To Design and Analyse the Performance of Microstrip Ring Slot Antenna for 2.4GHz

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Abstract - **A microstrip fed ring slot antenna is designed for 2.4GHz frequency range. To suppress the harmonics in the ring slot antenna inverted U-shaped slot is integrated into CRSA. By this, harmonic suppression over a wide bandwidth is achieved. This DGS can also be applied for the stacked annular ring microstrip-fed ring slot antennas**.

Keywords: Circular ring slot antenna (CRSA), Defected ground structure (DGS).

1 INTRODUCTION

THE ADVANCED wireless communication systems require a compact and low-cost transmitter front end without sacrificing system performance. Crucial factors for wireless transmitters include efficiency, size, and bandwidth. Ways of achieving this are typically through high system integration and improved performance. However, this may cause increased electromagnetic interference (EMI) between transmitter subsystems. This paper presents new design techniques which specifically address these factors. These goals are accomplished through increased integration between the amplifier and antenna. In a conventional system, the antenna is typically designed separately and connected to the amplifier by an interconnect.

Additionally, when multiple systems operating at neighboring frequencies exist in close physical proximity, there is an increasing EMI problem. To remedy this, a filter is often placed between the amplifier and antenna to reduce unwanted radiation. Traditionally, these components are designed with 50-input and output impedance and connected together. This conventional method works well at low frequencies and when system design requirements are not tight. However, at high frequencies, interconnects become lossy and may possibly radiate or couple with other elements. . Many planar antennas such as the microstrip patch or slot antenna can be designed for low input impedance and good radiation characteristics when operated near resonance. Therefore, the antenna and amplifier can be combined together with minimal matching circuitry in between. Perhaps the most crucial factor in power-amplifier design is increasing efficiency. Typically, most of the system power is consumed in the output power-amplifier stage. Since higher dc power adds to both system cost and weight, power-added efficiency (PAE) of the amplifier has to be maximized. Traditionally, this is done by using harmonic tuning, which reflects harmonic power back to the device [2]. Recently, biasing schemes have been reported for increasing PAE [3]. This technique optimized the power-supply voltage in accordance with the input signal level to reach maximum PAE. There are several techniques in harmonic tuning. Typically, higher order harmonics contain only a small amount of power. For this reason, practical designs usually terminate only second and third harmonics. Traditionally, tuning of the second harmonic is done by adding a quarter-wavelength (at the fundamental frequency) short-circuited stub at the output [4], [5]. Typically, this is most often placed at the drain bias line. At lower frequencies, this stub may use considerable circuit space. However, chip capacitors can also be used for rejection of the second harmonic if they have a self-resonance at the second harmonic [6]. Similar methods are used for tuning of the third harmonic. In this paper, we present several alternative methods for harmonic tuning. If designed properly, these methods offer a compact design. The first of these approaches is the active antenna approach. If the antenna input impedance is purely reactive (or zero)

at harmonic frequencies, it can be used to tune harmonics.

This has been demonstrated in [7]. In this case, tuning of the second harmonic with an integrated antenna was shown to increase the PAE by 7%. There are additional benefits to this approach. In addition to increased PAE or output power of the amplifier, a reduction of unwanted harmonic radiation that causes EMI and ultimately degrades system performance can be observed. The previously mentioned harmonic-tuning techniques are typically narrow-band. Some high-performance communication systems, for example those using multicarrier broadband code-division multiple-access communication (CDMA), require high-efficiency broad-band power amplifiers. Broadband harmonic tuning can be achieved using a microstrip filter based on the photonic bandgap (PBG) concept [8]. PBG is a periodic structure which prohibits wave propagation in certain frequency bands. Original PBG research was done in the optical region [9], but PBG properties are scalable and applicable to a wide range of frequencies. In the microwave region, PBG structures have been used in design of antennas [10], cavities [11], frequency-selective surfaces, and many other structures. In this paper, two-dimensional (2-D) structure based on etching a periodic 2-D pattern in the microstrip ground plane is used [12]. This structure has a stopband that is generally wider than can be achieved by using a single or double stub. This periodic structure is added between the antenna and amplifier. This configuration has an additional component, but can be used for broad-band operation. The analysis of active antenna amplifiers is quite challenging. Traditionally, nonlinear analysis such as harmonic balance is used to analyze power amplifiers. This kind of simulation cannot analyze antennas or PBG structures, in which a three-dimensional (3-D) full-wave solution of Maxwell's equations is usually required. In this paper, the finite-difference time-domain (FDTD) technique is used because it can simulate arbitrary 3-D structures and provide broad-band frequency response with one simulation. FDTD results can then be incorporated into nonlinear circuit design to analyze the whole structure. The amplifier design examples consist of class-AB, class-B, and class-F amplifiers, which are prevalent at microwave

frequencies. However, with increasing device technology, other potentially higher efficiency types of amplifiers have been reported at microwave frequencies. Recently, a class-E amplifier has been realized at 1 GHz with 73% PAE and output power of 0.94 W [13]. In this case, approximate class-E operation is achieved by open circuiting the second harmonic only. More recently, a four-element integrated-antenna array with class-E performance was demonstrated at 5 GHz [14]. *Output power greater than* $33\ dBm\ was$ demonstrated with a PAE of 65%. These classes of amplifiers are also expected to benefit from the above techniques.
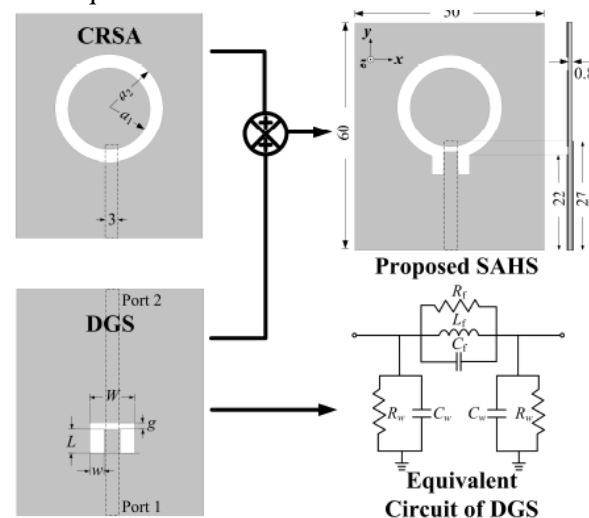
2. ANTENNA DESIGN

The antenna can be printed on an(60mm x 50mm x 0.8mm) FR4 substrate with a relative permittivity of 4.4 and loss tangent of 0.02 is depicted in fig. 1,and the corresponding photograph(both sides) is presented in Fig. 2. The proposed antenna is a combination of two simple structures, namely the microstrip-fed ring slot antenna. The main objective of this CRSA to induce a fundamental mode at approximately 2.4GHz band. Therefore, annular ring slot of inner radius

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a1=10mm and outer radius a2=13.5mm were calculated according to the following.

$$f_O \approx \frac{c}{\pi(a_1 + a_2)} \times \sqrt{\frac{\epsilon_r + 1}{2\epsilon_r}}$$

Where c is the speed of the light in free space, and $\pi(a_1 + a_2)$ is the mean circumference of the ring slot antenna. However, the effects tuning various parameters such g and L will be discussed later.

Simulation based on high-frequency structure simulator(HFSS) was performed on CRSA. The CRSA can induce a fundamental mode(Mode 1)at exactly 2.45GHz,and other four modes were at approximately3.42GHz(Mode2),5.15GHz(Mode3),7.07 GHz
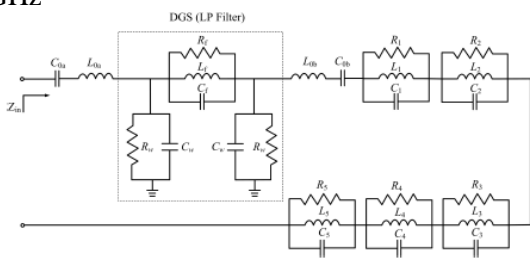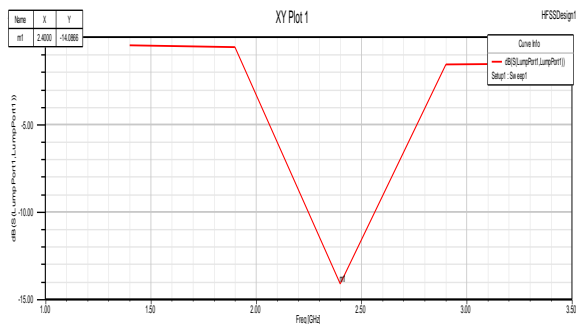

DGS (LP Filter)

TABLE I
RLC VALUES OF ALL FIVE MODES

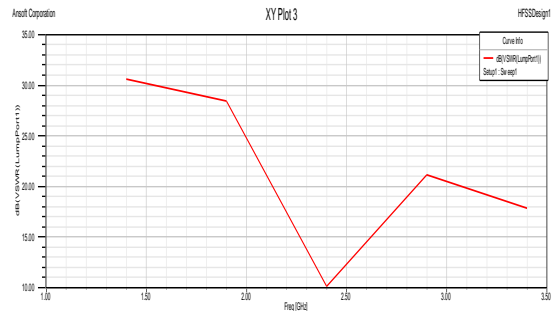|	MODE 1	MODE 2	MODE 3	MODE 4	MODE 5
R (Ω)	51	17	26	94	26
L (nH)	0.32	0.234	0.21	0.15	0.11
C (pF)	12.73	4.451	4.48	3.186	3.411

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III MEASURED RESULTS AND DISCUSSION

the simulated and measured return loss is of both CRSA and two results validated well with each other in both cases. Here the measured 10-dB impedance bandwidth of 2.4GHz.
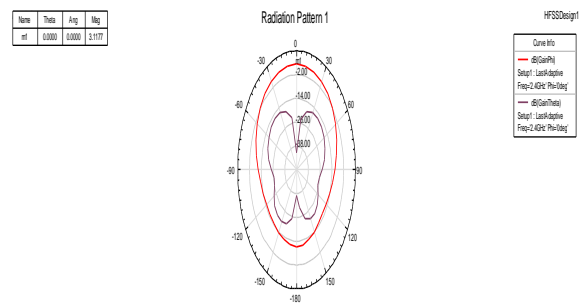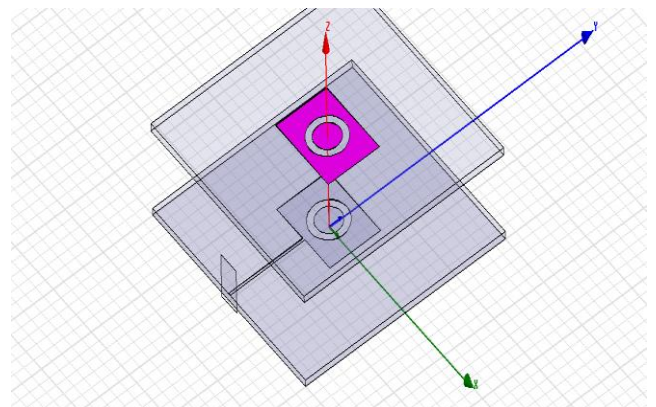
S-Parameter

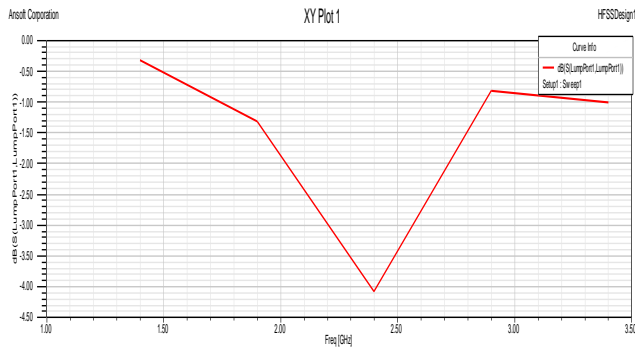

VSWR

Radiation pattern

The measured radiation pattern in two principle planes namely the x-y and y-z planes, for both the antenna. The pattern measurement technique used a single axis rotational pattern that involves antenna under test(AUT) placed on a rotational positional.

During the process of measuring the antenna patterns the gain and efficiency were measured via the anechoic chamber. Here the antenna efficiency is defined as the ratio of total power radiated by an antenna to the net power accepted by the antenna from the connected transmitted which is expressed in this work. The efficiency of the proposed antenna is 79%.
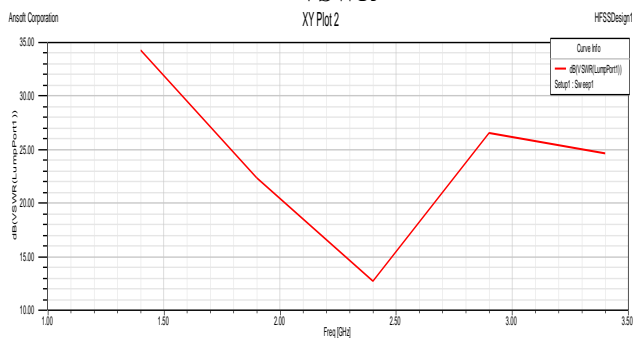
IV   STACKED ANNULAR RING

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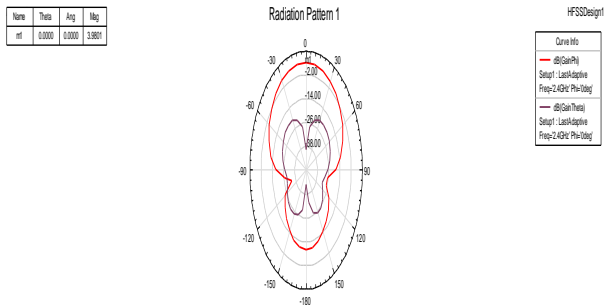**NCEASE-2015 Conference Proceedings**

S-Parameter

VSWR

Radiation pattern

V CONCLUSION

By stacking the annular ring we improve radiation pattern and return loss. This can be used in Bluetooth and Wi-Max application

REFERENCES

[1] K. Chang, R. York, P. Hall, and T. Itoh, "Active integrated antennas,"*IEEE Trans. Microw. Theory and Tech.*, vol. 50, no. 3, pp. 937−944, Mar.2002.

[2] D. Segovia-Vargas, D. Castro-Galán, L. E. García-Muñoz, and V.González-Posadas "Broadband Active Receiving Patch With Resistive Equalization," *IEEE Trans. Microw. Theory and Tech.*, vol. 56, no. 1, pp. 56−64, Jan. 2008.

[3] V. Radisic, Y. Qian, and T. Itoh, "Novel architectures for high- efficiency amplifiers for wireless applications," *IEEE Trans.Microw. Theory and Tech.*, vol. 46, no. 11, pp. 1901-1909, Nov. 1998.

[4] F. R. Hsiao, T. W. Chiou, and K. L. Wong, "Harmonic control of a square microstrip antenna operated at the 1.8 GHz band," *Microw. conf. proceedings Asia-pacific.*, pp 1052 -1055, Aug. 2001.

[5] V. Radisic, S. T. Chew, Y. Qian, and T. Itoh, "High efficiency power amplifier integrated with antenna," *IEEE Microw. Guided Wave Lett.*, vol.7, no. 2, pp. 39-41, Feb. 1997.

[6] Y. Horii and M. Tsutsumi, "Harmonic control by photonic bandgap on microstrip patch antenna," *IEEE Microw. Guided Wave Lett.,* vol. 9, no. 1, pp.13-48, Jan. 1999.

[7] X. C. Lin and L. T. Wang, "A broadband CPW-Fed loop slot antenna with harmonic control," *IEEE Antennas Wireless Propag. Lett.*, vol. 2, no. 1, pp. 323-325, 2003.

[8] A.S. Andrenko, Y. Ikeda, and O. Ishida, "Application of PBG microstrip circuits for enhancing the performance of high-density substrate patch antennas," *Microw. Opt. Technol. Lett.*, vol. 32, no. 5, pp. 340-344, Mar. 2002.

[9] Y. J. Sung, M. Kim, and Y. S. Kim, "Harmonics reduction with defected ground structure for a microstrip patch antenna," *IEEE Antennas Wireless Propag. Lett.*, vol. 2, pp. 111-113, 2003.

[10] S. Biswas, D. Guha, and C. Kumar, "Control of higher harmonics andtheir radiation in microstrip antennas using compact defected ground structures," *IEEE Trans. Antennas Propag.*, vol. 61, no. 6, pp. 3349-3353, Jun. 2013.

[11] N. A. Nguyen, R. Ahmad, Y. T. Im, Y. S. Shin, and S. O. Park, "A T-shaped wide-slot harmonic suppression antenna," *IEEE Antennas Wireless Propag. Lett.*, vol. 6, pp. 647-650, 2007

[12] D. H. Choi, Y. J. Cho, and S. O. Park, "A broadband slot antenna with harmonic suppression," *Microw. Opt. Technol. Lett.*, vol. 48, no. 10, pp.1984-1987, Oct. 2006.

[13] N. Boisbouvier, F. Le Bolzer, A. Louzir, A. C. Tarot, and K. Mahdjoubi, "Harmonic-less annular slot antenna (ASA) using a novel PBG structure for slot-line printed devices," *IEEE Antennas Propag. Soc. Int. Symp.*, vol. 2, pp. 553-556, Jun. 2003.

[14] D. J. Woo, T. K. Lee, J. W. Lee, C. S. Pyo, and W. K. Choi, "Novel U-Slot and V-slot DGSs for bandstop filter with improved *Q* factor," *IEEE Trans. Microw. Theory Tech.*, vol. 54, no. 6, pp. 2840-2847, Jun. 2006.

[15] K. L. Wong, C. C. Huang, and W. S. Chen, "Printed ring slot antenna for circular polarization," *IEEE Trans. Antennas Propag.*, vol. 50, no. 1, pp. 75-77, Jan. 2002.

[16] J. S. Park, J. H. Kim, J. H. Lee, S. H. Kim, and S. H. Myung, "A novel equivalent circuit modeling method for defected ground structure and its application to optimization of a DGS lowpass filter," *Microw. Symp. Digest, 2002 IEEE MTT-S Int.*, vol. 1, pp. 417-420, 2002.