



## Conformal Ultra-Wideband Radiating Structure (“WaveTrap”)

The need for a low-cost, electrically-small, conformal antenna, suitable for simultaneous support of multiple frequency bands and functions is well-established, yet up until now, unmet. Typical multi-function installations require multiple “dedicated” antennas creating significant packaging, aesthetics, aerodynamic, and Radio Frequency (RF) interoperability issues (mutual interference, receiver saturation, nulls, “drop-outs”, etc.) The *WaveTrap* is in fact a “unified” antenna solution and therefore represents a significant improvement in terms of efficiency, compactness, and bandwidth as compared to currently available commercial and military antenna technologies such as cavity-backed and printed spirals; patch elements; monopoles and “whips”; horns; disc-cones; bi-cones; and coaxial radiators.

The described antenna technology represents a new and effective solution for achieving multi-octave bandwidth, multi-functionality, and high efficiency in a single compact antenna element. These features are achieved by utilizing a novel internal electromagnetic architecture which is passive, simple, and low-cost, yet allows sufficient degrees of freedom to customize both its pattern and bandwidth properties. Design attributes including antenna size, operating bandwidth, efficiency, directivity, and beamshape(s) can therefore be traded in order to provide optimized solutions for specific applications. This antenna is ultimately capable of simultaneously supporting both “omni-directional” (fixed hemispherical) and “directive” (steerable lobes and/or nulls) beams via multiple (coax) feed ports.

The mechanically-robust antenna design is comprised of a small number of individual subassemblies, fabricated utilizing low-cost commercially-available materials (structural plastics) and processes (injection-molding and electro-less plating) and assembled in a low-cost, low-precision “snap-together” fashion. This plastic construction assures low-cost (commercial-viability) and light weight as well as enabling the fabrication flexibility required to support both planar and curved installations.

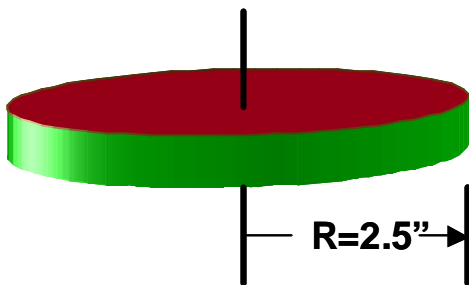


Figure 1. Typical WaveTrap Layout

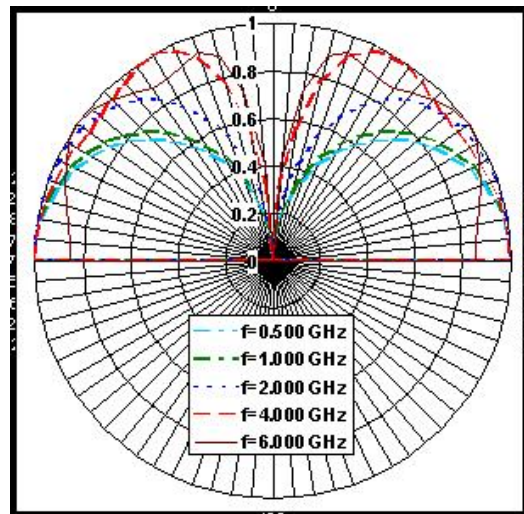


Figure 2. Predicted Antenna Patterns (Elevation Cut)

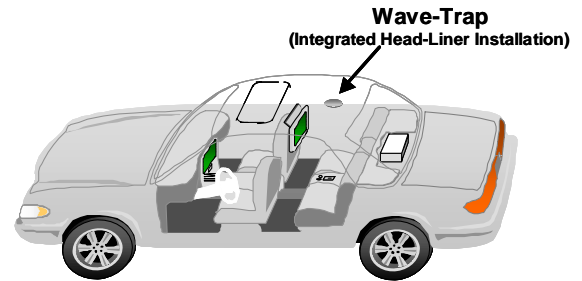
The “Basic” or “Dominant Mode” version of the antenna element supports a quasi-omni-directional, phi-symmetric antenna pattern (similar to a monopole). The dominant mode in this particular case is launched via a coaxial interface at the center-rear of the antenna. “Directive” or “Multi-Mode” versions of the antenna element support azimuth beam-forming functions in which one or more defined lobes and/or nulls can be adaptively “pointed” in the azimuth direction. It is anticipated that directive peak gains of +10 dBi and null-depths of -20 dBi will be achievable using this approach. In addition to a reconfigurable azimuth beam shape flexibility, the elevation beamshape of the antenna, as a function of frequency, can be customized in order to provide increased directivity in either the zenith/nadir-oriented or horizon-oriented directions. As an example, this design feature can be exploited in wideband communication applications, where terrestrial sources (horizon) are favored in one frequency range while satellite sources (zenith or omni) are favored in another frequency range.



Unlike a monopole, this antenna implementation can support multiple octaves of frequency bandwidth without the formation of nulls and while maintaining a quasi-constant input match (high efficiency). Figure 2 illustrates the predicted antenna patterns for the basic “omni” version of the antenna, comprised of 4 annular rings, over the frequency range of 0.50 to 6.00 GHz.

A prototype of this antenna, approximately 6 inches in diameter and 0.8 inch in depth is currently under development (internally funded.) This initial prototype will demonstrate a minimum efficiency of 70%, providing null-free omni-directional coverage and a minimum gain of between +1 and +4 dBi over the continuous frequency range of 1500 MHz to 6000 MHz. Future developments will build upon this initial prototype, designing and fabricating an enhanced version of the baseline design capable of supporting an extended 8:1 frequency range of 750 MHz (UHF) to 6000 MHz (C-Band) in a single antenna. This future development will also begin investigation of the “directive” capabilities of the antenna as well as demonstration of an innovative modular, low-cost, low-profile multiplexer as an optional supplement to the basic single-port implementation of the antenna. It is believed that (through reasonable dielectric-loading) this “high efficiency” (> 70%) bandwidth can be ultimately extended to a four-octaves (16:1) with “graceful” efficiency degradation at “secondary” frequencies outside of (below) the designated “primary” band.

0824-0849 MHz	AMPS/D-AMPS (Mobile Xmt)
0869-0894 MHz	AMPS/D-AMPS (Mobile Rcv)
0890-0915 MHz	GSM (Mobile Xmt)
0900-0931 MHz	2-Way Paging Services
0935-0960 MHz	GSM (Mobile Rcv)
1200-1250 MHz	GPS (L2)
1550-1600 MHz	GPS (L1)
1610-1626 MHz	Globalstar/Iridium (Mobile Xmt)
1805-1880 MHz	DCS 1800
1851-1909 MHz	PCS (Mobile Xmt)
1909-1930 MHz	PCS 1900 (Unlicensed)
1931-1989 MHz	PCS (Mobile Rcv)
1980-2010 MHz	ICO (Receive)
2110-2170 MHz	UMTS/3G
2170-2200 MHz	ICO (Transmit)
2310-2360 MHz	SDARS (Digital Satellite Radio)
2400-2500 MHz	ISM, Bluetooth, Globalstar(Rcv), 802.11b
5150-5350 MHz	UNII, 801.11a
5725-5875 MHz	ISM, UNII, 802.11a
5875-5950 MHz	DSRC, ITS



Automotive Application of WaveTrap



WaveTrap-Based Element  
(1.0" D x 0.35" H)

The proposed “unified” antenna solution therefore represents a significant improvement in meeting this need as compared to currently available commercial and military antenna technologies. Potential commercial “platforms” which would benefit from this technology include: general, business, and commercial aircraft; private and commercial automobiles and vehicles; as well as fixed installations including homes, businesses, and telecommunication infrastructures. Utilizing the proposed technology, multiple commercial functions including: VHF/UHF Broadcast, MDS, MMDS, Satellite Radio, 802.11x, 802.16x, Wireless LANs, Terrestrial- and Satellite-Based Cellular, Broadband PCS, GPS, Telematics, and ITS can be simultaneously supported with one compact low-cost antenna.

Relative advantages of this innovative technology include:

1. **Superior Aesthetics and Enhanced Mounting Flexibility.** Less than  $(\lambda_{max}/16)$  thick and less than  $(\lambda_{max}/4)$  in diameter, *Wave-Trap* can be structurally-integrated in fixed, mobile, and airborne platforms.
2. **Superior Gain and Efficiency over Multi-Octave Operating Frequency Bandwidths.** No absorptive materials. 70% minimum efficiency over 4:1, 8:1, and 16:1 bandwidths in the near-, mid-, and long-term.
3. **Superior Multifunctionality.** One integrated antenna replaces many discrete radiators. Reconfigurable Directive/Nulling capability and integrated modular multiplexer option(s) enhance performance and utility.
4. **Superior Electromagnetic Compatibility (EMC) and Field-of-View.** Unified antenna solution obviates all installation-specific mutual interference, blockage, local-scattering, and/or vehicle cavity effects.
5. **Superior Value – Low-Cost Materials, Simple Fabrication and Assembly.** Completely passive. Minimum parts count comprised of plated-plastic and stamped metal parts with “press-fit” assembly.

For further information, please contact ThinKom Solutions, Incorporated at (310) 371-5486 or via email at BusDev@thin-kom.com.