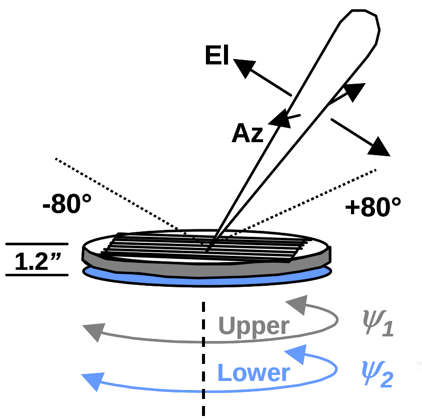
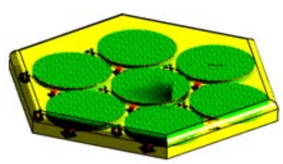
The Variable Inclination Continuous Transverse Stub (VICTS) Array

As a direct extrapolation of the patented Continuous Transverse Stub (CTS) array, the *Variable Inclination Continuous Transverse Stub (VICTS)* array benefits from the low-profile, ohmic efficiency, tunable bandwidth, mechanical robustness, fabrication simplicity, and low-cost advantages inherent (and proven) in the basic CTS design, building upon the established 10 year commercial and military history of this innovative antenna technology. The unique two-dimensional scan mechanism for the VICTS array is 100% mechanical, involving the simple rotation (common and differential) of two coplanar plates, one (upper) comprised of a one-dimensional lattice of continuous radiating stubs and the second (lower) comprised of one or more static line-sources. As the name implies, mechanical rotation of the upper plate relative to the lower serves to *vary* the *inclination* of incident parallel-plate modes and the resultant scan angle in the elevation (theta) plane. Common rotation of the two plates in unison achieves the desired agility in the orthogonal azimuth (phi) direction. Polarization control and diversity is supported by adding a fixed or rotating polarizer layer(s), mounted conformal to the aperture plate, thereby achieving fixed or selectable circular and/or arbitrarily-oriented linear polarization.

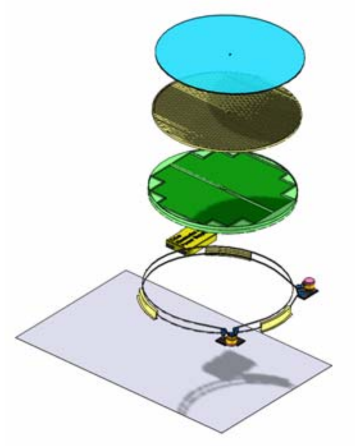


VICTS Scan Geometry

Ku-Band VICTS Array



VICT-Based Gateway Antenna



Typical VICTS Assembly

Relative advantages of this innovative antenna technology include:

1. ***Dramatically reduced component, assembly, and test costs.*** The VICTS is comprised of only three integrated passive RF components, with no phase-shifters, T/R modules, or associated control/power distribution structures. The VICTS assembly is simple and robust with no RF-critical bonds or joints. All parts are compatible with proven low-cost materials and processes (plastics, molding, plating, etc.)
2. ***Reduced prime-power and cooling requirements.*** VICTS requires no phase-shifters or T/R modules to achieve scanning. Typical prime power requirements (to support 600 deg/sec^2 angular accelerations) are 75W peak, 25W average with no active (liquid or forced-air) cooling required.
3. ***Conformal-Profile.*** Typical thicknesses are 2” or less, depending on frequency (including LNB and HPA, if applicable.)
4. ***Low Observable (LO)-Compatible.*** The conformal profile and continuous lattice of VICTS supports low radar cross-section installations and treatments including aperture-filter, shutter and FSS techniques. Bragg Lobes are confined and suppressed and may be selectively re-oriented for “stowed” configurations.
5. ***Low Probability of Intercept (LPI) via precision Sidelobe Control.*** Sidelobes are suppressed and confined to cardinal-planes which may be oriented to minimize adjacent satellite interference along the equatorial plane and/or to suppress horizon-oriented radiation signatures and terrestrial interference.
6. ***Improved Polarization Purity and Diversity.*** **T**he simple geometric orientation of its scan plane relative to the radiating surface greatly simplifies the conventional problem of achieving high polarization purity (low Axial Ratio) over the entire hemispherical scan volume. As a result, the VICTS array can uniquely support maximum Axial Ratios of 1.5 dB (minimum -21 dB Cross-pol isolation) to scan angles at and beyond 70 degrees. When ThinKom’s proprietary *Dual-Band* variant of VICTS (see below) is combined with its proprietary *Dichroic Polarizer* technology, a single VICTS aperture is capable of providing dual simultaneous orthogonal polarizations (RHCP and LHCP) in two distinct frequency bands, with precise polarization control and coincidental beam alignment.

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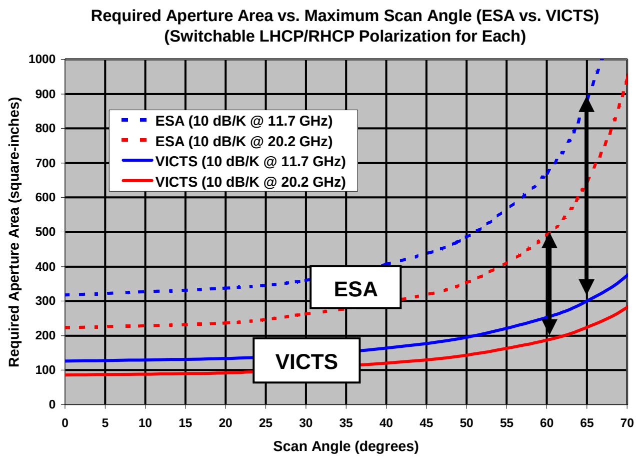
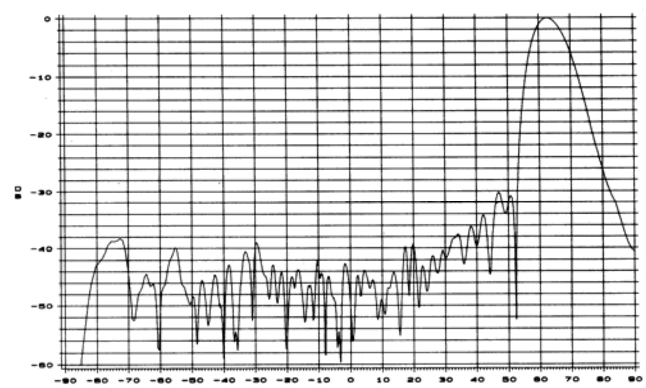
7. ***Improved Instantaneous Bandwidth (IBW).*** The primary scan mechanism of the VICTS is "true-time-delay" (optical) phenomena and the H-plane scan angle is therefore frequency-independent. VICTS typically supports instantaneous bandwidths 5 to 8 times greater than a conventional Electronic Scanned Array (ESA).
8. ***Dual-Band Shared-Aperture Capability.*** As a periodic structure, the VICTS array is capable of (full-duplex) high-efficiency operation supporting simultaneous offset frequency bands (transmit and receive) in a single shared aperture (This capability is currently under internal development.)
9. ***Low-Cost Electronic Closed-Loop Tracking.*** The VICTS array is compatible with high-agility (electronic) acquisition and closed-loop tracking via an innovative (ThinKom Proprietary) low-cost technique capable of accommodating angular vehicle accelerations in excess of 1000 deg/sec^2.
10. ***High Mechanical Agility.*** The "coplanar non-contacting disk" geometry of VICTS is kinematically simple, statically and dynamically balanced, and exhibits low moments-of-inertia. Required motor torques (size, weight, cost) are a factor of 5 to 10 times lower as compared to a comparable mechanically-scanned reflector. Angular accelerations in excess of 600 deg/sec^2 can be easily accommodated.
11. ***High Reliability.*** Electronic tracking dramatically reduces mechanical wear-and-tear as does the VICTS array's (balanced) mechanical drive simplicity. MTBF's in excess of 25,000 (operational) hours are typical (greater values are achievable with selective component redundancy.)
12. ***Improved Scan Efficiency.*** The unique composite scan mechanism of VICTS is hybrid, with both H-plane and E-plane components, and therefore extreme composite scan angles are achieved while maintaining moderate scan angles and well-behaved scan impedances in each of the cardinal planes.



An ESA Requires 2.5x to 3.5x Greater Aperture Area than a VICTS Array for a Given (G/T) Value



The VICTS Array Supports Precision Sidelobe Control for LPI and Interference Suppression

13. ***Dramatically Improved Aperture Efficiency.*** The aforementioned scan efficiency (pseudo-constant active impedance) and instantaneous bandwidth (beam stabilization) advantages, combined with the direct applicability and affordability of utilizing low noise (packaged discrete) LNB devices with VICTS in contrast to the higher noise (integrated MMIC) LNB devices typically utilized in ESA's, equates to a net aperture efficiency advantage of between 2.5 (+4.0 dB) and 3.5 (+5.5 dB), depending on maximum scan angle and instantaneous bandwidth. That is to say, for a given G/T requirement, an ESA requires 2.5 to 4.0 times the aperture area required for a VICTS array.
14. ***Analog Scanning (Continuous Datastream.)*** Unlike a conventional ESA, the VICTS scan mechanism is completely analog and the beam scan angle is therefore continuously defined and well-behaved (no "undefined" phase-shifter states during beam switching.)
15. ***Multi-Aperture Capability.*** The low-cost and wide scan agility of the VICTS array makes it an excellent subarray candidate for unique multi-aperture implementations of very large apertures in an efficient and conformal *"hexagonal-pack"* configuration. As each VICTS array is independently steerable, such multi-aperture arrays are reconfigurable to provide multiple independently steerable beams, either singularly or in coherent combination with one or more adjacent subarrays. Applications include lower cost, lighter weight, more highly capable conformal replacements for large Gateway Dish antennas obviating the need for the expensive radomes, specialized mounts, restrictive zoning regulations, structural reinforcements and higher installation costs associated with such antennas.

VICTS antenna designs at Ku-band (10.5 to 14.5 GHz), Ka-band (35 GHz), and W-band (94 GHz) have been reduced to practice, including the successful demonstration of all of the aforementioned performance and packaging features as well as closed-loop tracking and aperture modularization functions. Dual-Band, C-Band, X-Band, and Ka-Band (20 GHz) variants are currently in development. Current and potential exploitations of this antenna technology include low-cost/high-performance communication, radar, and sensor applications in both the military and commercial marketplaces. For further information, please contact ThinKom Solutions, Incorporated at (310) 371-5486 or via email at BusDev@thin-kom.com.