Square Microstrip Antenna for Circular Polarization Operation

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ABSTRACT
A circular-polarization (CP) operation of the square microstrip antenna with four slits and a pair of truncated corners is proposed and investigated. Simulated results show that the proposed compact CP design can have an antenna-size reduction of about 39% as compared to the conventional corner-truncated square microstrip antenna at a given operating frequency. Also, the required size of the truncated corners for CP operation is much greater than that for the conventional CP design using a simple square microstrip patch, providing a relaxed manufacturing tolerance for the proposed compact CP design. Details of the simulated results are presented and discussed.

Index Terms:
Square microstrip antenna, circular polarization, compact antenna, microstrip antenna.

1.INTRODUCTION
Many current communication and sensor systems require a high degree of polarization control to optimize system performance. For microstrip antennas to be exploited in such systems, high polarization purity and isolation between orthogonal polarizations- be they linear or circular- are needed. Many shapes of the patch like rectangular patch [1], elliptical patch [2], patch with loops [3], and Square ring microstrip antenna with truncated corners [4] were used to obtain circular Polarization. Circular polarization can be generated by exciting two orthogonal patch modes in phase quadrature with sign of relative phase determining polarization hand. These modes may be excited in a number of ways. The circular polarization can also be obtained by well known method of a single-feed square microstrip antenna with truncating a pair of patch corners design [5]. The major advantage of single-feed, circularly polarized microstrip antennas is their simple structure, which does not require an external polarizer. They can, therefore, be realized more compactly by using less board space than do dual-feed, circularly polarized microstrip antennas. In the present paper, a mathematical model is proposed to analyses the radiation characteristics of a compact square microstrip antenna for circular polarization. The typical configuration is shown in Figure 2, in which the square patch has a side length L. The four slits have an equal length of ℓ and a width of 1mm and are inserted at the four patch corners along the direction of $\varphi = \pm 45^0$. The truncated corners are of equal side length L. The single feed is place at point A and can be located either on the x-axis or y-axis. The proposed structure is simulated using MOM based simulator. The detail of entire investigations is given in the following sections.

2. ANTENNA DESIGN AND SIMULATION
Fig. 1 shows the truncated square reference microstrip antenna with the dimension of 28 × 28mm and truncated length 3.2mm. The used substrate has thickness of 1.6mm and dielectric constant 4.4. The antenna corners are truncated with equal side lengths L. The initial truncation length is kept 1mm, which is subsequently increased by 0.5mm in each successive step. The designs were then simulated and it is found that the maximum return loss is achieved with truncation length of 3.2mm and beyond which it reduced rapidly. Left hand CP operation was obtained by moving the feed position from point 'A' to a point in x-axis.
The proposed single feed square microstrip with four slits and a pair of truncated corners for compact circular polarization operation is shown in fig. 2. The square patch having an outer side length L = 28mm and slit length varies with substrate thickness h and relative permittivity $\epsilon_r = 4.4$ same as reference antenna.

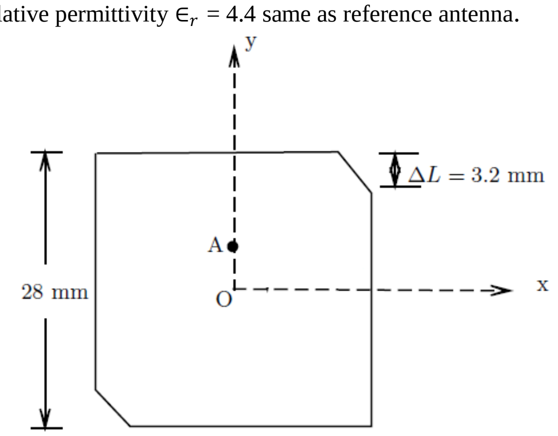

Fig 1 Geometry of square micro strip antenna with truncated corners

3. RESULTS AND DISCUSSION
Simulations for several designs have been successfully implemented. Fig 3 shows, the variation of resonance frequency with slit length. It is observed that the resonance frequency decreases from 2.5GHz to 1.97GHz as the slit length increases from 0mm to 16mm. It is due to the fact that slit offers a capacitive and inductive effects subsequently it changes the resonance frequency. The antenna shows a compactness of 39% in the antenna size. Fig. 4 shows, the variation of the return loss for the proposed compact square microstrip antenna with four slits and a pair of truncated corner for circular polarization with slit length ℓ = 16mm, 14mm, and 12mm, with the 28mm of side length of square patch. Return loss for the different antennas varies −26dB to −16.26dB which is well below 10dB. A compact square microstrip

antenna with four slits and a pair of truncated corner for circular polarization has been successfully implemented. When compared to the conventional corner-truncated square microstrip antenna for a fixed CP operation, the proposed compact CP design can result in a large antenna-size reduction (about 39%).

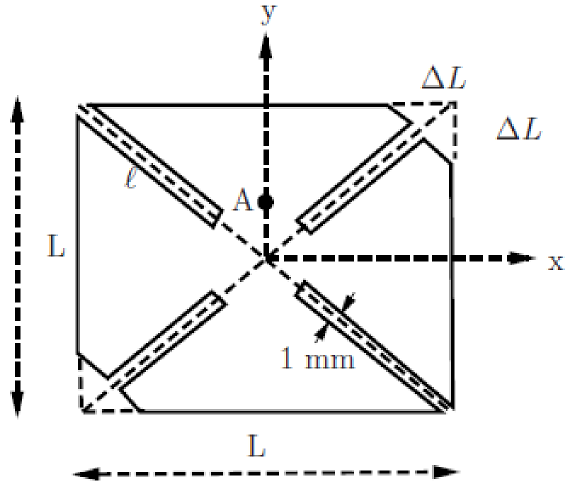

Fig 2 Geometry of a Compact Square micro strip antenna for circular polarization

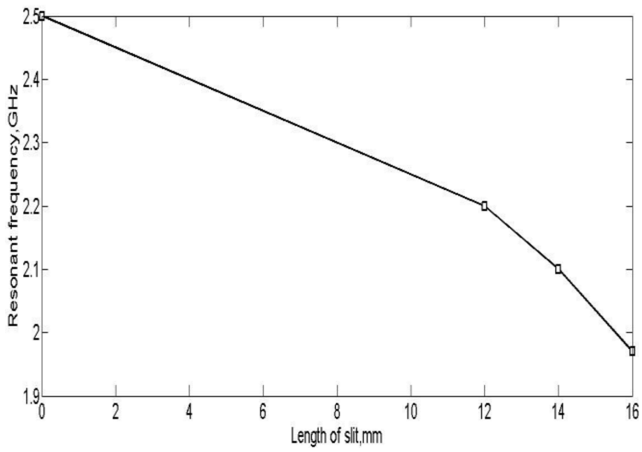

Fig 3 Variation of resonance frequency with slit length

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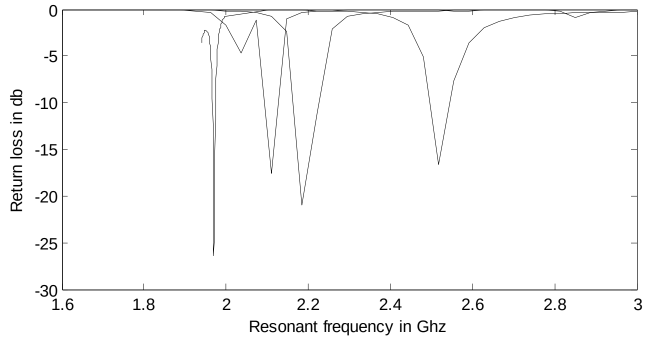

Fig 4 Return loss variation with resonant frequency for microstrip antenna

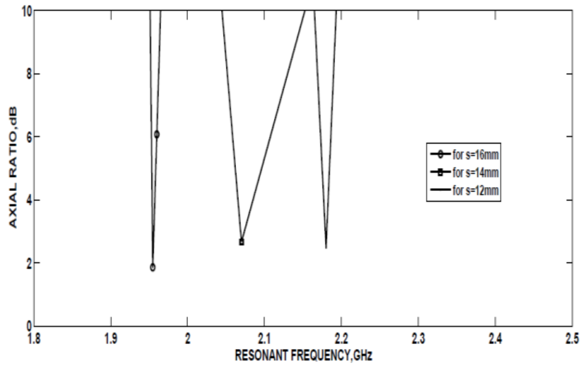

Fig. 5 Axial ratio with frequency in broadside direction for microstrip antenna

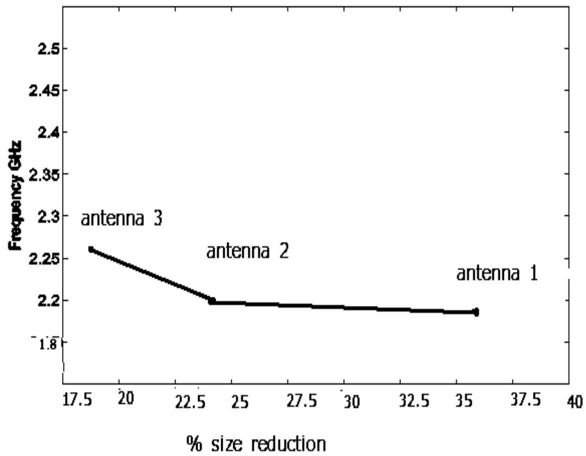

Fig. 6 Variation of size reduction with resonance frequency

4. CONCLUSION

A compact square microstrip antenna with four slits and a pair of truncated corner for circular polarization has beensuccessfully implemented. When compared to the conventional corner-truncated square microstrip antenna for a fixed CP operation, the proposed compact CP design can result in a large antenna-size reduction (about 39%). Also, good radiation characteristics are observed for the present proposed compact square microstrip antenna. It should also be noted that, due to the lowering in the center operating frequency for the proposed antenna which corresponds to an antenna-size reduction, the CP bandwidth and antenna gain are both decreased. The active device loading technique [10] can be applied for the gain enhancement and bandwidth improvement of the present proposed design.

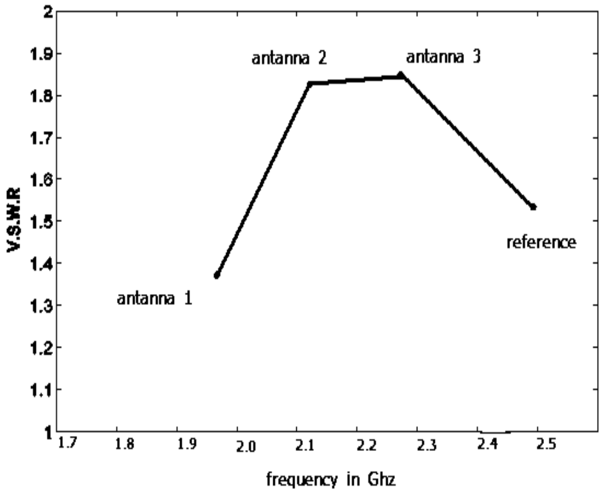

Fig.7 Variation of VSWR with resonance frequency

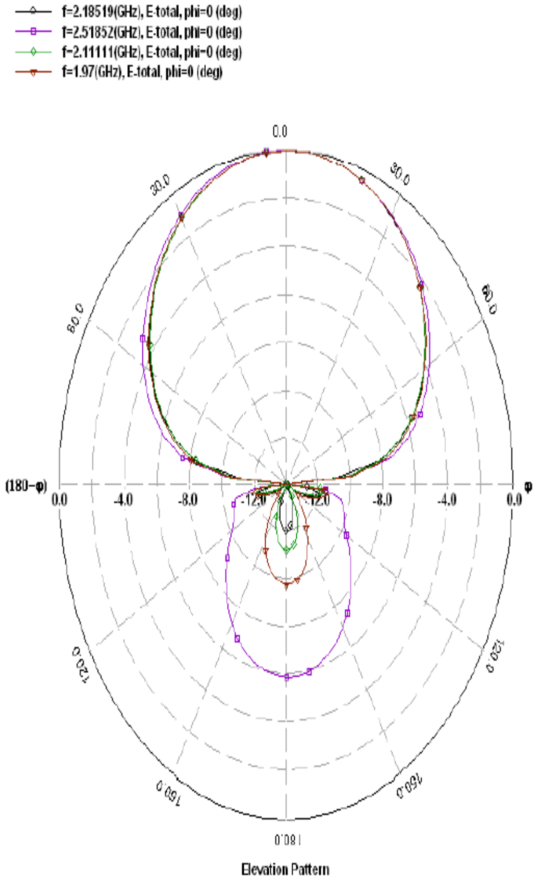

Fig.8 Radiation pattern for microstrip antenna

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