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X-BAND Applications Analysis with SCA (Self Complementary Antenna)- Communication System

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ABSTRACT
The self-complementary antenna (SCA) is a type of basic antenna for extremely broadband practical antennas. This antenna is an arbitrarily shaped antenna which is constituted with a half of an infinitely extended planar-sheet conductor such that the shape of its complementary structure is identical, or "self-complementary "with that of the original structure with two terminals for the simplest case. Self-complimentary antenna Dependencies of impedance bandwidth on shapes are clarified by experiments. The self- complementary antenna impedance matched to a 50 Ω system, utilizing a strip-line feed is designed and fabricated on a glass epoxy material (Єr = 4.2). The measured return loss less than -10 dB over a frequency range of 8 – 12 GHz., radiation pattern and gain are analyzed and seen in detail.

Keywords: Self-complementary, glass epoxy, impedance bandwidth, gain, X-band

I. INTRODUCTION

The self-complementary antenna (SCA) was first proposed by Y. Mushiake [1]. SCA is an arbitrarily shaped antenna which is constituted with a half of an infinitely extended planar-sheet conductor such that the shape of its complementary structure is identical with the original structure for the simplest case. The type of the SCA is not limited only to the case of a planar antenna, but there are more general types of structures with various grades of complexity in their structures such as, the number of terminals, the number of reference planes. In this paper, self-complementary antenna (SCA) fed by strip-line is proposed for X-band applications. A self-complementary rectangular slot is embedded on the ground plane, which results into self-complementary structure applied to a finite-sized flat ground plane is described. Because of the finite-sized ground plane, the antenna can be applied to small mobile terminals, for which wide bandwidth operation is required. It has been illustrated that by embedding self-complementary inclined rectangular slot on the ground plane results into V- shaped self-complementary structure (V-SCA).

II. ANTENNA DESIGN

Figure 1 shows the geometry of SCA ($\theta_1 = 0^0$) and V-SCA ($\theta_2 = 10^0$). The design consists of a rectangular slot etched on the ground plane of the substrate material. The length and width of the substrate material are *L* and *W*. The length and width of the slot *Ls* and *Ws* are taken in term of $\lambda_0/2$ and $\lambda_0/16$ respectively, where λ_0 is the free space wavelength in cm. The slot is placed at a distance *d* from one end of the substrate material along the center axis of the substrate material, which is in terms of $\lambda_g/4$, where λ_g is the guide wavelength in cm. This antenna is energized by strip-line feed, which is placed at the bottom surface of the substrate material. The length and width of the feed line are L_f and W_f respectively. The various dimensions of the antenna are listed in table 1.

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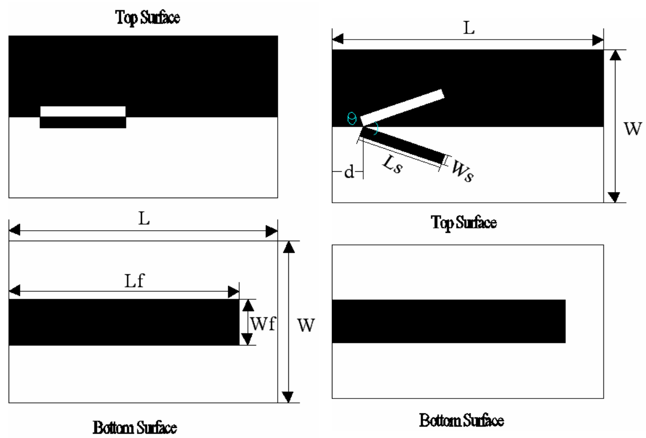

(a) (b)

Figure 1 Geometry of (a) SCA and (b) V-SCA TABLE I - Various dimensions of SCA and V-SCA

L	5.00 cm
W	3.00 cm
L_s	1.60 cm
W_s	0.20 cm
L_f	4.29 cm
W_f	0.84 cm
d	0.57 cm
θ_1	0^0
θ_2	10^0

III. EXPERIMENTAL RESULTS

The impedance bandwidths over return loss less than –10dB for the proposed antennas are measured. The measurements are taken on Vector Network Analyzer (Rohde & Schwarz, German make ZVK Model). The variation of return loss versus frequency of SCA and V-SCA are shown in Fig. 2. From this graph, the impedance bandwidth is calculated by using the equation

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Vol-22-Issue-33-December-2019

$$BW = \left[\frac{f_H - f_L}{f_C}\right] \times 100\% \quad (1)$$

Where, f_H and f_L are the higher and lower cut-off frequencies of the band respectively when its return loss is -10 dB and f_c is the center frequency of band.

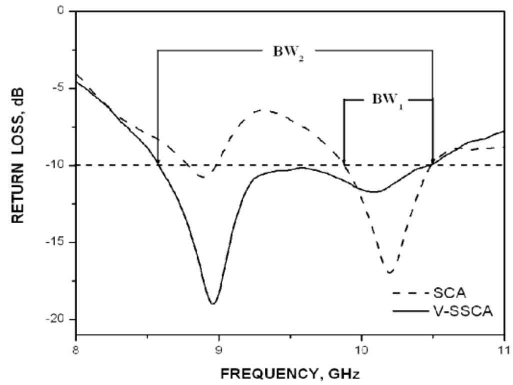

Figure 2 Variation of return loss versus frequency of SCA and V-SCA

From Figure 2 it is clear that the experimental impedance bandwidth (BW_1) of SCA for the angle θ_1 resonating at 10.02 GHz is found to be 210 MHz i.e. 1.92 %. The impedance bandwidth (BW_2) of V-SCA for the angle θ_2 resonating at 8.97 GHz is found to be 1920 MHz i.e. 19.73 %, which is 10.30 times more when compared to SCA for the angle θ_1. Further from the graph it is observed that the antenna V-SCA is resonating for lower frequency resulting in compactness of 11.5 %.

The *X-Y* plane co-polar radiation patterns of SCA and V-SCA for the angles $\theta_1$and θ_2 are measured at resonating frequencies and are shown in Figure 3. From the figure it is clear that the antenna V-SCA shows nearly omni-directional radiation pattern.

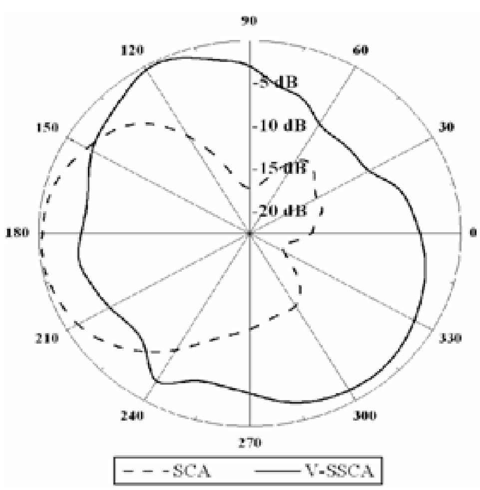

Figure 3 Variation of relative power v/s azimuth angle of SCA and V-SSCA

In order to calculate the gain, the power received (P_s) by the pyramidal horn antenna and the power received (P_t) by SCA and V-SCA for θ_1 and θ_2 are measured independently. With the help of experimental data, the gain of antenna under test (G_T) in dB is calculated using the formula,

$$(G_T)_{dB} = (G_s)_{dB} + 10 \log (P_t/P_s) \quad (2)$$

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Vol-22-Issue-33-December-2019

Where, G_s is the gain of pyramidal horn antenna. It is seen that the gains of SCA and V-SCA for θ_1 and θ_2 are 1.15 dB and 1.09 dB respectively.

Since V-SCA gives wide impedance bandwidth, the variation of input impedance is shown in Figure 4. It is seen that the input impedance has a single loop at the centre of Smith chart that validates its wide single band operation.

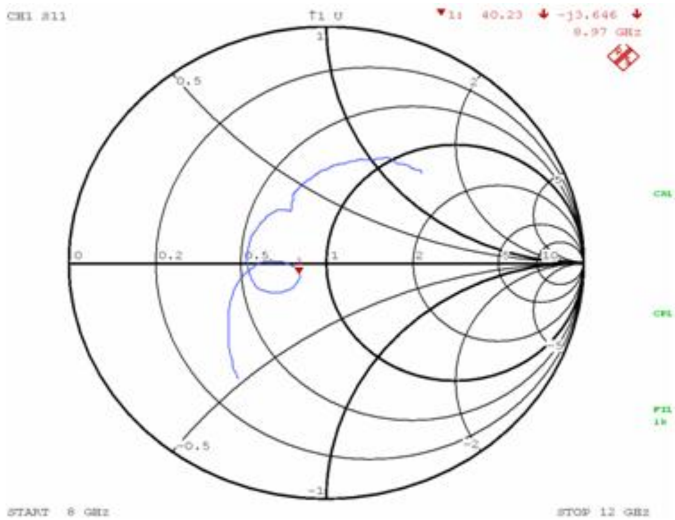

Figure 4 Input impedance profile of V-SC

CONCLUSION

From the detailed study, the proposed antennas are quite simple in design and fabrication and quite good in enhancing the impedance bandwidth with compact size with improvement in radiation pattern. These antennas are also superior as they use low cost substrate material. These compact antennas are more suitable where limited antenna real estate is available and finds application in modern communication systems.

REFERENCES

[1] Y. Mushiake (1992) “Self-Complementary Antennas”, *IEEE Antennas and Prop. Magn.*, Vol. 34, no. 6, pp. 23-29.

[2] Y. Mushiake (2004) “A Report on Japanese Development of Antennas: From the Yagi-Uda Antenna to Self-Complementary Antennas”, *IEEE Antennas and Prop. Magn.*, Vol. 46, no. 4, pp. 47-60.

[3] Pu. Xu, K. Fujimoto (2003) “L- Shaped Self-Complementary Antenna” *Antenna and Prop. Soci. Int. Symp.* 2003., Vol. 3, pp. 95-98.

[4] Lu Geo *et., al.*, (2008) “A Miniature Quasi-Self-Complementary Antenna for UWB Applications”, Microwave Conf. *APMC 2008*., PP. 1-4.