became familiar with it while stationed in Germany in 1979 as a US Signal Corps officer. We needed an antenna to cover several VHF frequencies, but we could not get one through the military supply system. I remembered this antenna design in *QST* and decided to build one for my unit's use. It worked so well that I wound up building several of them. Today's serious need makes this antenna an excellent multi-frequency radiator and an option to be aware of.

The Discone Advantage

Discones have some unusual operational characteristics that can be distinct advantages as Homeland Security communications antennas. The antenna radiates like a quarter wave vertical above a ground plane. While there is little gain, the antenna shows extremely wide bandwidth—a major asset. Discone antennas behave like high-pass filters [or impedance transformers, coupling to free space.—*Ed.*] in that, *above* a designed cutoff frequency, the antenna radiates well. *Below* that cutoff frequency the SWR rises sharply and the antenna ceases to function. Above the cutoff frequency, the SWR can remain acceptable for up to 10 times that frequency. This means a Discone designed for a lower-end frequency of 144 MHz will operate at all frequencies up to and well past 450 MHz while maintaining a 2:1 SWR. [Kandonian presents data that shows the SWR to be about 3:1 at the cutoff frequency and rapidly approaching a value of 1.3:1 at 50% above the cutoff frequency, where the cutoff frequency is 200 MHz.[4] It appears best, therefore, to design a VHF-UHF Discone for a low-end cutoff frequency slightly below the operating frequency. The design formula in Figure 1 reflects that goal.—*Ed.*]

Geiser commented that his design worked at 1.3 GHz with a 5:1 SWR. While I haven't tried them at 1.3 GHz, the antennas I built for 144 to 444 MHz all had SWRs at or below 2:1, across that range. For Homeland Security operations this means that one antenna can transceive on the VHF/UHF amateur bands and also receive law enforcement, fire, EMS, government, military and other emergency service frequencies. The antenna could even be put into emergency backup service by those agencies.

Construction

Simply stated, a Discone looks like an inverted cone with a round disc placed on its top and insulated from the cone. Amateur ingenuity will quickly bring to mind several ways one could construct such an antenna.

My first *test* antenna in 1979 was constructed not of metal, but from very heavy cardboard covered with heavy aluminum foil, appropriated from the military "mess hall." It worked like a charm and wound up sitting on the attic rafters of a German building for several years with good results. So much for the *test* model!

Geiser's design used "hardware cloth" or very stiff galvanized steel "chicken wire" that is manufactured as a ¼ inch square mesh. This design is based on the original version, but updated. This material does not need a lot of support if you intend to place the antenna inside an attic, out of the wind and weather. For outside use, a wood or PVC "tree" can be placed inside the antenna for rigidity and support. Here is how to do it.

Lay out a 5 foot long length of hardware cloth. Tack the corners down so it won't roll up. Use a felt tip marker pen to draw the cone and disc designs. Using a heavy metal shear, *carefully* cut out these antenna elements. Heavy gloves are recommended to protect hands from the sharp wire edges, which can inflict painful cuts. Fold the wire cloth into the cone shape. The height and diameter of the cone are about the same, about 110% of a ¼ wavelength at the lowest operating frequency, according to Geiser. The diameter of the disc is about 67% of the same parameter. Aluminum ground wire or nuts and bolts can hold the edges together to start. Some of the edge wires can be folded into hooks to give added strength to the seam. Use a heavy soldering iron to spot-solder the wire seam together. Figure 1 shows the general construction technique for the antenna, together with design formulas.

[1]Notes appear on page 41.

May 2003 *QST* - Copyright © 2009 American Radio Relay League, Inc. - All Rights Reserved

To feed the antenna, an inverted SO-239 coaxial connector can be used to screw or solder the top of the cone to the connector's mounting flange and then solder the top disc to the center conductor. I prefer to solder the cable directly to the antenna and not use a coax connector. If you use a 1½ inch × 3 foot long PVC pipe as the center support, the pipe can be pushed through the cone and out the small end. The hardware cloth can then be screwed around its top lip. A small hose clamp can work well here, if you desire.

Run the coax up the PVC pipe and out the top. Notch the pipe end to let the shield rest in the notch and solder the shield to the top of the cone. The center conductor of the coax should then stand straight up. Drill a small hole in the center of a 3 or 4 inch plastic disc or square. (I used a PVC coaster.) Place it on top of the PVC pipe and run the center wire of the coax through the hole. Using PVC cement, glue this PVC disc to top of the PVC pipe. Solder the center conductor of the coax to the center of the wire disc. Center the hardware cloth disc on the plastic disc and attach it with several screws. That's it.

Options for construction material and technique are as varied as one can imagine. For the cone and disc, copper window screen can be used with wood strips for inside cone support. For larger antennas, you might consider self-supporting wire for the cone and disc rather than the screen material. I have seen very large discone antennas for the HF spectrum and they looked like string lights on a pole at Christmas. Now there's a thought!

On The Air

The VHF/UHF Discone is a lot more forgiving of construction techniques than are Yagi or quad antennas. Initial tests will surely be successful if you get the antenna in the clear and elevate it. For a first test, I had my antenna on my desk. I got a 59 report from a station about 3 miles away. Not spectacular, but I was inside the house with the antenna on a metal desk at ground level and it was being fed less than 10 W of RF. Once I put it up at 50 feet it worked well on every VHF/UHF frequency I tried. The SWR remained below 2:1 on both 146 MHz and 440 MHz.

Any good commercial $^5/_8$-wave antenna, small Yagi or homebrew VHF/UHF quad can beat this antenna at gain on a given design frequency, but none of these will have the gain-bandwidth product across the VHF/UHF spectrum that this performer has. If you need a high bandwidth, easy to construct antenna that's ideal for emergency communications, the Discone is worth a look.

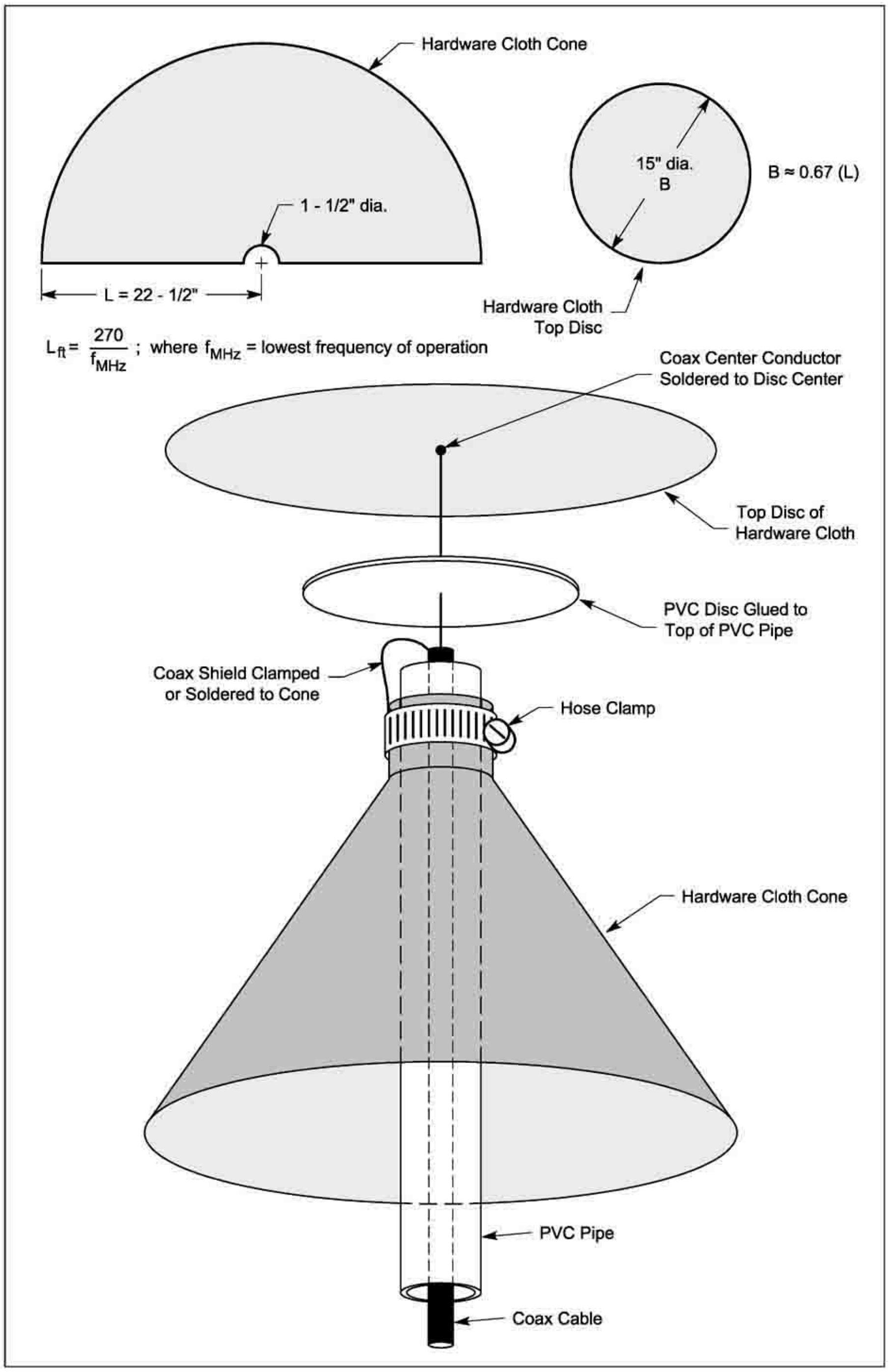

Figure 1—Construction of the hardware-cloth discone antenna.

Notes

[1]D. Geiser, WA2ANU, "An Inexpensive Multi-band VHF Antenna," *QST*, Dec 1978, pp 28-29.

[2]A. G. Kandonian, "Three New Antenna Types and Their Applications," *Proceedings of the I.R.E.*, Vol 34, Nr 2, Feb 1946, pp 70-75.

[3]J. M. Boyer, W6UYH, "Discone—40 to 500 Mc Skywire," *CQ*, Jul 1949, p 11.

[4]See note 2.

Bob Patterson, K5DZE, is an Amateur Extra class amateur and Life Member of ARRL with over 45 years of ham radio experience. He has operated across the country as well as overseas, where he has held the call signs HL9EZ and DA1EZ. Bob spent five years with the US Marines and 25 years with the US Army, retiring as a Lt Colonel. He holds a BS in Professional Aviation from Louisiana Tech University. Bob is currently vice president of Finance and Administration for Central Bible College in Springfield, Missouri. He is the faculty advisor and club trustee of the CBC ARC, W5CBC, which won the ARRL Achievement Award 2000 as top college/school club in the US. He is an active volunteer examiner and emergency coordinator, and is a former DEC. His operating interests include QRP, CW and DX. You can contact the author at 1280 W Burntwood St, Springfield, MO 65803; **k5dze@arrl.net**.