# *APPLICATION OF HIGH PERFORMANCE FLAT PANEL ARRAY (FPA) ANTENNAS IN ACCESS MICROWAVE NETWORKS*

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**Abstract**

*Harris Corporation Microwave Communications Division's Millimeter Wave Design Center has released into production a new family of high frequency MicroStar access radios that incorporates a new class of Flat Panel Array (FPA) antennas. The relative advantages of this new array antenna include: unusually high aperture efficiencies and precision sidelobe control; benign active impedance dependence to both frequency and scan angles; and an aesthetically-pleasing design that features robustness, simplicity, and low-cost attributes.*

*The MicroStar FPA antenna is now available as a commercial product for radio systems as a low profile, high-efficiency, low sidelobe antenna for Point-to-Point (PTP) applications. This paper describes the relative advantages and benefits of MicroStar's Flat Panel Array technology, specific to PTP radios in the 37 to 40 GHz frequency band.*

**Introduction**

Harris Corporation's Microwave Communications Division has released a new family of MicroStar millimeter wave radios that incorporates novel Flat Panel Array (FPA) antenna technology. Unlike typical antenna arrays (*dipole, slot, patch*, etc.), this antenna's unique array architecture results in significant frequency bandwidth advantages.

These antennas also exhibit superior polarization purity and backlobe and sidelobe performances compared with competing planar array and reflector implementations.

In addition, with the "diamond" shape of this FPA antenna oriented with its point on top, rain, snow, and condensation channels off the antenna. This unique antenna also discourages the lighting of birds on or near the vicinity of the aperture.

Moreover, this unobtrusive design blends well into building architectures, a feature of increasing importance with the wider distribution of exposed antennas on urban area and downtown buildings in this wireless age.

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**Figure 1. Harris MCD Integrated 38 GHz MicroStar FPA Antenna/Radio Product.**

**"Conformal" Form Factor**

The thin profile of this family of MicroStar antennas (typically <2”), and their lightweight (typically <8 pounds), allow for significant flexibility and versatility in terms of installation.

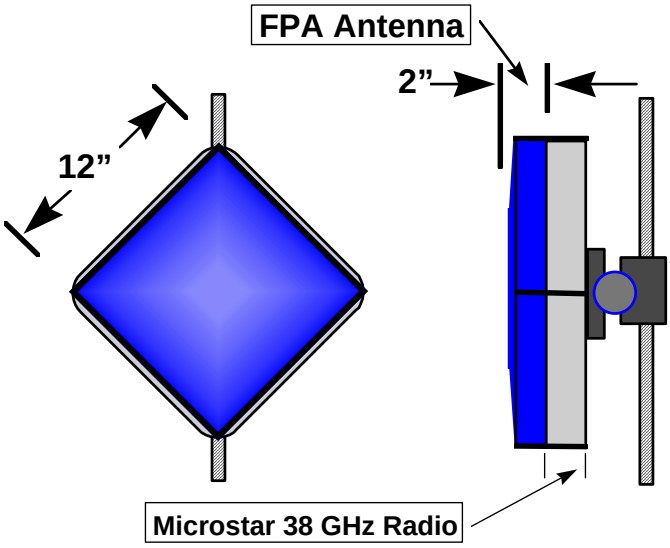


**Figure 2. “Conformal” 38 GHz MicroStar FPA Antenna**

As an example, the antenna may be “conformally” integrated with the transceiver/radio to form a compact low-profile integrated radio/antenna assembly as pictured in Figures 1 and 2. The aesthetic benefits of the antenna’s compact form-factor allow for increased flexibility in terms of “concealed” installations. This is especially critical to countries and locales mandating strict architectural and/or zoning restrictions.

The simplicity of a lightweight, compact, integrated radio/antenna unit can also have a dramatic impact on the ease and cost of installation (reduced installation time, number of personnel, etc.).

And finally, the reduced footprint of this compact antenna serves to minimize the weight and performance impact of ice-accumulation and/or wind loading. This allows for the use of smaller, lighter-weight installation hardware and mounting platforms

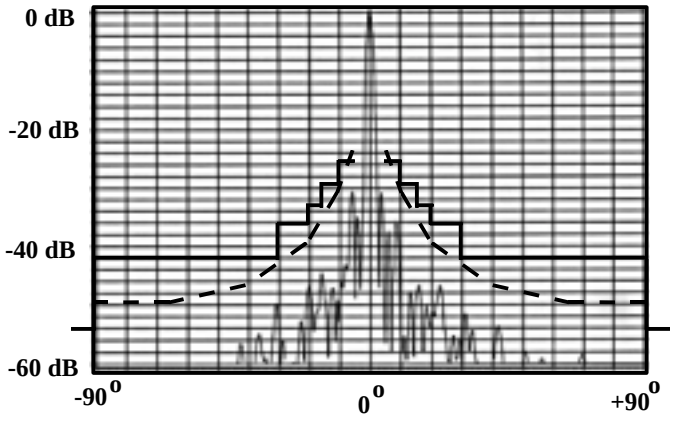


**Figure 3. Radiation Pattern for 38 GHz MicroStar Plus FPA antenna with UK MPT1414 (dashed line) and FCC Category “A” (solid line) mask specifications overlaid for comparison.**

**High Performance, Efficiency, and Commonality**

The 38 GHz MicroStar FPA antenna (see Figure 1) exceeds *all* international “High Performance” requirements, including *all* applicable ETSI, UK MPT, German BAPT, and FCC Category “A” mask specifications, over the *entire* contiguous frequency bandwidth from 37.0 to 40.0 GHz.

Specifically, the co-polarized (VV and HH) Radiation Pattern Envelope (RPE) for the FPA maintains an 8 to 12 dB average margin below the UK MPT 1414 and FCC Category “A” mask specifications, respectively, down to a relative sidelobe level of -50 dB.

Cross-polarized energy is likewise dramatically suppressed, falling below a -50 dB level for all angles outside $2^{o}$ of the antenna’s main lobe. Typical front-to-back ratios exceed -60 dB.

Figure 3 illustrates a typical measured radiation pattern for the 38 GHz FPA with UK MPT 1414 (dashed line) and FCC Category “A” (solid line) mask specifications overlaid for comparison.

Figure 4 below illustrates measured +2.3 sigma (95% percentile) Radiation Pattern Envelopes (RPEs) for both co-polarized and cross-polarized components.

As an additional feature, this FPA antenna exhibits *identical* vertical (VV, VH) and horizontal (HH, HV) RPEs for both co-polarized and cross-polarized responses. Most reflector-based solutions typically exhibit polarization-dependent RPEs due to inherent asymmetric feed horn illuminations. These reflector-based RPEs are commensurately worse for horizontal polarization as compared to vertical.

The favorable polarization equivalence of the MicroStar FPA antenna, taken together with its suppressed co-polarized and cross-polarized RPEs, enables increased flexibility and interoperability performance, particularly in "high density" sites and installations.

The MicroStar FPA achieves a *total* aperture efficiency of greater than 60% . This equates to an average gain of 39.7 dBi over the 37 to 40 GHz operating bandwidth, as illustrated in Figure 5.

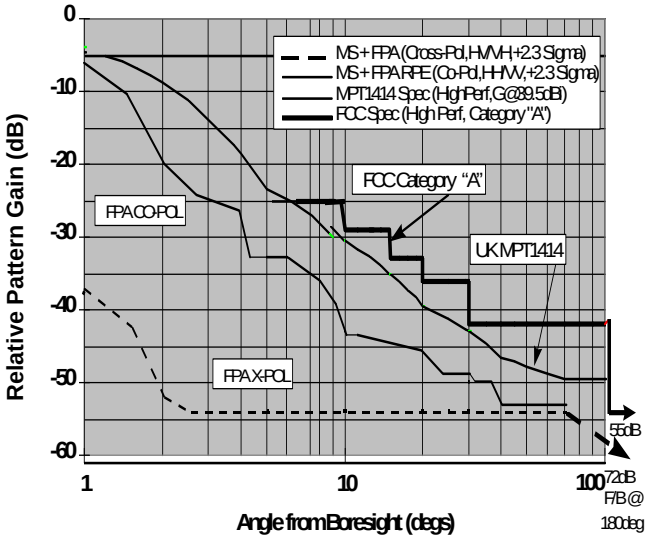


**Figure 4. Measured Co-Pol (solid) and Cross-Pol (dashed) Radiation Pattern Envelopes (RPEs) for 38 GHz MicroStar FPA Antenna with UK MPT1414 and FCC Category "A" mask specifications overlaid for comparison.**

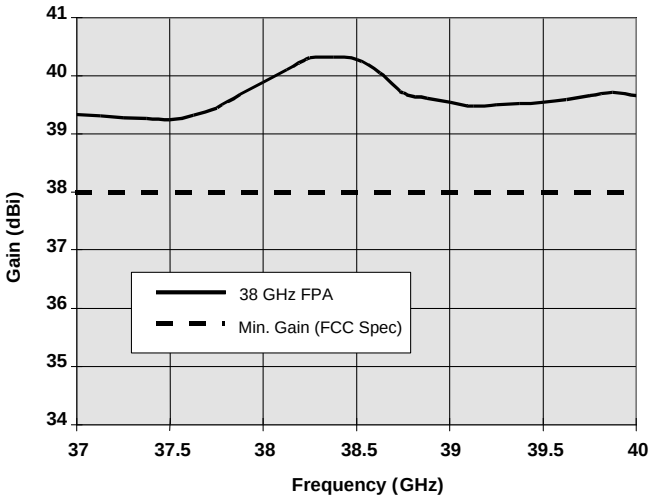


**Figure 5. Measured Gain/Bandwidth Performance of the 38 GHz MicroStar FPA Antenna**

Figure 6 below illustrates the measured VSWR vs. frequency response typical for the 38 GHz MicroStar FPA antenna.

Though not explicitly mandated by regulatory requirements, a well-matched antenna aperture exhibiting low Voltage Standing Wave Ratio (VSWR) across the frequency band of operation is critical for stable and reliable radio operation.

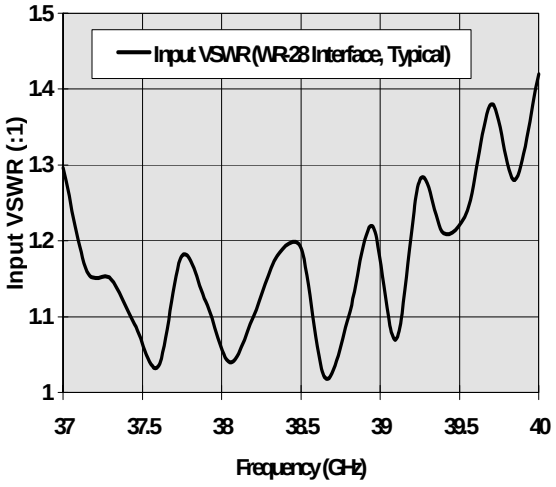


**Figure 6. Measured Input VSWR of 38 GHz MicroStar FPA Antenna (WR-28 Waveguide Interface)**

Again, because of the unique architecture of its constituent components, the MicroStar FPA antenna exhibits an unusually low VSWR (good impedance match) as compared to conventional planar array implementations.

**Figure 7. The MicroStar FPA Antenna**

**Highly *Producible* and *Flexible***

Currently in full-scale production for Harris Corporation's 38 GHz MicroStar point-to-point radios, this FPA architecture also enjoys a high design, performance, and component reuse for similar MicroStar family radios in the 23 and 26 GHz bands. MicroStar FPA antennas in these other frequency bands exhibit performance characteristics very similar to the 38 GHz example described in this paper.

**Conclusion**

As a result of its unique design architecture, the MicroStar flat-plate antenna described in this paper, offers a state-of-the-art antenna system to today's radio system operator.

This antenna system is capable of providing significantly enhanced performance attributes, aesthetically pleasing configurations, and installation and operational advantages over all other competing antenna systems in a broad range of point-to-point radio applications.