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Comparison of Three Band-rejected Cross Semi-Elliptic Monopole Antennas

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1. Introduction

Since the advent of UWB technology, planar monopole antennas have been renewal of interest in recent years [1-2]. Although the planar monopole antennas can be obtained very wide impedance bandwidth fit to use with wideband communications by varying the antenna elements, but have non-omni-directional radiation at higher frequency. For this reason, the studies of cross monopole antenna had been proposed and investigated in [3-6]. In addition, several papers had been devoted to study band-rejected antennas for planar monopole antenna [7-9]. It is because of wideband system normally overlaps several narrowband wireless technologies such as 5.2 GHz (5150-5350 MHz) and 5.8 GHz (5725-5825 MHz) bands. It leads to that wideband devices are required to provide filtering in those bands to avoid interference between narrowband systems and wideband systems. Therefore, the technique of the antennas with band-rejected operation can relieve the requirements for the filtering electronics within the wideband devices.

In this paper, we present three different band-rejected structures for the UWB cross semi-elliptic monopole antenna. By embedding four slits or slots on each lobe of the cross semi-elliptic monopole antenna, the band-rejected characteristic is achieved while maintaining wideband performance and good omni-directional radiation. Details of the proposed antennas are described, and the performance of band-rejected operation for proposed antennas are compared and discussed.

2. Antenna Characteristics

The geometry of three band rejected cross semi-elliptic monopole antennas are shown in Fig 1. Prototypes of cross semi-elliptic monopole antenna were fabricated and vertically mounted on a $120 \times 120\ mm^2$ finite square ground plane at spacing H = 1 mm. All antenna elements are made of 0.1 mm thickness sheet of copper. In addition, the length of the major axis is $2H_1$ = 56 mm, the length of the minor axis is W_1 = 32 mm. When there is no embedded slits or slots the cross semi-elliptic monopole antenna with the dimension chosen in this study can provide very wide bandwidth of 1.85 GHz to above 11 GHz has been presented in [6].

The band-rejected operation can be obtained by embedding the quarter-wavelength resonant slits or the half-wavelength resonant slots. The slit length in the inverted L slits cross monopole antenna (case **a**) is given by $(L_1 + L_2) - 0.5 \times (W_2 + W_3)$ resonate at quarter-wavelength. The slot length in U slots cross monopole antenna (case **b**) and tilted U slots cross monopole antenna (case **c**) are given by $2L_1 + W_3$ resonate at half-wavelength. By adjusting this slit or slot length to be about their resonant wavelength at the desired rejected-frequency band, the proposed cross semi-elliptic monopole antenna will become non-responsive at that frequency band. Details of dimension for three proposed antennas are shown in Table 1.

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Table 1: Detail of dimension for three proposed antennas (unit: mm).

	L_1	L_2	S_1	S_2	W_2	W_3	W_4	α
Case **a**	6	4	8	–	2	2	–	–
Case **b**	13	–	4	7	2	2	2	–
Case **c**	13	–	2	5	2	2	2	30°

3. Experimental Results and Discussion

Fig 2 shows the measured return loss for the three proposed antennas. Result for the reference antenna (the proposed antenna in Fig. 1 without the slits or slots) is also shown for comparison. In case **a**, by adjusting the slit length to agree with the desired rejected-frequency band (5.5 GHz for the 5 GHz band). The rejected band is wide, but the effect of band-rejected characteristic for return loss is unapparent. In case **b** and case **c**, the total slot length is 28 mm, which are also close to half-wavelength of the frequency at 5.5 GHz. From the results, the band-rejected operation is achieved for the three proposed antennas in the 5 GHz band.

To further demonstrate the effects of three different band-rejected structures on the rejected frequency band, we measured and compared the antenna gain of the proposed and reference antennas are shown in Fig 3 and Fig 4. All of the proposed antennas have a sharp decrease in antenna gain at the rejected frequency band. In addition, the antenna gains at the other frequencies outside the rejected frequency band are almost the same for both proposed and reference antennas. It is noted that case **a** only have good rejected characteristic in x-y plane, because the inverted L slits is embedded on outside of the cross semi-elliptic monopole antenna, the influence of slits on the current distribution are significant. But case **a** has not gain decrease at 5 GHz band in y-z plane for operation bandwidth agree with the desired rejected-frequency band.

However, small gain decreases in x-y plane and y-z plane for case **b**. the effect of gain decrease of case **a** is better then that of case **b** obviously. But case **c** has significant gain decrease both x-y plane and y-z plane, just slant angle ($\alpha = 30^\circ$) of band-rejected structure (U slots). It is because the oblique U slots band-rejected cross monopole antenna has more strong effect than U slots band-rejected cross monopole antenna.

4. Conclusion

UWB cross semi-elliptic monopole antennas with three band-rejected structure for achieving the band-rejected characteristic have been proposed and successfully implemented. The results indicate that simply by adjusting the length of the slit or slot, the desired rejected frequency band can be easily controlled. By varying direction of the slots, the oblique U slots band-rejected cross monopole antennas have significantly antenna gain decrease for both x-y plane and y-z plane. In addition, the frequencies outside the rejected frequency band have very small effects, about the same for both proposed and reference antennas.

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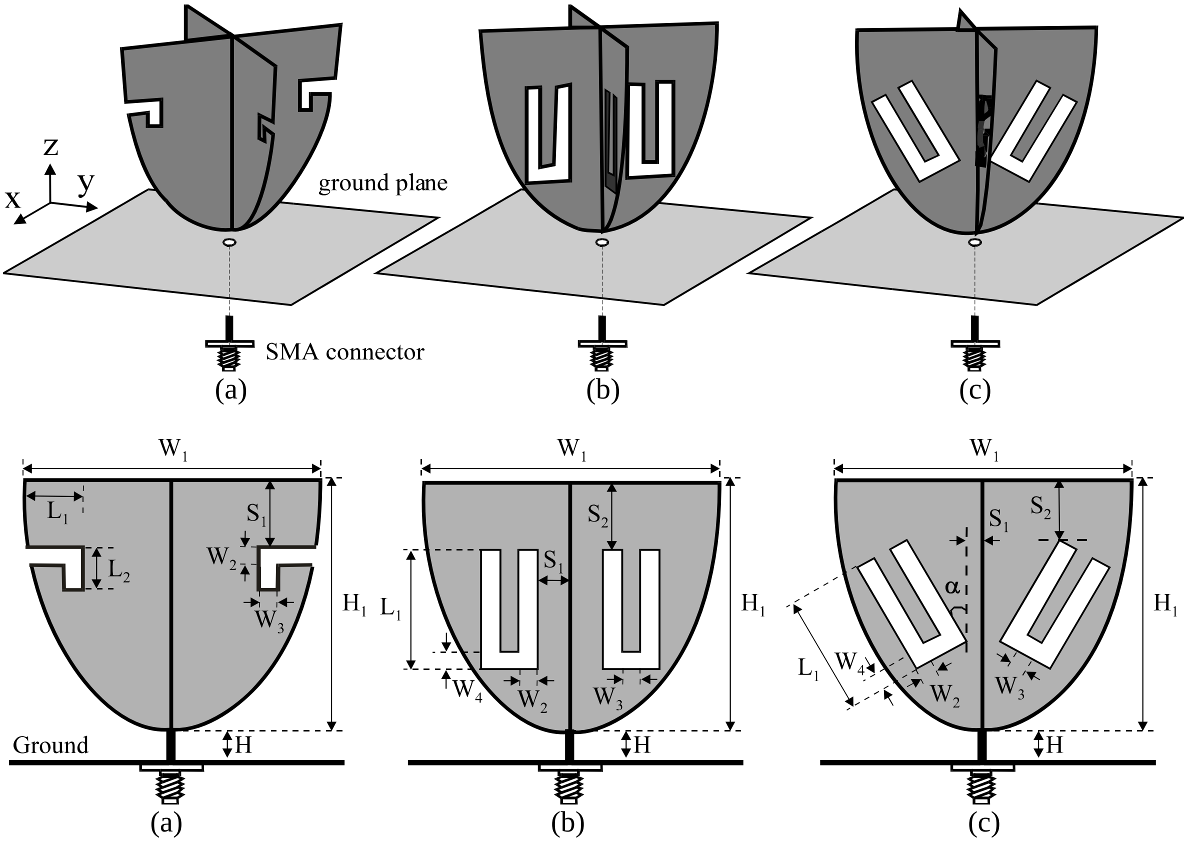

Figure 1: Geometry of the proposed three band-rejected cross semi-elliptic monopole antennas

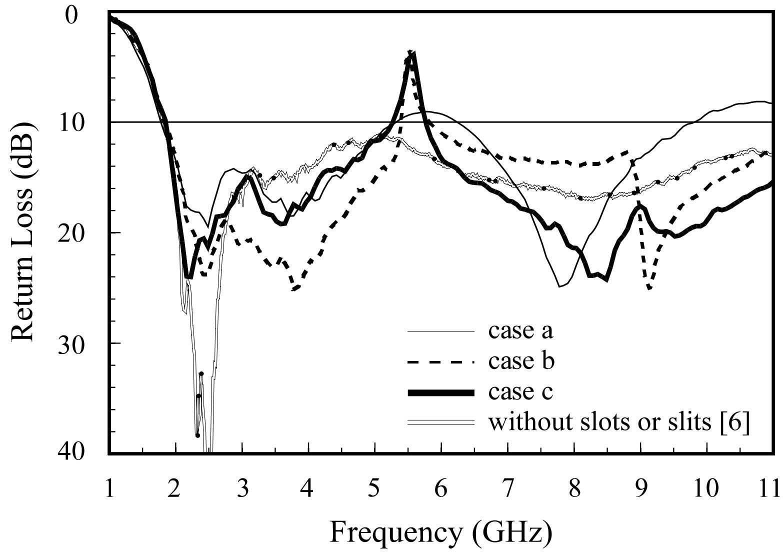

Figure 2: Measured return loss for the proposed three antennas

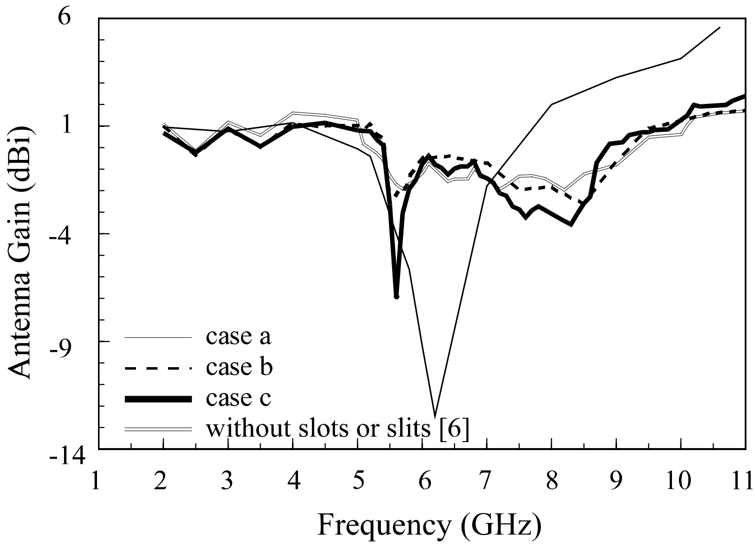

Figure 3: Measured antenna peak gain against frequency for the proposed antennas in x-y plane

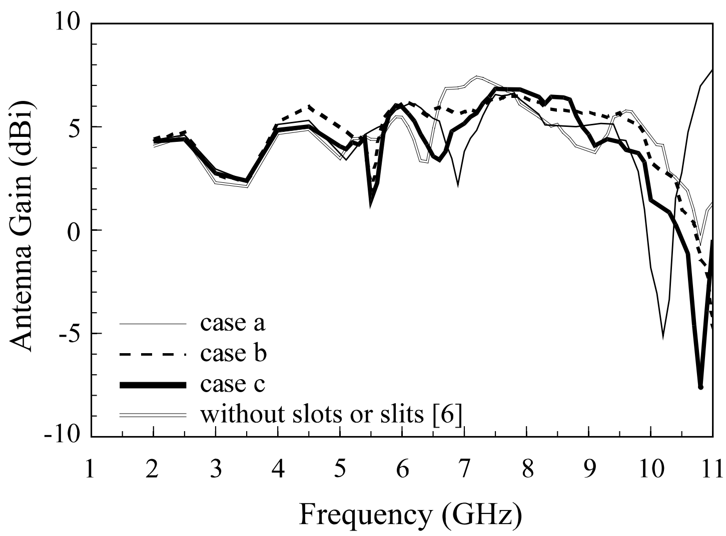

Figure 4: Measured antenna peak gain against frequency for the proposed antennas in y-z plane