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Printed Triangular Quasi-Self-Complementary Antennas for Broadband operation

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1. Introduction

Self-Complementary Antenna(SCA) having a constant impedance of about 60π were proposed[1-2]. Since the size of ground plane of perfect SCA must be infinite, this Perfect CSA has a limitation for modern antenna applications of small size and low cost. Some antennas with finite size of SCA have been renewal of interest in recent years [3-7]. The finite size I-shape monopole and slot with terminal resistance 188~250Ω for broadband operation was shown[3,4]. the finite size L-shape CSA with terminal resistance 188~250Ω for broadband effect was also published[5]. Some broadband designs with terminal resistance were proposed in [6, 7]. In [6], the finite size CSA printed on meta-substrate was shown, but this substrate was expensive and hardly using. In [7], the finite size CSA using 3-section Chebyshev transformer for impedance matching to achieve broadband effect were published. Although the antennas can be obtained wide impedance bandwidth by using the terminal resistance[1-6] or technique of impedance match[7] , these design have more cost and complex. For this reason, the studies of cross monopole antenna had been proposed and investigated in [3-6]. Recently, the paper of [8] has been devoted to study for Quasi-Self-Complementary Antennas(QSCA). The QSCA has a finite size and without terminal resistance and matching circuits, which leads to simplify the antenna design and reduce the cost.

In this paper, we present a broadband operation for quasi-self-complementary structure. By using triangular monopole and slot printed on FR4, the broadband characteristic of the proposed antenna is achieved. Details of the proposed antennas are described, and the performance of broadband operation for proposed antennas are described and discussed.

2. Antenna and Experimental Results

The geometry of printed triangular QSCA antenna is shown in Fig 1. Prototype of a printed triangle QSCA is printed on FR4 substrate with a permittivity of 4.4 and a thickness of 1.6. And, the FR4 substrate is a lossy medium with loss tangent of 0.0245. The overall size of the proposed antenna is $75 \times 75 mm^2$.

A right triangle of area of $55 \times 32 mm^2 / 2$ acts as the triangular monopole of the QSCA. And, the 50Ω cable is feed at the two acute angles shown in Fig. 1. The triangular monopole is designed to a half wavelength at 2.38GHz. The triangular monopole offers more current paths at different frequencies, which leads to increase the bandwidth. And, the triangular slot is a complementary structure for triangular monopole. Please note that the proposed QSCA with a lossy substrate has reduced the impedance of QSCA, which leads to decrease impedance to approach the 50Ω system. It reduces the complexity of designing antenna. This design also needs not terminal resistance, which leads to reduce the cost. By adjusting the size of triangular monopole, also the impedance bandwidth can be improved. When adjusting the length of the gap between the triangle

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slot and the triangle monopole, the proposed triangular QSCA can provide very wide bandwidth of 2.38 GHz to above 12 GHz.

Fig 2 shows the measured return loss for the proposed antennas. The obtained bandwidth as VSWR<2.5(or RL>7.36dB) covering 2.38GHz to above 12GHz is achieved. This performance of bandwidth can applied to the UWB application or other applications needing broadband bandwidth. For observing the impedance characteristics of triangular QSCA, the real and image impedance of the proposed antenna is plotted in Fig. 3. The impedance is almost matching at the frequency larger that 2.38GHz. It is also obviously shown that the very wide band of the proposed can be obtained.

The antenna gain of the proposed antenna is shown in Fig. 4. The gain of the proposed QSCA is from 2.7~6.2dBi. The radiation patterns of the proposed antenna are also measured. The Fig. 5 shows the radiation patterns in XY-plane, XZ-plane and YZ-plane at some typical operating frequencies. The radiation characteristic of the proposed antenna is suitable for wireless applications (UWB, WUSB…).

3. Conclusion

The triangular QSCA printed on lossy FR4 substrate for achieving the broadband characteristic have been proposed and successfully implemented. The results indicate that simply by adjusting the size of the monopole and slot and the gap between the monopole and slot, the desired frequency and broadband bandwidth can be easily obtained. The bandwidth of the proposed antenna is covering 2.38 to above 12GHz. In addition, the gain over operating frequency is from 2.7 to 6.2dBi. Therefore, the proposed triangular QSCA is suitable for UWB systems.

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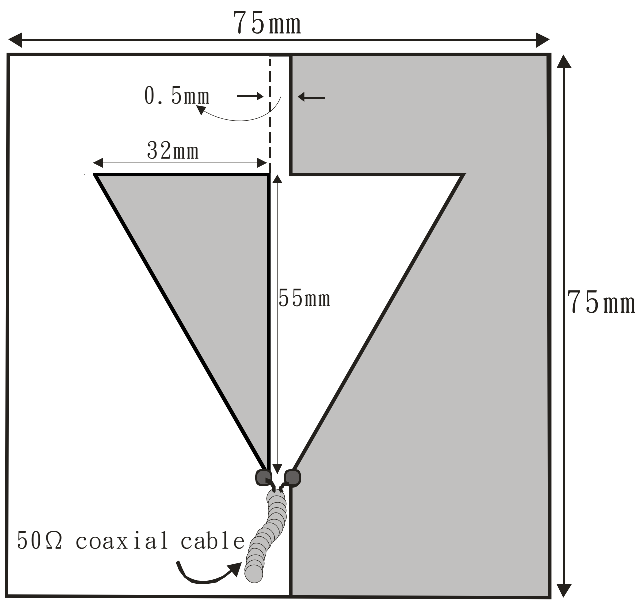


Figure 1: Geometry of the proposed complementary antenna

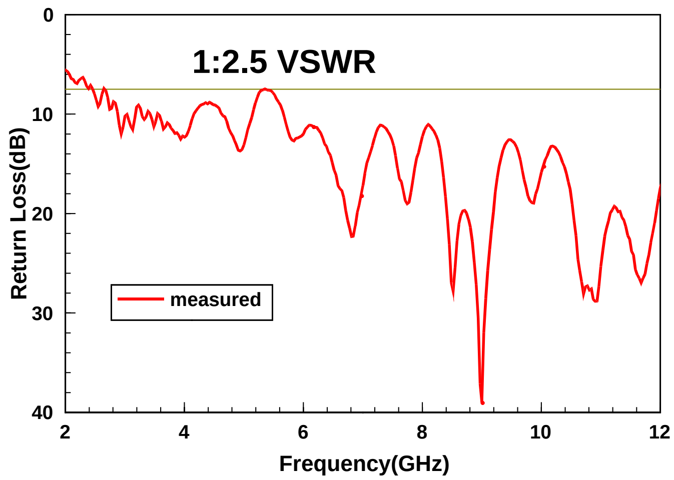


Figure 2: Measured return loss for the proposed three antenna

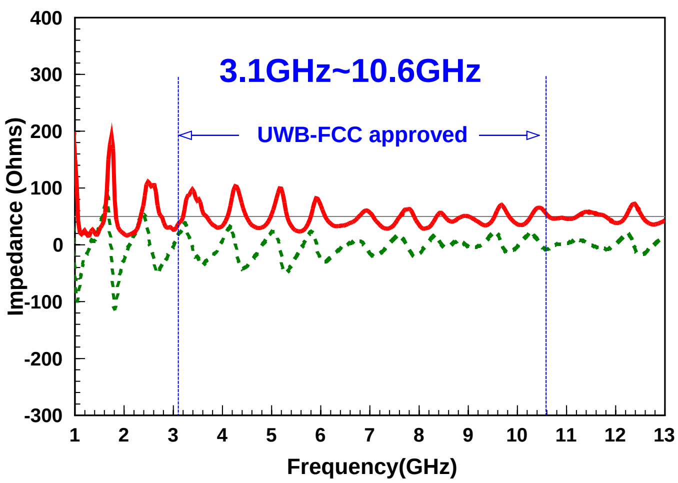


Figure 3: Measured impedance against frequency for the proposed antenna (Where real impedance presented by solid line, and image impedance presented by dash line)

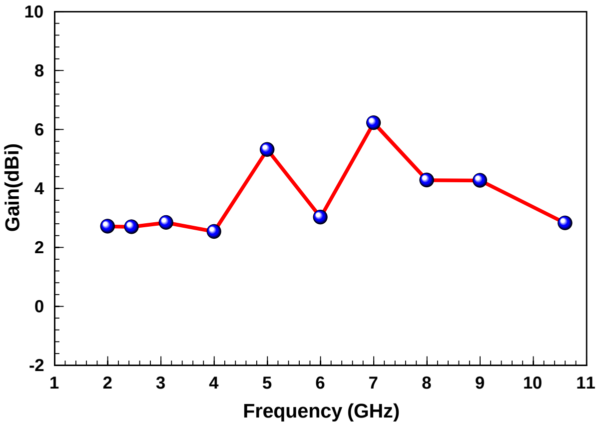
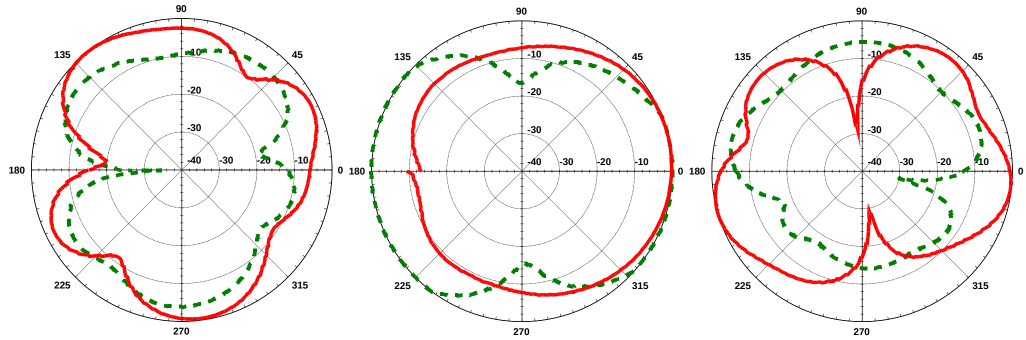
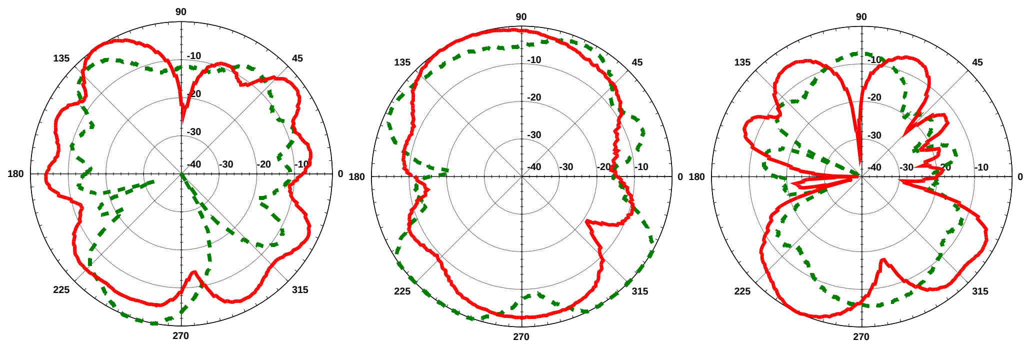


Figure 4: Measured antenna peak gain against frequency for the proposed antenna



XY-plane XZ-plane YZ-plane

(a)



XY-plane XZ-plane YZ-plane

(b)

Figure 5: Measured far-field radiation patterns of Antenna in the X-Y plane, X-Z plane and Y-Z plane at (a) f = 3.1GHz, and (b) f = 7GHz, (Where co-pol presented by solid line, and cross-pol presented by dash line).