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목 차

Defected Microstrip Structure Transmission Line

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Abstract

In this paper a concept of defected microstrip structure (DMS) transmission line is proposed. By an etching of signal pattern in microstrip line, band rejection characteristics, which behaves similar way to the conventional defected ground structure, can be obtained. The electrical length of transmission line can be increased by using proposed structure. To show the validity of the DMS transmission line, harmonic suppression network load is designed for WCDMA applictions operating at frequencies 2.11 GHz ~ 2.17 GHz.

I. Introduction

In recent years, there is a growing interest in study of microstrip transmission line with various periodic structure that prohibit the wave propagation in certain frequency bands such as photonic band gap (PBG), defected ground structure (DGS) [1-2]. By the etching specific pattern such as dumbells or spiral shape on ground plane, called DGS, a band stop frequency characteristics can be obtained. Currently DGS is widely used in microwave circuits such as microwave filters, plannar antennas, and power amplifier modules, etc [2].

The defected microstrip strucute (DMS) is realized by the etching uniform or non-uniform slot over the signal in top plane [3]. Thus DMS disturbs the current distribution on strip and giving the modified microstrip line with the certain band stop and slow wave characteristics. Thus the same band rejection characteristics as DGS can be obtained by DMS structure. Thus DMS is can also be used in many microwave circuits.

In this paper, the concept of DMS transmission line is proposed. Using DMS in transmission line, the equivalent inductance can be increased which provides the increase in electrical length of transmission line. To show the validity, a harmonic suppression network is designed for a wideband code division multiple access (WCMDA) application operating at 2.11 ~ 2.17 GHz.

II. Defected Microstrip Structure

Figure 1 shows a basic pattern shape of the DMS. Instead of the pattern etching on the ground plane as the DGS, the etching uniform or non-uniform slot over the signal strip is done in the DMS. And the etching is done the very small slits perpendicular to main slit. By the using this structure in signal line, the current distribution on strip is changed and thus giving the modified microstrip line with certain band stop frequency and the slow-wave characteristics. Thus the DMS increases the equivalent inductance and associated electrical length of transmission line. Due to increase of the equivalent inductance and electrical length, this structure can used to reduce circuit size such as microwave filters, amplifiers, and plannar antennas, etc.

Recently, it is known that a high efficiency power amplifiers such as class E and F needs to suppress the certain number of harmonics to increase the efficiency as the power amplifier is one of module that consumes the most of power of RF front ends. In many cases, a quarter-wavelength transmission line is used to suppress the harmonics but this can reject only a certain specific harmonic. By an employing the DMS structure, the required harmonics can be suppressed by selecting the appropriate slot size tuned to specific harmonics.

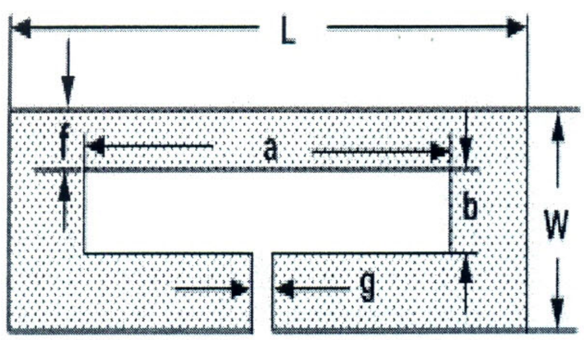

Figure 1. Defected microstrip structure.

III. DMS Frequency Response

Figure 2 shows the structure of DMS used in an electromagnetic (EM) simulation program, Ansoft HFSS version 11. The used substrate is duroid 5880 of Rogers with dielectric constant of 2.2 and thickness of 31 mil. The physical dimensions for this structure are a=6.2 mm, b=0.5728 mm, g=0.2 mm ,f=0.4 mm, L=20 mm and W=2.38 mm, respectively.

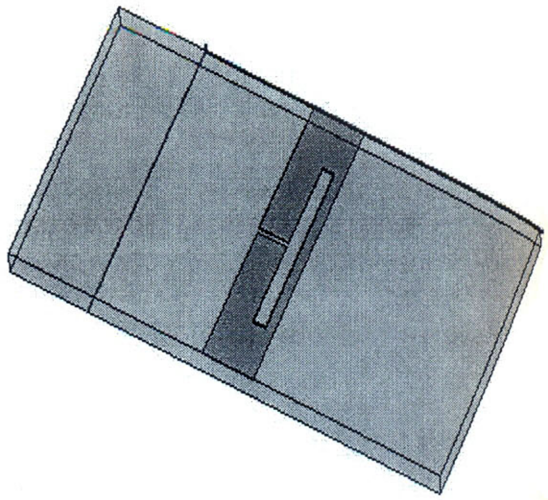

Figure 2. Electrmagentic simulation layout of defected microstrip structure.

Figure 3 shows the simulation frequency response of DMS, which is almost similar to the series-connected parallel resonant circuit characteristic.

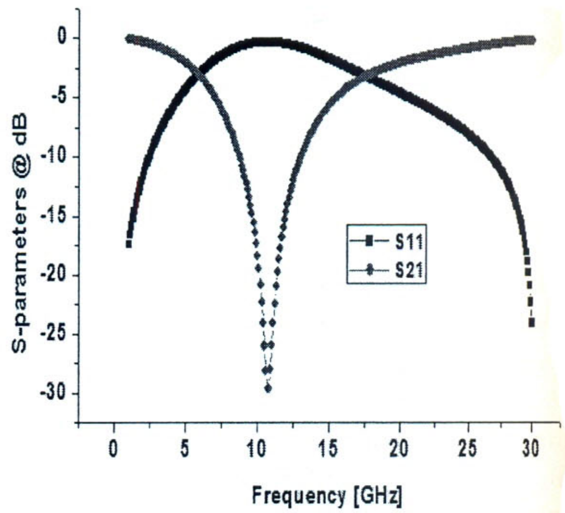

Figure 3. Simulation frequency response of DMS.

From figure, it is seen that band stop around 10.5 GHz. The cutoff frequency of DMS structure is at 5.9 GHz and bandwidth is approximately 1.3 GHz (S_{21}<-20 dB).

Figure 4 shows the frequency response according to different slot lengths of the DMS. By the increasing the slot length of the DMS, the band stop frequency can be changed. The longer slot length shift the band stop frequency toward the lower frequency.

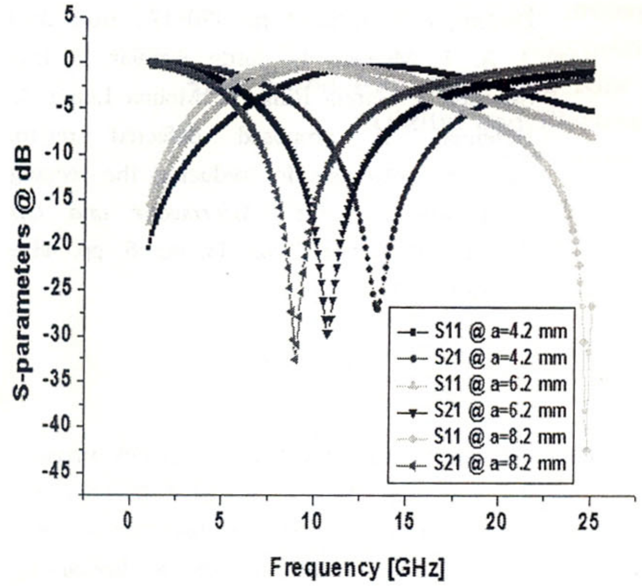

Figure 4. Frequency variation characteristic according to DMS slot lengths.

IV Applications of DMS

As the DMS provides the increase in electrical length of transmission line and the band rejection characteristics which can be used to reduce the size of certain microwave devices or circuits.

As the DMS provides good band rejection properties, it can used in a power amplifier to enhance the efficiency by suppressing the harmonics. For this purpose, the harmonic suppression load-network is designed for WCDMA applications operating at frequency 2.11 GHz ~ 2.17 GHz.

Figure 5 shows the layout of harmonic suppression load-network. For this purpose, T-type DMS two units are used. The physical dimension of one unit structure are a=14.7 mm, b= 0.9 mm, g=0.5 mm, f=0.3mm, L=40 mm and W=2.38 mm, respectively.

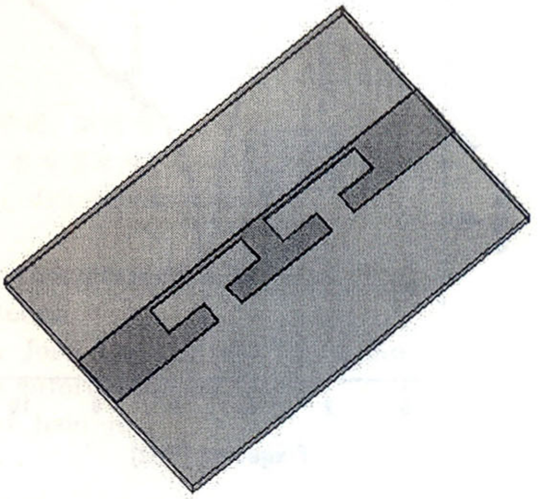

Figure 5. T-type DMS two units for harmonic suppression load-network.

Figure 6 shows the EM simulation result of T-type DMS two units for the harmonic suppression load-network. The simulation result shows that the return loss and insertion loss at fundamental frequency 2.14 GHz are good enough respectively, whereas high attenuation is obtained at the harmonic bands.

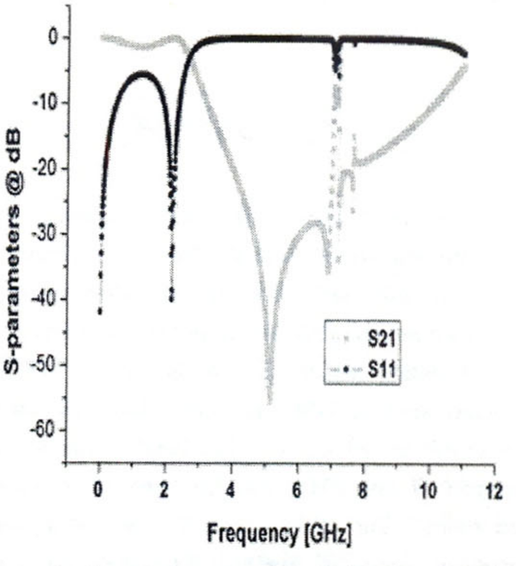

Figure 6. Simulation result of T-type DMS two units

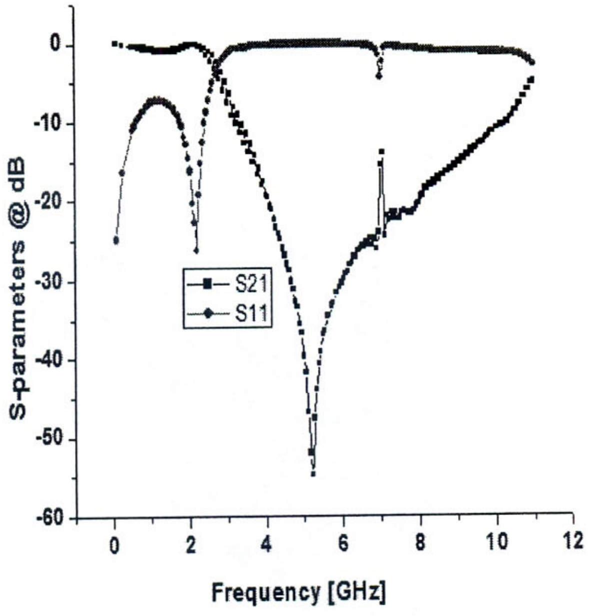

Figure 7. Measurement result of T-type DMS two units.

Figure 7 shows the measured result of T-type DMS two units. The measurement result is good agreement with the EM simulation result. From this figure, it is seen that the return loss and the insertion loss at frequency 2.14 GHz are -23.12 dB and -0.2 dB, respectively. The insertion loss at frequency range 4.22 ~ 6.51 GHz is greater than -22 dB. This characteristics of this DMS structure can be used in harmonic suppression load-network in the power amplifier such as Class E amplifier.

V. Conclusion

We proposed the concept of defected microstrip structure transmission line. By the etching of top pattern of microstrip line, the modified transmission line is obtained. This effect gives the band rejection characteristics which is similar to the DGS. The defected area of DMS is very small. By increasing the length of defect, the stop band frequency can be changed. Thus DMS can be used to suppress the harmonics. For this purpose, we designed the harmonic suppress load-network for the WCDMA applications.

References

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