Ultra Wide Band Frequency Selective Absorber with Asymmetric Absorbing Performance

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***Abstract*—In this paper, a frequency selective absorber (FSA) with asymmetric performance is proposed. Modified log-periodic dipole array (LPDA) elements are applied to construct the FSA. With the ultra wide band (UWB) property of the LPDA-shaped elements, the FSA gets the UWB absorbing band. Due to the directionality of the LPDA, the FSA is asymmetric network which means that the reflection coefficients of the FSA are different when the incident wave lit the two surfaces respectively. Simulations and analysis are done to study the UWB and absorbing properties. The results show that the proposed FSA can effectively absorb or reflect the incident wave in 6.45GHz-20GHz when the incident wave lit the two surfaces respectively.**

***Keywords*—Absorber; ultra wide band; asymmetric; frequency independent**

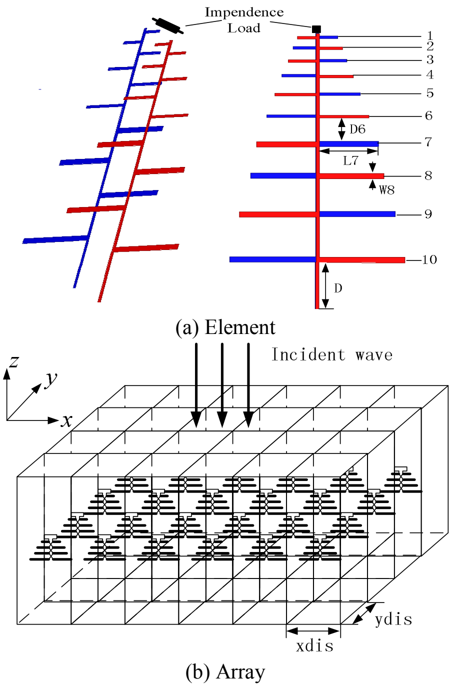
I. INTRODUCTION

Frequency selective surface (FSS) is a kind of spatial filter which is widely used in microwave and millimeter wave applications such as radomes, dichroic subreflectors, RCS reduction, and EMC [1]. In the application of EMC, the FSS provides a specified frequency band in which the incident wave will be reflected or pass through to prevent the devises from being interfered. However the reflected signals may still disturb the other wireless equipments because the signals are always in the space no matter how many times they are reflected.

Absorbers are effective method to eliminate the interference signals which makes they are commonly used in the RCS reduction and EM shielding [1]. On one hand, if the absorbers can eliminate the incident wave in a large frequency range, the space the shielding structure takes will be reduce which is meanful to the design of shielding walls, miniaturized equipments and RCS reduction. On the other hand, if the absorber has asymmetric absorbing property, more Choices will be provided when we need reflection and absorbing properties on the two surface respectively.

Several kinds of absorbers are proposed such as Salisbury screen [2], Dallenbach screen [3], Jaumann screen [4], metamaterial absorber [5] and so on, while most of the absorbers are symmetric and hardly work in ultra wide band.

In this paper, an ultra wide band frequency selective absorber (FSA) is proposed based on the frequency independent property of the log-periodic dipole array (LPDA). With the directionality of LPDA, the asymmetric absorbing property of the absorber is achieved. The results show that the absorber can absorb the incident wave on one direction and reflect it on the opposite direction in the ultra wide band.



(a) Element

(b) Array

Fig. 1. Structure of the FSA

II. STRUCTURE OF THE FSA

The structure of the proposed FSA element and array is shown Fig. 1(a)-(b). The FSA element consists of impendence load and LPDA-shaped structure which contains 10 arms. The length and width of the arms are L1 to L10 and W1 to W10. The distance between the neighbor arms is D1 to D9. The detailed sizes of the structure are shown in Table 1. In the array, the distances between the elements is xdis and ydis as shown in Fig.1(b).

TABLE I. SIZES OF THE FSA (UNIT: MM)

	L	W	D		L	W	D	xdis
1	2.3	0.4	1.2	**6**	6.05	0.4	3.56	30
2	2.8	0.4	1.52	**7**	7.3	0.8	3.97	**ydis**
3	3.41	0.4	1.88	**8**	7.96	0.8	4.92	3
4	4.15	0.4	2.36	**9**	9.4	0.8	6.04	**D**
5	5.06	0.4	2.88	**10**	10.52	0.8		84

In the case of the proposed FSA, the function of the impendence load is keeping good matching with the LPDA-shaped structure and absorbing the received energy. To keep matching, the impendence of the load does not need to be set according to any industry standard such as 50ohm or 75ohm, but can be set as any value. Based on the input impendence of the FSA in the array, the load impendence is set as 50ohm.

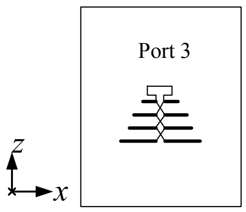


Fig. 2. The configuration of the simulations

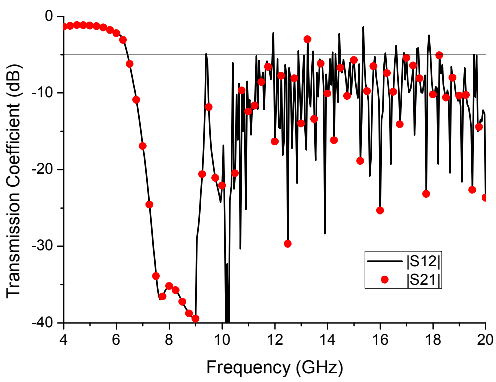


Fig. 3. The transmission performances of the FSA

III. PERFORMANCES AND ANALYSIS

The configuration of the simulation is shown in Fig. 2. In order to find out how the incident energy is absorbed, there are 3 ports are set: Port1 and Port2 are the commonly used probes to get the transmission and reflection coefficients of the FSA, Port3 is the LPDA port which is loaded by a port with impendence instead of a lumped impendence. According to the law of conservation of energy, if the elements are lossless there is

$$|S11|^2 + |S21|^2 + |S31|^2 = 1 \quad (1)$$

The asymmetric absorbing can be expressed by

$$|S11| \neq |S22| \quad (2)$$

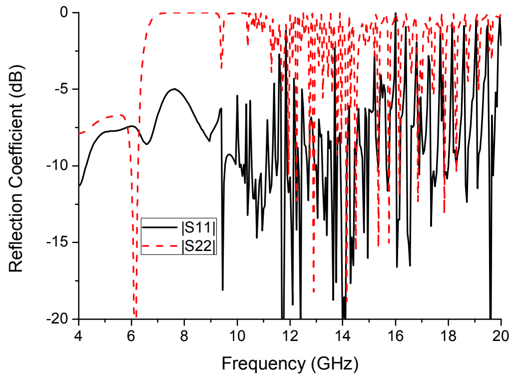


Fig. 4. The reflection performances of the FSA

With this configuration the transmission and reflection performances of the proposed FSA are simulated. The incident wave is x-polarized plane wave. The transmission properties are shown in Fig. 3. The |S12| and |S21| curves are in good coincidence which means that the incident wave can hardly pass through the FSA when it comes from the direction of (0°, 0°) or (180°, 0°). As shown in Fig. 4, the FSA's reflection coefficients curves are studied to prove its asymmetric absorbing property. From the |S11| and |S22| curves we can find out that the |S11| and |S22| are similar and both lower than -6dB in the band of 4GHz-6.2GHz. In the frequency range higher than 6.2GHz, the incident wave can be reflected when it comes from (180°, 0°). The transmission and reflection coefficients are both very small when the incident wave comes from (180°, 0°), so the incident energy must be absorbed by the impendence of Port3 according to the equation (1). Moreover, the reflection performances of the FSA on the opposite two direction is largely different, because the LPDA-shaped element is a directional structure which leads to the different receiving performances on the direction of (0°, 0°) and (180°, 0°). To improve this, the transmission coefficient between Port1 and Port3 is simulated as shown in Fig. 5. It can be seen that the |S13| curve is much higher than the |S23| curve which means that the incident wave from the direction of (0°, 0°) can be received and absorbed while the incident wave from the direction of (180°, 0°) can hardly be received but reflected.

Based on the analysis above we can concluded that in the operating band the proposed FSA can effectively absorb the incident wave from the direction of (0°, 0°) and reflect the incident wave from the direction of (180°, 0°). As shown in Fig.3, under the condition of |S21|<-5dB, the absorbing band of the proposed FSA is 6.45GHz-20GHz (relative bandwidth is 1:3.1).

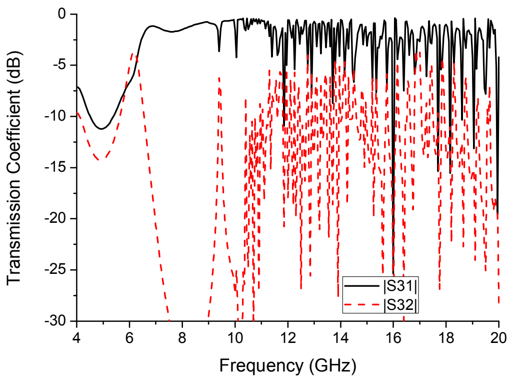


Fig. 5. The transmission performances between Port1 and Port3

IV. CONCLUSION

Ultra wide band frequency selective absorber with asymmetric absorbing performance is proposed in this paper. The ultra wide absorbing band is achieved by the frequency independent property of the LPDA-shaped element. The asymmetric absorbing property is caused by the directionality of the LPDA-shaped element. The results shown that in a ultra wide band the incident wave can be effectively absorbed or reflected when it lit the FSA on the two opposite surfaces respectively.

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