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Suppression of Common mode signal using novel DGS for high speed circuit applications

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Abstract- The common mode noise suppression is the critical issue In high speed digital circuits .In order to suppress this various techniques are available like common mode chokes ,multi layer technique, Defected Ground Structure(DGS) and so on. In DGS technique the bandwidth is limited to enhance this a novel chakra type dumbbell structure was introduced in the ground plane, this additional defect in the ground plane increases the effective capacitance and inductance Hence broad bandwidth was enhanced . This novel structure provides better than 3 dB differential mode insertion loss over the frequency range 0.1 GHz to 10 GHz and also has the common mode insertion loss better than 20 dB from 2.7 GHz to 5.8GHz.

I. Introduction

Nowadays, as data rate of high speed digital circuits has been increased rapidly, differential signaling is one of the alternative transmitting method due to its high compatibility to noise, low crosstalk and low electromagnetic interference (EMI). However, in practical circuits, the common-mode noise is generated because of power and ground plane resonances of a printed circuit board (PCB), imbalances of the differential line, and external noises which is unavoidable. In general, a common-mode choke, using ferrite core with two coils wound on it is used to suppress common-mode noise . [1]–[3]. But it is applicable only for MHz range and it is very bulky in size . For wideband noise suppression up to several GHz range A Multi-layered Low Temperature Co-fired Ceramic (LTCC) [4] was proposed which is very compact in size and having very wide stop-band at gigahertz for common-mode. However, it is difficult to use in multilayer PCB because of it chip type and embedding in multilayer is a tough one and also the cost of fabrication is very high. There are few other methodologies are there with wide band suppression of common mode noise like creating a resonator in power/ground plane such as electromagnetic bandgap (EBG) [5] structure and localized spiral resonator have been proposed Similar to this creating a resonator in ground layer by modifying it(Modified Ground Structure) [6] or defecting it (Defected Ground Structure) The DGS concept is the most affordable technology which is very compact in size and has very high compatibility to harmonics and spurious emissions. It can be used in very wide applications like low pass filters, Band pass filters and also in RF phase shifters. The proposed work is to achieve the wide band common mode noise suppression without varying the physical dimensions.

II. Design Concept And Modeling

A dumbbell shaped structure has been etched periodically below the differential lines in a ground plane .Normally the return current density of the differential signal is very low compared to the common mode signal. Hence the return current flow of the differential signal through the ground plane will have very minimal degradation almost a negligible one, but for common mode signal which has a very high return current density will pass through the ground plane, and this structure will create a very significant impact on this . When a physical discontinuity persists in a return path that forces the current to deviate from the ideal path, the total area of the current loop has been increased and the return current must flow through a region of increased impedance. A DGS having the characteristics of stop band, slow-wave effect and high impedance .The slot part accumulates charge and increases the effective capacitance of the circuit. Two rectangular defected structures and one connecting slot correspond to the equivalently added inductance and capacitance , respectively. Accordingly, a resonance occurs because of this L-C circuit. Repetition of this physical structure in the ground plane (a periodic structure) can be used to reduce the circuit size and also used to increase the bandwidth of the circuit. The bandwidth of the circuit depends on the Shape of the unit DGS, distance between the two DGS and type of the DGS used. In order to accomplish this, the square shape of the basic structure [1] as shown in fig Fig-1, has been rotated six times in its center of axis with the angle of 30 degree which will give a Chakra type structure shown in Fig-2. Because of this modification it will create an additional length in the return current path of the common mode signal due to this an additional bandwidth of several hundred MHz has been improved . The modification does not change the frequency behavior of the original DGS. This Novel configuration has a broad stop band and allows a large number of periods in a reasonable circuit area.

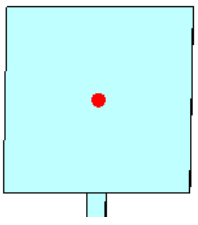

Fig-1: Square shape of the basic structure

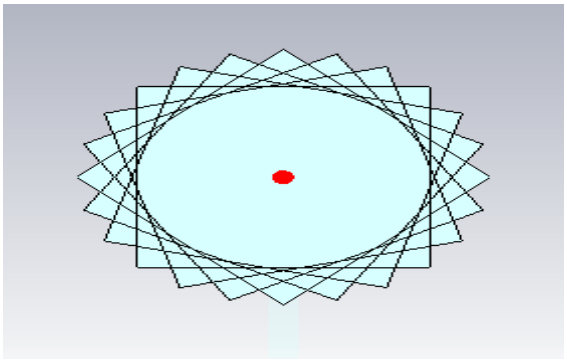

Fig-2: Chakra shape structure

III. Results and Analysis

As shown in fig -4 a modified common mode filter has been designed on a glass epoxy substrate(FR4) with 0.8 mm .In order to enhance the stopband bandwidth the defected structure has been altered from the basic structure as shown in fig -3.The proposed structure has been simulated using CST microwave studio.Fig-5 shows the insertion loss of Differential signal and the wide band suppression of Common mode noise signal from 2.7 GHz to 5.8 GHz . Fig -6 shows the time delay response of the common mode signal for modified structure. Two pulse trains with different amplitude has been given as a inputs in the input ports and the output has been verified in the output ports. The common-mode noise is defined as half of the sum of the measured voltage at these output ports, and it is very clear that it has been reduced sufficiently.

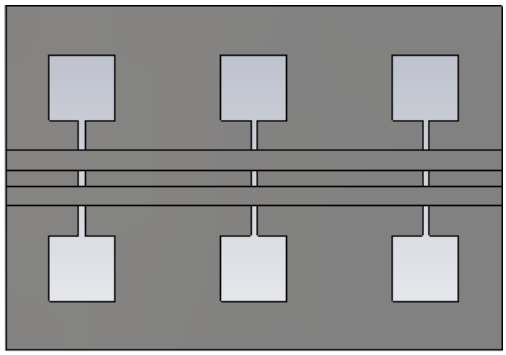

Fig-3 : Base structure for common mode

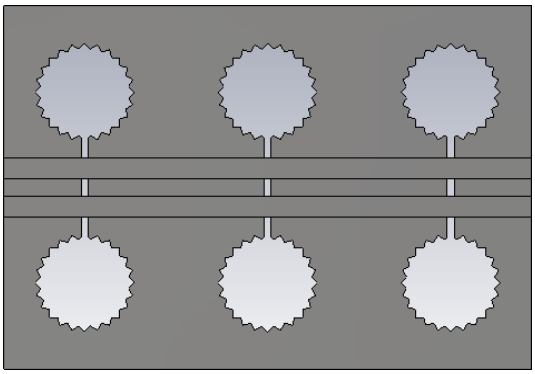

Fig-4 : Chakra structure for bandwidth filter enhancement

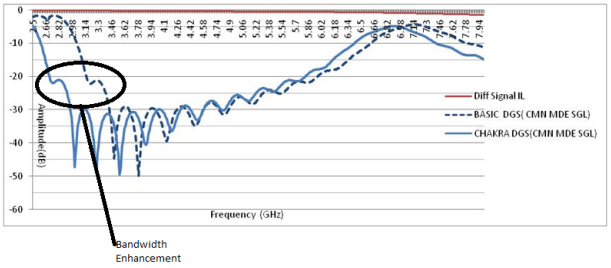

Fig-5 : Insertion loss of the common mode signal

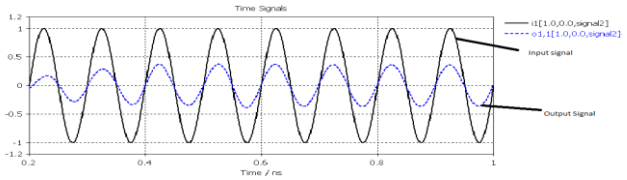

Fig -6 : Time delay response of the modified structure

IV. conclusion

DGSs were proposed and they had become one of the most interesting areas of research and their extensive applicability in microwave circuits. This paper proposes a novel common-mode noise suppression filter has been modified by varying its electrical length a broad bandwidth has been achieved in the same physical dimension. The ripple free transmission with wider bandwidth from 2.7GHz to 5.8 GHz has achieved without any degradation in the overall performance.

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