[This design won first place (6m and above category) in the ARRL 2017 Antenna Design Competition.]

Durable, Low Profile 2m Mobile Antenna

This unique 2m antenna is ideally suited for low profile mobile operation, and where high durability is needed, such as on the roof of RV's, trucks, vans and SUV's.

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The slot antenna, originally developed in 1938 for VHF television broadcasting, has not found frequent application in ham radio. This design is an exception, Figure 1. Being horizontal, it is low in profile, yet it is vertically polarized, essential for mobile operation. It has an omni-directional azimuth gain of 4.83 dBi on the roof of a vehicle. In the same location, a ¼ wavelength vertical spike has an azimuth gain of 3.74 dBi. See Figure 3. The 3dB bandwidth is greater than 5 MHz, Figure 2.

Figure 1: Antenna on cab of pickup truck, attached by neodymium cup magnet mounts

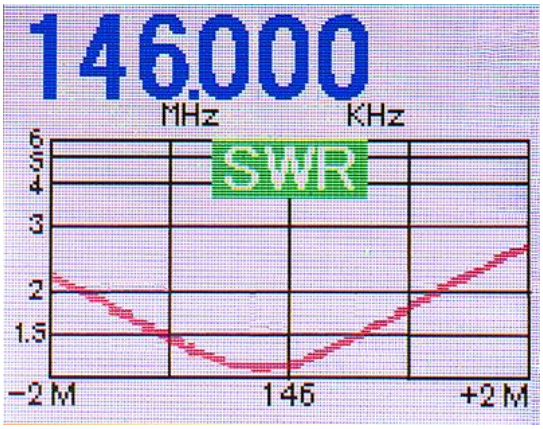

Figure 2: SWR sweep 144-148 MHz Comet CA-500 MkII Antenna Analyzer

Basic Theory

This antenna is a derivative of a classical slot antenna. It is not a patch antenna. Patches radiate at right angles to their metal surfaces and are therefore usually mounted vertically. Also, the surfaces are not electrically connected. In this slot antenna, the conductive surfaces are connected by two ¾ in. aluminum shorting posts. The surfaces and the posts form a one wavelength horizontal slot antenna.

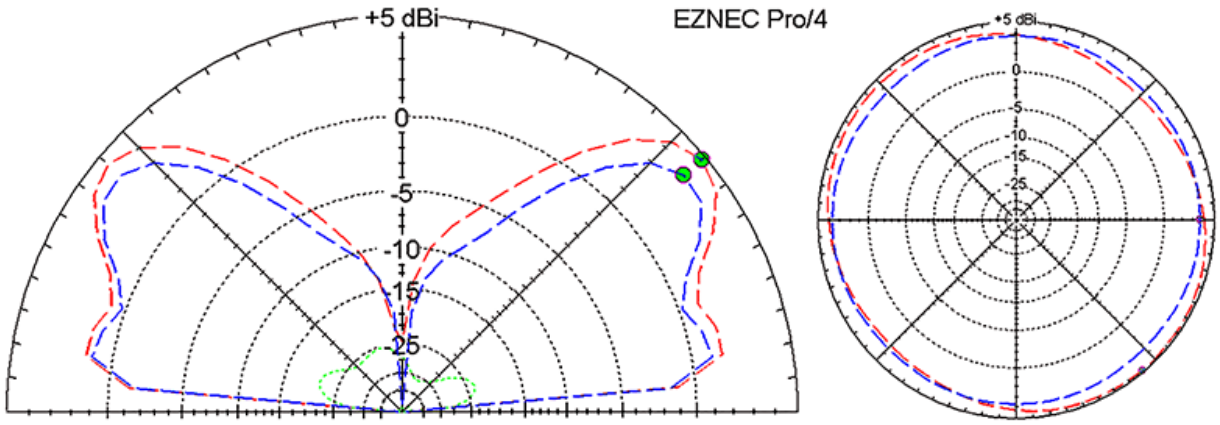

Figure 3; EZNEC Radiation Patterns. (Red) this antenna, (Blue) ¼ wavelength spike, over a 5 ft. square wire grid, 5 ft. high, over average soil (generic vehicle)

The big difference here, in comparison to a conventional slot antenna, is that slot and surfaces are not in the same plane (normal to each other). They are at right angles (orthogonal). As stated above, a horizontal slot yields vertical polarization, essential to mobile operation. This 90-degree rotation of polarization is a fundamental difference between slots and dipoles. Four neodymium cup magnets mount the antenna on the vehicle. This attachment method has been extensively tested at highway speeds.

Construction

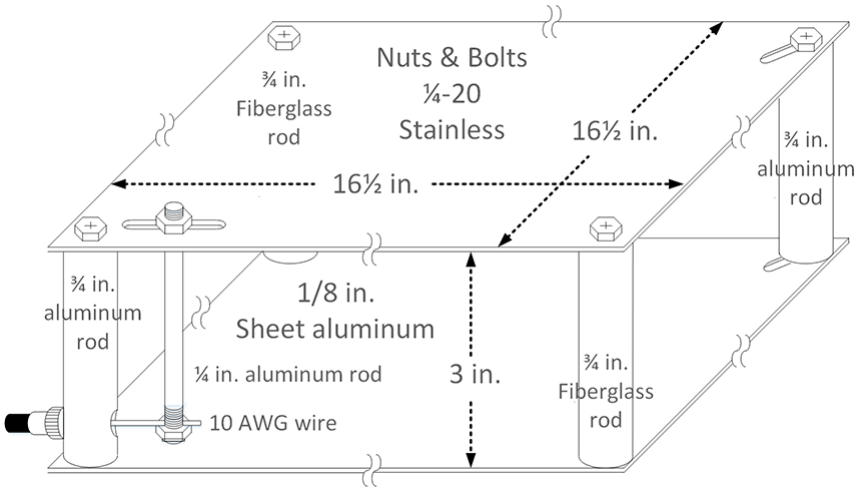

Figure 4: Construction details. Length and width foreshortened for clarity:

List of Materials

2	16½ in. square aluminum sheets, 1/8 or 3/32 in.
	May be perforated metal or heavy wire cloth.
2	¾ in. x 3 in. aluminum rods, drilled and tapped for
	¼-20 bolts, both ends
2	¾ in. x 3 in. fiberglass or acrylic rods, drilled and tapped for
	¼-20 bolts, both ends
1	¼ in x 3 in. aluminum rod, threaded for ¼-20 nuts, both ends,
	one end 1/8 in. cross-drilled, 5/16 in. from end
8	¼-20 stainless bolts x ¾ in. and washers
4	¼-20 stainless nuts
4	1¼ in. Neodymium cup-magnet mounts with holes for mounting
4	Stainless mounting screws and nuts for cup magnets
1	Chassis-mount connector of your choice and hardware

Tuning and Matching

The match to 50 Ohms (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, the tuning range is roughly 141-148 MHz. Set the match first, then the operating frequency. Once set, the match changes little with adjustment of the frequency. As with all antennas, it is best to tune this antenna in its intended operating location. 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.

Variations

The distance between the metal plates is not fixed. The biggest change with greater separation is bandwidth. A wider spacing has higher banwidth. The 3 in. spacing shown is a good compromise between a low profile and a low SWR across the 2m band.

Similarly, the shape of the metal planes is not rigidly defined. As the height and/or the width changes, or the shape of the plane is bent into a curve or an elbow, the radiation pattern and the overall size changes. Otherwise, the operating characteristics remain essentially constant. A circular shape is

the most compact and omni-directional. A square version is more convenient to construct.
Another variant is the type of metal used. Aluminum is not essential; steel is quite satisfactory if protected from the weather. Also the metal does not have to be solid. Perforated metal or even wire cloth may be used. The RF does not see small openings. Similarly, conductor resistance is not a problem owing to the large surfaces.

Merely as examples, Figures 5 and 6 show two other shapes created during prototyping. Aesthetically the boomerang shape is more attractive than a simple square. The bat-shaped version was created purely for fun, although it is entirely functional and is popular in parking lots and at radio club meetings and rallies.

Figure 5: Omni-directional, boomerang shape with 2 in. separation

Figure 6: Novelty shape with 2dB additional front-back gain but loss to the sides

Conclusion

For low-profile mobile operation where durability is an asset, this orthogonal-plane slot antenna is ideal. Its main application is on RV's, trucks and SUV's. It may also find application on military vehicles owing to its ruggedness and non-conventional appearance. It is not readily seen as an antenna. It is also stealthy for fixed rooftop use. It requires no ground plane and works well on metal rooves.

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