A Durable, Low Profile 2-Meter Mobile Antenna

A vertically polarized slot antenna designed to withstand the rigors of automotive rooftop mounting.

John Portune, W6NBC*

Originally developed in 1938 for VHF television broadcasting, the slot antenna has not found frequent application in Amateur Radio. This design, shown above mounted to a truck rooftop, is an exception. Being horizontal, it is naturally low-profile, yet it is vertically polarized, which is essential for mobile operation. Its omnidirectional azimuth gain is 4.83 dBi when mounted on a vehicle roof. In the same location, a quarter-wavelength vertical spike has an azimuth gain of 3.74 dBi (see Figure 1). The 3 dB bandwidth is greater than 5 MHz, as shown in Figure 2.

Basic Theory

This antenna is a derivative of the classical slot antenna, but it is not a patch antenna. Patch antennas radiate at right angles to their metal surfaces and are therefore usually mounted vertically. Also, their surfaces are not electrically connected. In this slot antenna, the conductive surfaces are connected by two ¾-inch diameter aluminum shorting posts. Together, the su[illegible]s and shorting posts form a [illegible] wavelength horizontal slot antenna.

*First-place winner in the 6 Meters and Higher category in the 2017 *QST* Antenna Design Competition

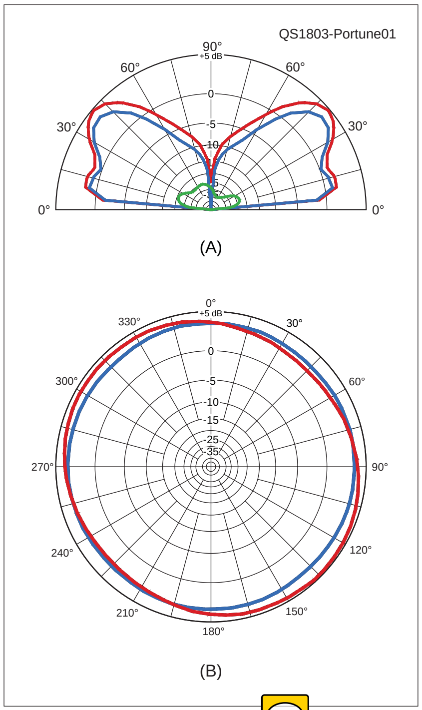

Figure 1 — Omnidirectional [illegible] of the slot antenna (red) compared with a quarter-wave spike (blue), both mounted on a vehicle roof.

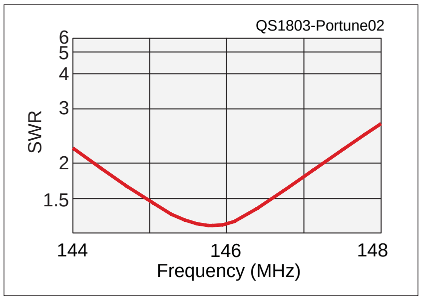

Figure 2 — The 3 dB bandwidth of the antenna is greater than 5 MHz.

In contrast to a conventional slot antenna, the slot and antenna surfaces are not in the same plane. The slot, formed by the aluminum shorting bars connecting the two antenna surfaces, is orthogonal to the two planes. Even though the plane of the slot is vertical, it still acts as a horizontal slot because it connects two horizontal antenna surfaces. Again, as stated above, a horizontal slot yields vertical polarization, which is essential to mobile operation. This 90-degree rotation of polarization is a fundamental difference between slots and dipoles.

Construction

The assembly drawing is shown in Figure 3. Construction is straightforward and can be accomplished with hand tools. Although aluminum is easier to work, it is not essential; steel is quite satisfactory because conductor resistance is not a problem due to the large areas. Steel, however, must be protected from the weather. Also, the metal does not have to be solid. Perforated metal or wire cloth may be used because RF does not "see" small openings.

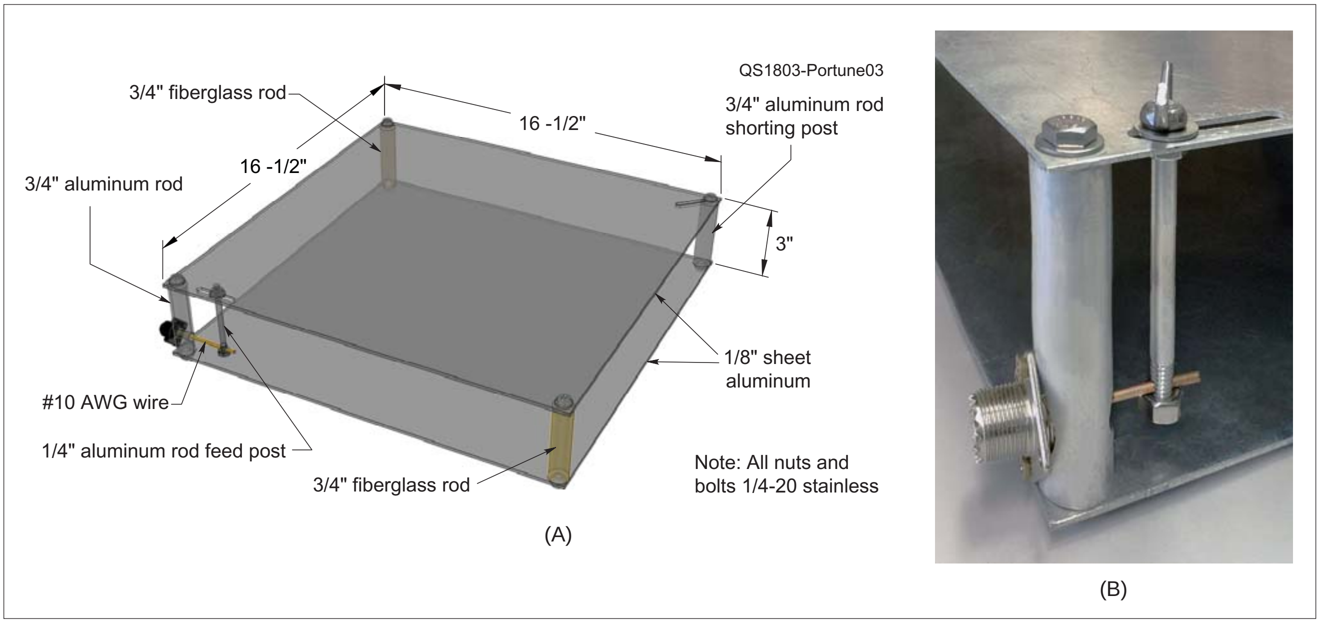

Figure 3 — At (A) is the mechanical layout of the antenna. Note the feed point in the lower left corner: the shield of the feed line is connected to the lower plate and the inner conductor passes through the aluminum shorting rod and connects to the upper plate via a ¼-inch diameter threaded aluminum rod. At (B) is a close-up of the adjustable feed point.

When forming the slots (either by drilling or cutting) for the shorting rod adjustment, clamp the top and bottom panels together so that the slots will register. The adjustment slot for the feed rod is only required in the top panel. Drilling, threading, and tapping aluminum is much easier if cutting fluid formulated for aluminum switch [illegible]sed, such as Tap Magic Aluminum.

Four neodymium cup magnets mount the antenna on the vehicle. This attachment method has been extensively tested at highway speeds.

Tuning and Matching

The match to 50 Ω (i.e., low SWR) is easily achieved with an antenna analyzer, simply by moving the feed-point fixture. Moving the shorting post opposite the feed point sets the operating frequency. As shown in Figure 3, the tuning range is roughly 141 – 148 MHz.

To tune the antenna, first install it in its intended operating location. Next, set the match by adjusting the position of the aluminum feed post. Finally, set the operating frequency by adjusting the position of the aluminum shorting post in its slot, diagonally opposite the feed post. Once set, the match should change little with adjustment of the frequency.

Figure 4 — Alternative shapes are also possible. At (A), a boomerang shape is aesthetically more pleasing than the square, but requires more fabrication effort. At (B), the novelty bat-shaped antenna is always a fun attention-getter.

Materials List

(2) 16½ × 16½ × ⅛ inch aluminum sheets (can be as thin as 0.09 inches or substitute perforated metal or heavy wire cloth)

(2) ¾ × 3 inch aluminum shorting rods tapped for ¼-20 bolts at both ends

(2) ¾ × 3 inch fiberglass or acrylic spacing rods tapped for ¼-20 bolts at both ends

(1) ¼ × 3 inch aluminum connecting rod threaded for ¼-20 nuts at both ends, one end cross drilled with a ⅛-inch hole, $\frac{5}{16}$ inch from the end

(8) ¼-20 × ¾ inch stainless bolts and washers

(4) ¼-20 stainless nuts

(4) 1¼ inch neodymium cup magnet mounts with holes for mounting

(4) stainless mounting screws and nuts for cup magnets

(1) chassis-mount connector of your choice with mounting hardware

The size and shape of the vehicle will change the match and tuning. It will change even more if the antenna is used on a non-metallic surface, such as a rooftop. So, if the antenna is moved from its initial setup location, it will probably need to be retuned at its new location.

Shape Variations

The distance between the metal plates can be varied, which will affect the bandwidth, with a wider spacing having a wider bandwidth. The 3-inch spacing in the prototype is a good compromise between a low profile and a low SWR across the 2-meter band.

Similarly, the shape of the metal planes is not rigidly defined. As the rectangular aspect ratio changes or the rectangle is morphed into a curved shape, the radiation pattern will change, but the operating characteristics will remain essentially constant. A circular shape is the most compact and is omnidirectional, but the square version is the easiest to construct. The trade-off is yours to make.

Merely as examples, Figure 4 shows two other shapes created during prototyping. Aesthetically, the boomerang shape (see Figure 4A) is more attractive than a simple square. The bat-shaped version (see Figure 4B) was created purely for fun and is entirely functional. It is popular in parking lots and at radio club meetings and rallies.

Conclusion

This orthogonal-plane slot antenna is ideal for low-profile mobile operation on RVs, trucks, and SUVs, where durability is required. However, it may also find application on military vehicles, owing to its ruggedness and an unconventional appearance that is not readily seen as an antenna. Its stealthy profile also makes it ideal for fixed rooftop use, especially metal roofs, due to the fact that no ground plane is needed.

Photos by the author.

John Portune, W6NBC, is an ARRL member and frequent contributor to *QST*. He has been licensed for 52 years and has held an Amateur Extra-class license since 1972. John has a BS in physics and also holds FCC Commercial General Radiotelephone Operator and FCC Radiotelegraph licenses. He retired as a broadcast television engineer and technical instructor at KNBC in Burbank, and then from Sony Electronics in San Jose, California. You can reach John via e-mail at **jportune@aol.com** or through his website at **www.w6nbc.com**.

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New Products

UrbanBeam Multiband Antenna from SteppIR

The SteppIR UrbanBeam Yagi antenna features a 4-foot boom length and turning radius of less than 16 feet, and covers 40 through 6 meters. It's designed for hams living in urban or suburban areas with limited space to install antennas. Weighing less than 45 pounds, it can be mounted on a pole or roof. The UrbanBeam functions as a Yagi on the 20 through 6 meter bands, and is said to provide performance close to a dipole on 30 and 40 meters. As with other SteppIR antennas, its elements are tunable to the operating frequency. Price: $1,769. For more information, or to order, visit **www.steppir.com**.