The Use of Buried Technology In Microsystem Packaging Achieves The New Type of Electronic Band Gap

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***Abstract*—novel two-dimensional EBG is put forward to suppress the simultaneous switching noise of electronic systems, Based on the inductance enhanced by the development of the micro system substrate embedded technology in recent years in the long-linemetal between adjacent unit cell, the novel two-dimensional EBG structure is achieved by the units lattice structure,which is made of the connection of a square metal and two metal serpentine lines.Simulation results show that the stopband bandwidth of new EBG structure labeling on capacitor is 0 ~ 8GHz ($S_{21} \leq -15dB$)in the same parameters EBG classic .**

***Keywords*—simultaneously switching noise(SSN); electromagnetic band gap(EBG); Electromagnetic compatibility(EMC)**

I. INTRODUCTION

With the integrated modern digital communication systems continuing to increase, as well as meeting the system requirements of high speed and low power consumption,The edge of the clock signal is continuously precipitous, signal voltage is continuously reduced. A large number of high-speed switching devices switching simultaneously in high-speed circuit systems work process produces simultaneous switching noise (Simultaneous Switching Noise, SSN),which is also known as the random Noise (Ground Bounce Noise) transmiting in the parallel plate waveguide between the power of the circuit board and the ground plane,Ground bounce easily provoked plane resonance which resultin serious signal integrity (SI) and electromagnetic interference (EMI) problems, signal integrity (SI) and electromagnetic interference (EMI) can interfere with the surrounding high-speed chip to cause malfunction, thus affecting the overall stability of the system ,If the SSN in the design process can not be timely detection and suppression, the digital system will be a serious problem in signal integrity (SI), power integrity (PI) and electromagnetic compatibility (EMC) etc[1-4].Therefore, with the digital system to the high clock frequency, high speed data transfer rate and low supply voltage trends,it is significance that how to effectively suppress the SSN of the electronic systems in integration and packaging.

Early EBG structure is mainly 3-D structure [5-7] ,Implementation in Electromagnetic Band Gap(EBG) requires multi-layer circuit boards,which increases the difficulty of making design ,and improve the cost of the product. Meanwhile, the traditional structure of Electromagnetic Band Gap (EBG) is generally half the wavelength of the cutoff frequency,which thus limit the EBG application in the low-frequency and lead to the weak performance in the low-frequency electromagnetic noise suppression.Meanwhile, the three-dimensional electronic band structure requires the use of more board layers and a lot of metal through holes, which lead to increasing in the cost of products, so the two-dimensional electronic band gap preventing electromagnetic noise has become the development trend of today[8-12]. Therefore, the two-dimensional electronic band gap has become the development trend to noise suppression, the buried technology based on in microsystem packaging in recent years achieves the new type of electronic band gap which has suppressed SSN in the range of from 0 to 8 G frequency, this can not realize in in traditional EBG structure

II. PRINCIPLE ANALYSIS AND DESIGN

With the plane being widely used to electronic products, the research of multi-layer circuit board become the theme.The flat plates of the power and ground ,which is acted as the power supply in low frequencies,become a waveguide in high frequencies.The knowledge of waveguide helps to solve the problem of SSN,the voltage distribution of the plane (5 × 5 mm) is determined by the resonator mode, and the resonant frequency depends on the modulus. The resonant frequency of the plane can be obtained by the following formula

$$f_{min} = \frac{1}{2\pi\sqrt{\mu\varepsilon}} \sqrt{\left(\frac{n\pi}{b}\right)^2 + \left(\frac{m\pi}{a}\right)^2}$$

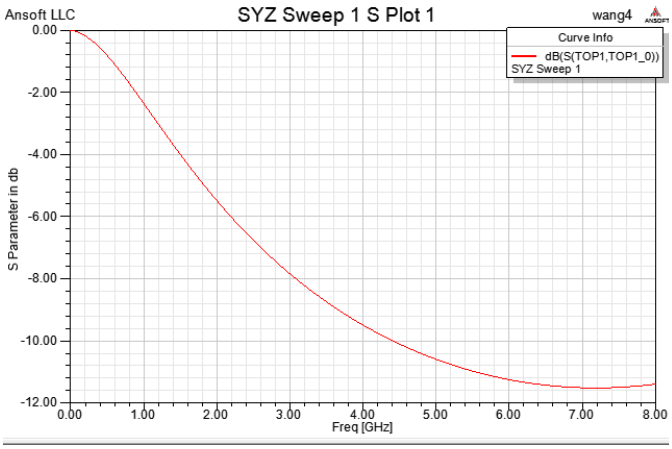
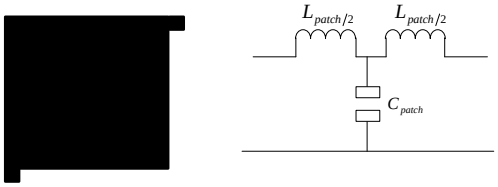


Fig1 show the isolation degree with frequency, when the surface structure size in the EBG have the 5x5 mm units metal microstrip

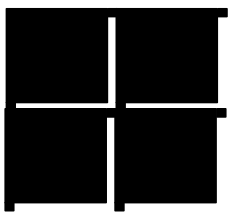
As can be obtained From the graph 1，the geometry size of substrate in microelectronics encapsulation system is small , If the power supply and ground plane of the high-speed electronic system connects the planes respectively, the power switch noise of high-speed system can affect the system signal integrity,then leading to system paralysis.

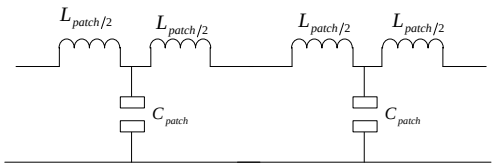
A. The traditional two-dimensional electronic band gap

JinwooChoi, and VinuGovind[7] put forward a new type of plane electromagnetic band gap structure in 2004, Novel planar EBG structure was later named AI-EBG, which consists the unit of the a large metal patch and two small metal patches, (as can be seen from Fig2).By the electromagnetic field and microwave technology theory, when the microwave transfer in the units of surface defect structure, large patch and the small patch is respectively equivalent for the equivalent capacitance and inductance.the units of surface defect structureis equivalent to the equivalent circuit .



(a)the viewof the unit blockand the corresponding equivalent circuit





b)Equivalent circuit diagram

Fig2. Typical principle of EBG structures and the corresponding equivalent circuit

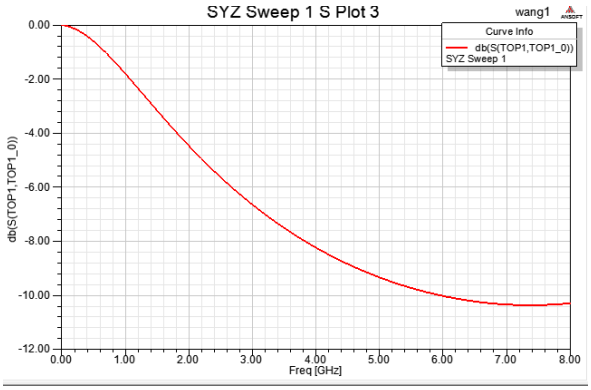


Fig2.the isolation degree under the size of microstrip 0.1 x0.1 mm

Fig2 show the isolation degree with frequency, when the surface structure sizein the EBG have the 5x5 mm units metal microstrip, each unit of sheet size is respectively 0.9x0.9mm, with 0.1x0.1mm metal microstrip .

Obtained From the graph 2,the conventional EBG structure cannot solve the problem of electromagnetic switch noise in the micro encapsulation system,

B. The modified two-dimensional electronic band gap

In order to realize the effective inhibition of electromagnetic noise in the low frequency rang,This paper adopts the buried inductance instead of the original metal straight line, which significantly increases the value of the inductance based on the development of the microsystem substrate embedded technology in recent years, which helps the lattice lower resonant frequency, which can be derived from the formula ($\omega_0 = 1/\sqrt{LC}$). That help to improve the suppression of low frequency in thesurface defect structure

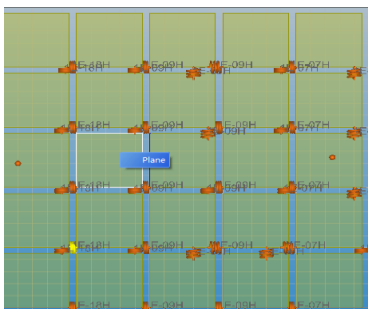


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Fig4. principle of EBG structures with the buried inductance and the corresponding equivalent circuit

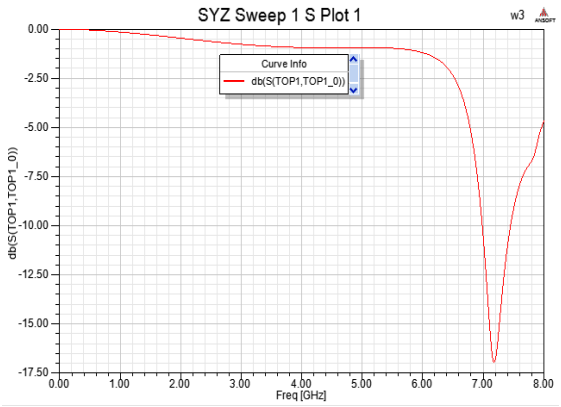

Fig5. |S_21 | of EBG structures with the value of a single capacitance buried inductance

As been shown in Fig5，When buried a single value of inductance in microsystems , the power system can only stimulate a single resonant frequency electromagnetic wave according to $\omega_0 = 1/\sqrt{LC}$, electromagnetic wave can better through with in the scope of the resonant frequency, thus forming the frequency range is relatively narrow bandpass filter,

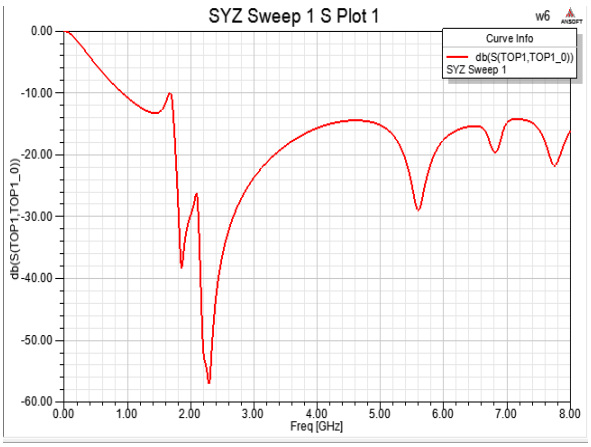

Fig6. |S_21 | of EBG structures with the two values of buried inductance

Fig6 show that the two different value of inductor buried in sequence form the filter with a larger bandwidth, which obviously improve the performance of the EBG. But this structure show that electromagnetic switch noise suppression is weak in low range of frequency, which hindered the promotion of the structure of EBG.

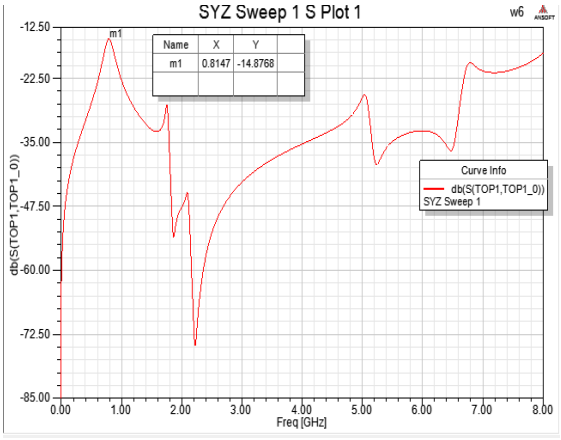

Fig7. |S_21 | of EBG structures with the three values of buried inductance

As can be obtained From the graph 7, the inhibition to SSN of modified EBG with the three values of buried inductance is comparing the modified EBG structure. The new improved EBG structure is achieved with implanted different resistance inductance, the structure not only has the ability to electromagnetic noise isolation under the condition of high frequency, at the same time have the outstanding performance in the low frequency.New electronic band gap achieve the S_21 ≤ -15dB in 0-8GHz electromagnetic frequency range ,which basically meet the needs of practical engineering practices.

CONCLUSION

In high-speed circuit systems，Signal integrity problems increasingly attracted the attention of designers, especially simultaneous switching noise influencingon the signal line interconnect.By analyzing the traditional two-dimensional electronic band gap structure equivalent circuit,New method to improving the bandwidth of the EBG is put forward by using the embedded inductance, which achieve the purposes of the suppression of lower frequency noise and the broaden bandwidth of EBG structure,The method to solve the two-dimensional EBG structure exists bandgap narrow bandwidth and high frequency of problems provides a new way of thinking. The simulation of software verify the correctness and effectiveness of the proposed method. With the modified two-dimensional electronic band gap as an example, the paper achieve the better inhibitory effect of electromagnetic noise by adjusting the labeled capacitance, which is greatly reducing in the cost of implementation, and has a practical value in the works.According to the simulation of the data (S_21≤ -15dB as the standard), the inhibition bandwidth of new EBG is 0--8GHz bandwidth, which basically meet the needs of the conventional electronic system noise isolation.

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