Triple Band Circularly Polarized Square Microstrip Antenna with Crank Slits

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***Abstract* - A triple band circularly polarized square microstrip antenna is proposed. The antenna has two pair of crank slits at each edge and is excited by an L-probe feed. With simulations, the operational principle for circular polarization at triple band are clarified. The simulated bandwidths of 2-VSWR with 3dB-axial ratio are approximately 10MHz at triple band in GPS(L1/L2/L5 bands).**

***Index Terms* — Microstrip antenna, Triple band antenna, Circular polarization, L-probe feed, GPS.**

I. INTRODUCTION

The global positioning system (GPS) is the most well known system in global navigation satellite systems. Circular polarized microstrip antennas (MSA) is a popular choice for the GPS receivers due to their numerous advantages including light weight, low profile, easy circuit integration, low fabrication cost, and ease of fabrication.

Authors have proposed a triple band circularly polarized square MSA with two pair of *L*-shaped slit at each edge [1]. The MSA proposed in [1] is excited on the patch by a coaxial feed through the dielectric substrate. The frequency bandwidth of 10 dB-return loss with 3-dB axial ratio is less than 1MHz at all frequency bands. They do not satisfy the specification of the GPS.

In this paper, the antenna is excited by an *L*-probe feed [2] to enhance the bandwidth at the three frequency bands. Moreover, in order to reduce the size of the antenna patch, two crank slits are installed. A triple band MSA for GPS is designed according to the parametric studies. Moreover, the operational principle for triple band circular polarization is explained using the simulated electric current distributions.

II. ANTENNA DESIGN

Figure 1 shows a proposed triple band circularly polarized square MSA. The geometry of the patch conductor is a square with two pair of crank slits at each edge. The dimension of the square patch conductor is $W_{Tx} \times W_{Ty}$. W_{Tx} and W_{Ty} are fixed at 42.6 and 44.3 mm, respectively. The width of the crank slits is also fixed at S_t=0.5mm. In order to radiate circularly polarized waves at the three frequency bands, the dimensions of the crank slits along the *x*-axis are different from those along the *y*-axis. In order to tune impedance matching at the triple frequency ranges, the antenna is excited by an *L*-probe feed which lies at the diagonal on the square patch conductor. The thickness and the relative dielectric constants of each dielectric layer are h_1=1.6mm and h_2=3.2mm and $\varepsilon_{r1}= \varepsilon_{r2}$= 3.8, respectively. The loss tangent of both the dielectric substrates is 0.022. Dimension of the dielectric substrate is fixed at $W_g \times W_g$=80mm×80mm.

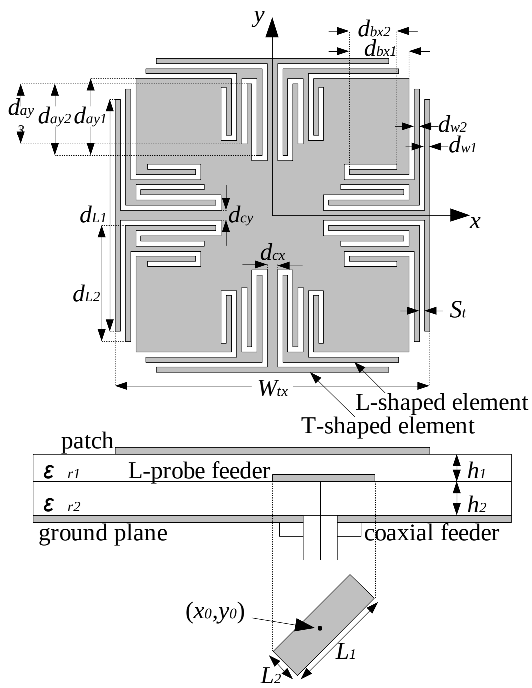

Figure 1 Geometry of a proposed MSA

III. RESULT AND DISCUSSION

For the simulations in this paper, the simulation software package FEKO [3], which is based, fast multipole moment method, is used.

Figure 2 shows the simulated results of the axial ratio and VSWR. The bandwidths of 3-dB axial ratio with 2-VSWR are 9.0 MHz in L5 band, 9.2 MHz in L2 band, 13 MHz in L1 band. The simulated bandwidths satisfy the specifications (4MHz) of the GPS [4].

Figures 3(a)-(c) show the time-averaged electric current distributions at triple band. In the L5 band, the electric current flows strongly on the *T*-shaped elements at the center of edges. In the L2 band, the electric current flows on the T-shaped elements and the elements between two crank slits. In the L1 band, although the electric currents flow on the elements between two crank slits, those on the *T*-shaped elements are very small. Therefore, the T-shaped elements, the inner crank slits and the outer crank slits operate as the radiation elements in the L1, L2 and L5 bands, respectively.

Figure 4 shows the radiation patterns at L2 band. Radiation peak is high elevation angles. However, the gain is low. The radiation patterns at the L1 and L5 bands are similar to that at the L2 band, and are omitted in this paper.

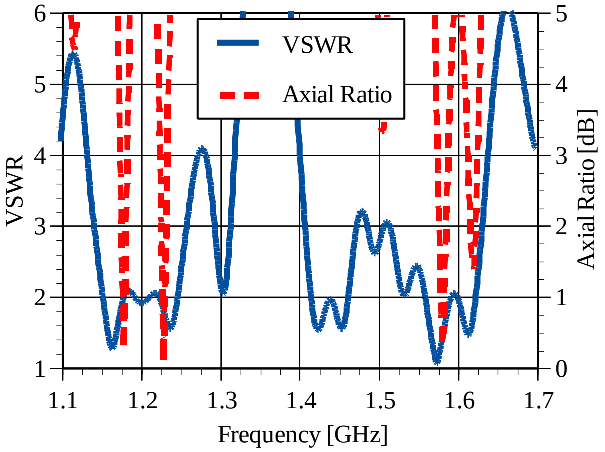

Figure 2 Axial ratio, VSWR

d_{ax1}=13.2, d_{ay1}=11.8, d_{ax2}=11.6, d_{ay2}=10.4, d_{ax3}=10, d_{ay3}=9, d_{L1}=35.1, d_{L2}=17, d_{dy}=2.95, d_{w1}=d_{w2}=0.4, d_{bx1}=d_{by1}=10.5, d_{bx2}= d_{by2}=6.5, d_{cx}=1.29, d_{cy}=1.71, d_{dx}=3.55, L_1=16, L_2=3 : [mm]

IV. Conclusion

A triple band circularly polarized square MSA with two pairs of crank slits has been proposed. The operational principles of circular polarization at triple band have been clarified using simulated electric currents. Moreover, the proposed antenna is designed for GPS (L1, L2, and L5 bands).

References

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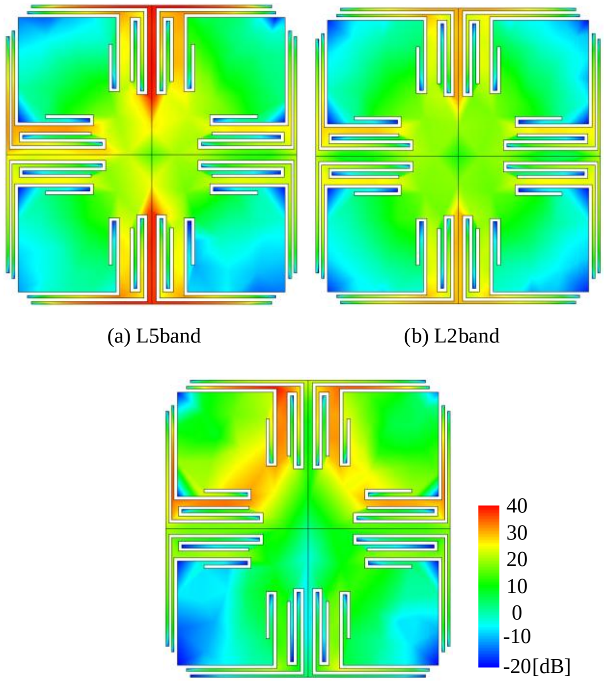

(a) L5band (b) L2band

(c) L1band

Figure 3 Time-averaged electric current distributions

d_{ax1}=13.2, d_{ay1}=11.8, d_{ax2}=11.6, d_{ay2}=10.4, d_{ax3}=10, d_{ay3}=9, d_{L1}=35.1, d_{L2}=17, d_{dy}=2.95, d_{w1}=d_{w2}=0.4, d_{bx1}=d_{by1}=10.5, d_{bx2}= d_{by2}=6.5, d_{cx}=1.29, d_{cy}=1.71, d_{dx}=3.55, L_1=16, L_2=3 : [mm]

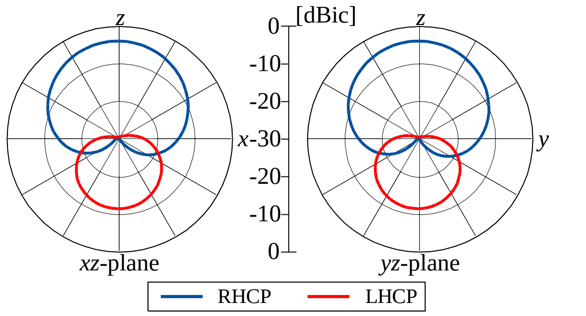

Figure 4 radiation patterns at L2band

d_{ax1}=13.2, d_{ay1}=11.8, d_{ax2}=11.6, d_{ay2}=10.4, d_{ax3}=10, d_{ay3}=9, d_{L1}=35.1, d_{L2}=17, d_{dy}=2.95, d_{w1}=d_{w2}=0.4, d_{bx1}=d_{by1}=10.5, d_{bx2}= d_{by2}=6.5, d_{cx}=1.29, d_{cy}=1.71, d_{dx}=3.55, L_1=16, L_2=3 : [mm]