A Novel Design of Square Microstrip Antennas for Triple Band Operation

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Abstract— A novel design of square microstrip antenna is design for triple band operation. The triple band is achieved by inserting the E-slot in the square patch with the bandwidth of 2.95%, 4.78% and 2.54%. When E-slot is replaced by C-slot there is an enhancement in the all three respective bands with a maximum bandwidth of 3.12%, 8.4% and 2.8%. This antenna may find applications in Microwave Communication system.

Key words: Square Microstrip Antenna, Triple band, E-slot, U-slot, Bandwidth

I. INTRODUCTION

The antenna is a device used to feed the electromagnetic energy in the required direction or to receive maximum electromagnetic energy from the required direction. Antennas are used for various wireless communications like cellular phones, mobile communication, broadcast communication, microwave communications, satellite linking etc. Different antennas radiate maximum power in different directions depending upon the shape, size and orientation of the system. Depend upon shape and dimensions there are so many types of antennas like monopole, lens, parabolic, helical, microstrip etc [1]. Among all microstrip has special attraction because it has various advantages like light weight, easy to fabricate, easy to handle, low cost low volume etc [2-3]. The microstrip antenna is a metal patch on a thin layer of dielectric substrate on a ground plane. Further, there various shapes of microstrip antennas like rectangular, square, circular, elliptic etc. and these antennas can be design by applying using various techniques like slot loading, arrays, parasitic, stubs, spurs etc. So in this paper slot loading technique is used to design the square microstrip antenna by placing E-slot and C-slot to study their parameters.

II. DESCRIPTION OF ANTENNA GEOMETRY

The proposed antennas have been design by using Auto-CAD software. The simulation is performed on Ansoft HFSS (High frequency structure simulator 13.0). The thickness is taken as h = 0.32 cm and relative permittivity of the substrate as $\varepsilon_r = 4.2$.

The conventional square microstrip antenna (CSQMA) is design at the resonating frequency of 3.5 GHz. The geometry of CSQMA is as shown in below figure 1. The length and width of square patch is L. The antenna is fed by using microstripline feeding. This feed arrangement consist of quarter wave matching transformer of length L_t and width W_t which is connected between microstripline feed of length L_f and width W_f. At the tip of microstripline feed a 50Ω co-axial SMA connector is used for feeding the microwave power.

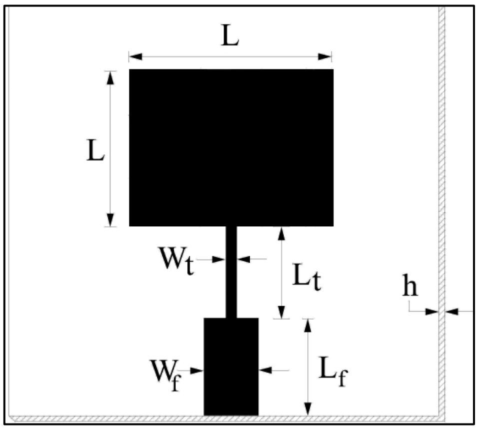

Fig. 1: Geometry of CSQMA

Fig. 2 shows the geometry of E-slot square microstrip antenna (ESQMA). The length (L_S) and width (W_S) of the E-slot are taken in terms of λ_o corresponding to the design frequency of 3.5GHz, where λ_o is the free space wavelength in cm.

Further the study is carried out by removing the middle arm from E-slot and that becomes the C-slot by keeping same dimensions of ESQMA. This antenna is named as C-slot square microstrip antenna (CSSQMA).

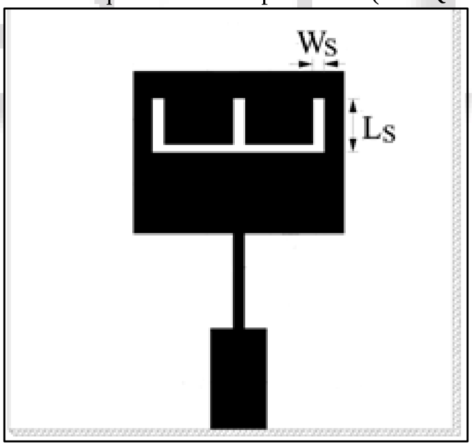

Fig. 2: Geometry of ESQMA

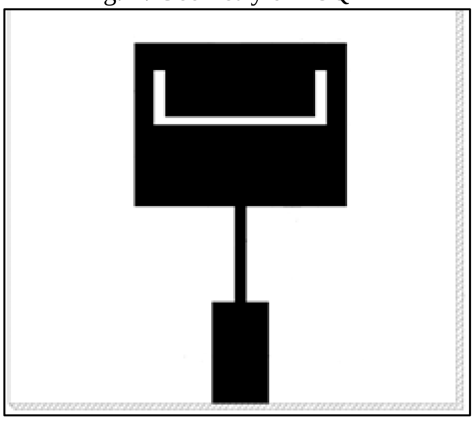

Fig. 3: Geometry of CSSQMA

III. EXPERIMENTAL RESULT

The results of simulation, made by means of software HFSS of the CSQMA is as shown in figure 4. i.e. the variation of return loss versus frequency of CSQMA. From this figure it is seen that, the antenna resonates for single band BW_1. The bandwidth of this operating band is found to be 4.43% which is determined by using the following equation [4],

$$BW = \left[\frac{(f_2 - f_1)}{f_c}\right] \times 100\ \%$$

Where, f_1 and f_2 are the lower and upper cut-off frequencies of the band respectively, when its return loss becomes -10 dB and f_c is the centre frequency between f_1 and f_2.

The variation of return loss versus frequency of ESQMA is as shown in Fig. 5. From this figure it is seen that, the antenna resonates for three bands of frequencies BW_2, BW_3 and BW_4 with a bandwidth of 2.95%, 4.78% and 2.54% [5]. The three bands are due to the effect of placing a slot on the square patch, which converts the single band to triple band operation. [6].

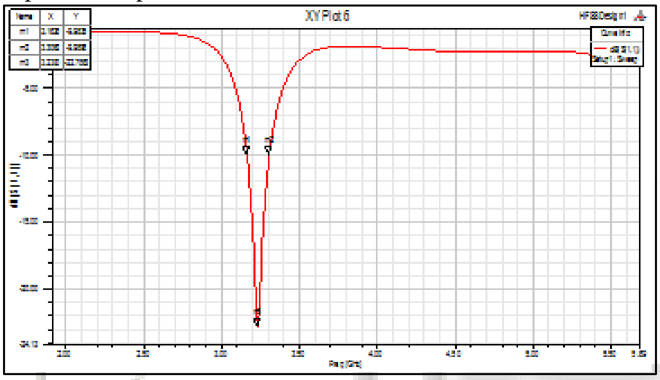

Fig. 4: The variation of return loss versus frequency of CSQMA

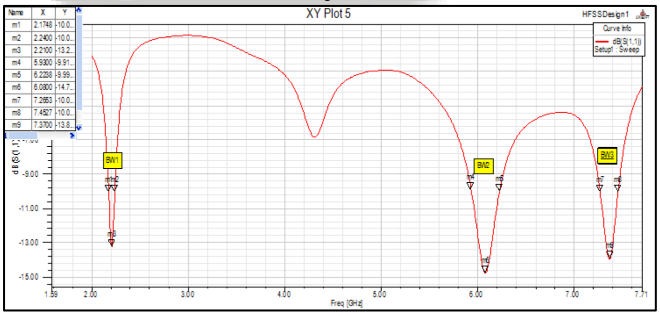

Fig. 5: The variation of return loss versus frequency of ESQMA

The variation of return loss versus frequency of CSSQMA is as shown in Fig. 6. It is clear from the figure that, by removing middle arm from E-slot. The antenna again resonates for triple band of frequencies BW_5, BW_6 and BW_7 by giving a highest bandwidth of 8.4%. [7-8].

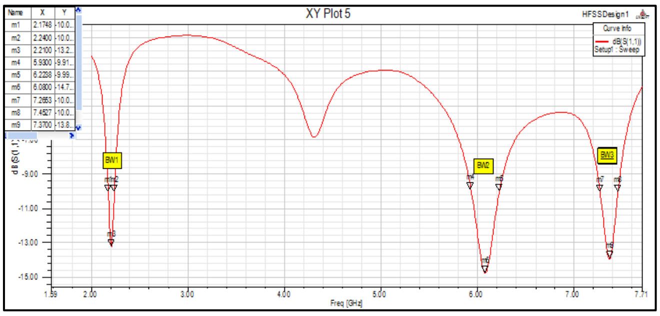

Fig. 6: The variation of return loss versus frequency of CSSQMA

Fig. 7 and 8 shows the co-polar and cross-polar radiation pattern of ESQMA measured at 6.10 GHz, CSSQMA measured at 6.25 GHz respectively. From these figures it is clear that, the patterns are broadsided in nature.

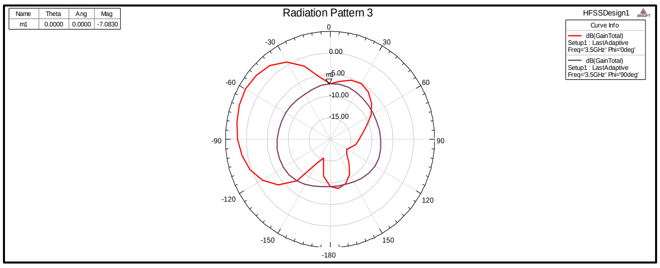

Fig. 7: Radiation pattern of ESQMA measured at 6.10 GHz

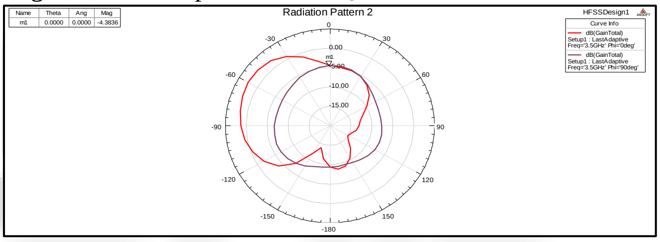

Fig. 8: Radiation pattern of CSSQMA measured at 6.25 GHz

IV. CONCLUSIONS

From the detail study it is concluded that, by placing E-slot on the patch i.e. ESQMA, the antenna is quite capable in producing triple band operation. These triple bands can be enhanced by placing a C-slot of the patch i.e. (CSSQMA). This antenna also gives a highest bandwidth of 8.4 %. The proposed antennas are simple in their design and simulation and may find applications in microwave communication systems.

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