

Frequency Selective Surface Absorber Using Resistive Cross-Dipoles

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A novel frequency selective surface (FSS) absorber is presented for 5 GHz WLAN applications. It consists of a conventional conducting cross-dipole FSS and a matching resistive FSS. This thin configuration has shown good stopband and absorption characteristics for 5 GHz WLAN signals while allowing 900/1800/1900 MHz mobile signals to pass through almost unattenuated. Preliminary theoretical results on absorption and transmission are described.

Introduction

Salisbury and Jaumann screens provide very good absorption characteristics in their stopband frequencies [1]. Outside the stopband, these screens behave as pure reflectors and therefore can not be used in applications where out of band frequencies are desired to be passed. The concept of frequency selective surface (FSS) absorbers is considered as a solution to this problem and has been investigated by different researchers over a period of time [2,3]. One of the main challenges behind the design of selective absorbers is to decrease the quarter wavelength distance between the FSS and resistive sheet [2]. This in turn is useful in making more compact and practical designs. In this research, a FSS absorber has been designed and simulated for 5 GHz WLAN applications. It has a good absorption characteristics in the stop band while allowing 900/1800/1900 MHz mobile bands to pass through it almost unimpeded. Moreover, the distance between the dual layers of FSS has successfully been decreased to less than quarter wavelength at resonant frequency, ultimately giving a more compact design. The prototype has shown good results for both linear and vertical polarizations in contrast to what have been described in [3].

The Design

The dimensions and layout of the FSS absorber are depicted in Fig. 1 while its prototype is depicted in Fig. 2. Each FSS layer is printed on a 460x310 mm FR4 sheet with dielectric constant of 4.4. The bandstop characteristics are achieved by incorporating an array of conducting cross dipoles on one side of one of the FR4 sheets, which has a thickness of 1.6 mm. The function of this conventional FSS layer is to act as a reflector for WLAN signals while passing mobile phone signals. The absorption characteristics are achieved by placing a second FSS layer consisting of resistive cross dipoles, approximately 10 mm in front of the conducting FSS layer. This concept follows the principle of the conventional Salisbury screen where a uniform resistive sheet is employed for wave absorption. However, unlike in a Salisbury screen, our resistive layer is also a periodic FSS. Its pattern is matched to the first layer, and it absorbs WLAN signals reflected by the first layer while passing mobile phone signals. The thickness of FR4 used for the resistive layer is chosen as 0.8 mm, and the surface resistance of

resistive dipoles is chosen as 50 ohms per square, as surfaces with these parameters are readily available. The dimensions of cross dipoles on both conductive and resistive layers are the same.

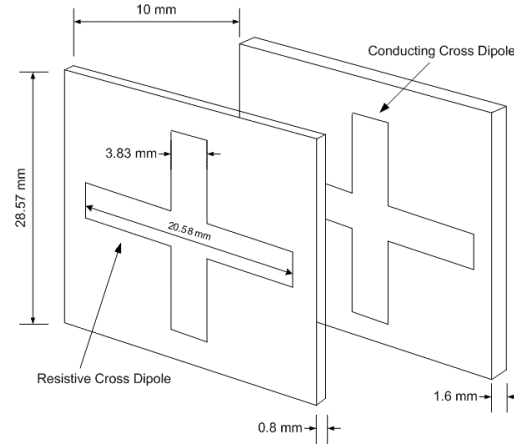


Fig 1. The configuration of FSS absorber and its dimensions.

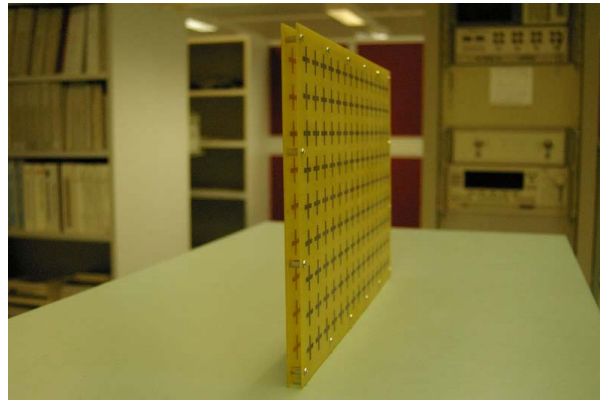


Fig 2. The prototype of FSS absorber.

Results

First, the conventional conducting FSS layer was simulated and designed using Ansoft HFSS commercial software. The theoretical results showed good bandstop transmission and reflection characteristics for the prescribed bands. At 5.25 GHz, the transmission and reflection coefficients are -29.2 dB and -0.3 dB, respectively. The stop band has a -10 dB transmission bandwidth of 620 MHz. At 900 MHz the transmission and reflection coefficients are -0.1 dB and -17.4 dB, respectively. Around 1800/1900 MHz these coefficients are approximately -0.4 dB and -11.3 dB. The results are depicted in Fig 3.

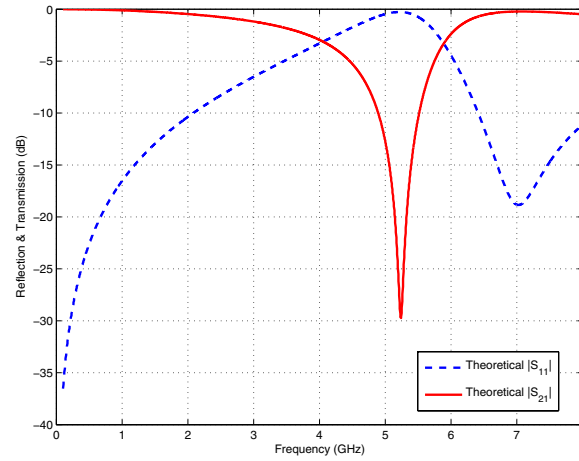


Fig 3. Reflection and transmission of conventional conducting bandstop FSS.

The second *resistive* layer was designed to absorb reflections caused by the first layer at the resonance frequency. This FSS absorber was simulated using Ansoft HFSS, and the results are shown in Fig. 4. At 5.25 GHz, the transmission and reflection coefficients are -37.6 dB and -12.7 dB, respectively. It is worth noting that the reduction of WLAN signal reflection by more than 12 dB is due to the absorption by the resistive FSS layer. The stop band -10 dB bandwidth is now 880 MHz. At 900 MHz the transmission and reflection coefficients are -0.1 dB and -17.4 dB respectively. At 1800/1900 MHz these coefficients are -0.9 dB and -8.8 dB. In short, the second layer did not significantly affect the transmission of mobile phone signals through the structure.

The initial experimental results of FSS absorber are in good agreement with the theoretical results. Its resonance occurred at 5.37 GHz, with a transmission coefficient of -25.2 dB and a reflection coefficient of -10 dB.

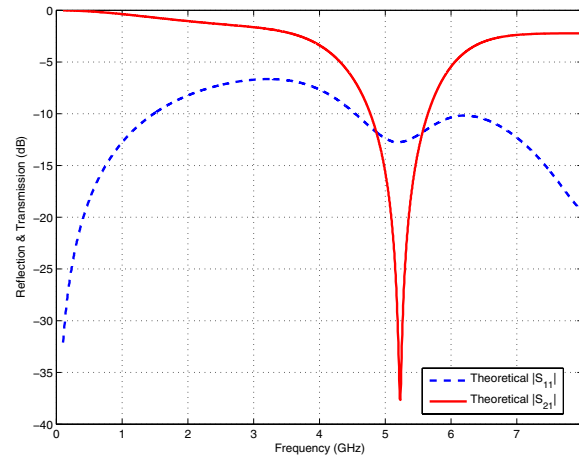


Fig 4. Reflection and transmission of FSS absorber with 50 ohms cross dipoles on FR4.

Conventional absorbers use 377 ohms resistive sheet spaced quarter wavelength from the conducting ground plane for absorption in the stopband. This method only gives good absorption characteristics in the stopband but the out of band transmission is poor. Fig. 5

shows the theoretical results of FSS absorber when the resistive cross dipoles (on FR4) have been replaced by a full 377 ohms/square resistive sheet. In this case the transmission and reflection coefficients for a particular 900 MHz are -3 dB and -8 dB. In case of resistive cross FSS, these are -0.1 dB and -17.4 dB respectively giving better transmission characteristics for mobile signals. This comparison shows the resistive cross-dipole FSS gives improved transmission for mobile bands compared to the use of a full 377 ohm resistive sheet.

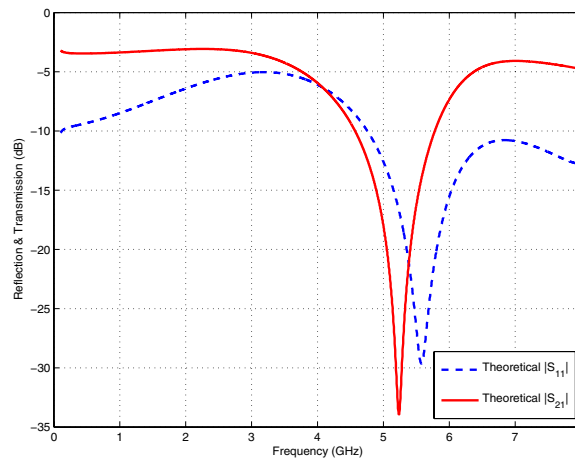


Fig 5. Theoretical results of absorb/transmit FSS when full sheet of 377 ohms is used instead of resistive crosses

Conclusion

An FSS absorber using resistive cross-dipoles has been investigated. Our design has shown good absorption of 5GHz WLAN signals and good transmission of mobile signals. The absorber may be placed in office walls to provide WLAN security and/or WLAN system isolation. The absorption of the FSS surface will serve to curb additional WLAN multi-path fading, delay spread and signal degradation caused by high reflections from conventional (i.e. conducting) FSS sheets. This technique could be extended for two-way absorption as well by incorporating a third FSS layer similar to the resistive FSS on the other side of the conducting FSS. More details including measured results will be presented at the conference.

References

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