

Design and Radiation Characteristics of Low Profile TM21 Ring Antenna and Concentric Linear Monopole Assembly

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This report presents the design considerations for a low profile TM21 mode satellite-radio antenna at 2.3GHz. A low profile antenna assembly, intended for installation on top of an automobile, is created to generate a circular polarized (CP) conical pattern for satellite reception (optimized for geosynchronous satellites) and a linear monopole radiation pattern for terrestrial reception. The CP conical pattern is generated using a two wavelength ring tuned for the TM21 mode (fig. 1) (R. Garg, P. Bhartia, I. Bahl, A. Ittipiboon, "Microstrip Antenna Design Handbook", Artech House). A simple low profile CP patch does not have a broad enough beamwidth to serve as a satellite antenna for lower elevations. A helix or crossed dipole can be used to generate cardioid patterns, but these are taller antennas.

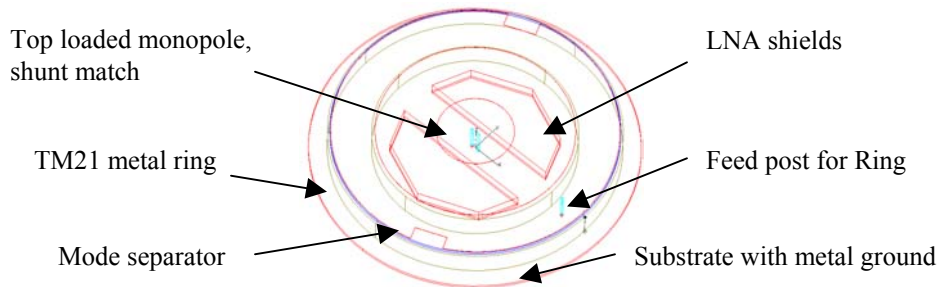


Fig. 1: CP TM21 ring / linear monopole (satellite/terrestrial) antenna assembly.

A design parameter is the width of the ring. Wider is better than thinner for four reasons: First, the radiation from a wide-trace ring is dominated by the E fields on the outer edge of the ring, and the gain closer to the horizon is greater. The feed point impedance is reduced to a reasonable design value, due to the ability to move the feed point inwards from the outer circumference. Finally, the bandwidth is larger and the efficiency is better due to the larger effective antenna volume.

The TM21 ring antenna needs a ground plane. A very small ground plane is better than an infinite ground plane for low elevation gain (fig. 2). An infinite ground plane prohibits CP radiation along the horizon. Smaller ground planes can be used on fiberglass trucks or front dashboards. The gain at low elevation can also be increased (better than most other antennas) by placing the ring on a metal pedestal, due to imaging effects (fig. 3).

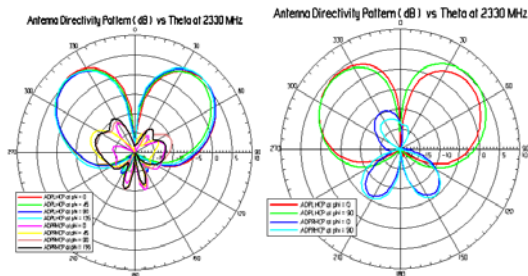


Fig. 2: Satellite pattern using 20 inch and 4.4 inch diameter ground plane.

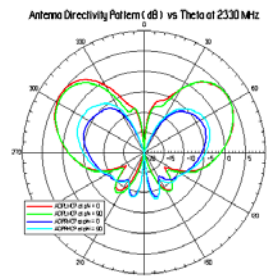


Fig. 3: Satellite pattern when the ring antenna is placed on a 0.8inch high, 4.4 inch diameter metal pedestal. This is a great pattern for the far Northern States.