Design of Meander Slotted Patch antenna for Wireless Application - A Review

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Abstract *– A compact handheld wireless communication devices has grown significantly. Microstrip Meander slot antenna is mostly utilized in modern wireless communication devices mainly because of their small size. In this review paper a survey is conducted on design and techniques used in meander slot antenna by numerous authors for designing of a miniature, efficient, affordable, low profile compact meander slot antenna for multiband wireless application. Meander Slot insertion causes size reduction which increases the bandwidth and return loss.*

Keywords: *Wideband, Dual Band, CPW, Meander Slot Antennas, WLAN, WiMAX, Return Loss, RFID, 4G.*

I. INTRODUCTION

Antenna is very useful for wireless communication systems. Design of an efficient wide band miniature antenna is a big challenge for recent wireless applications. In Modern wireless communication systems, antenna with multiband has been playing a very vital role for wireless service requirements [1]. Due to the advancement of technology meander slot antennas are used in modern printed circuit technology, GPS, communication system, Wireless Local Area Network (WLAN), Bluetooth, Wi-MAX etc. Considerable attempt has been made for the advancement and improvement of the bandwidth, return loss and size reduction of antenna to achieve more bands however minimization of the antenna structure is still a challenge for antenna designers. The meander slot antenna is one of the categories of microstrip antennas. This technique is applied in the designing of an antenna having small size and gives a wideband performance [2]. Having the advantage to miniaturize antenna in proposed methods [3] [4] [5], meander slot antenna is chosen because it is able to reduce the size of the antenna. It is smaller and very flexible to be repositioned [6]. The functioning of the meander slot antenna depends on various factors such as the number of turns and position of meander slots in the patch.

II. COMPARATIVE STUDY

Abdelnasser A. Eldek et al [7] proposed two antenna designs, for dual and wide band operation in wireless systems. First design was realized with a tapered meander slot with micro-strip feed to allocate operation at frequency bands 1.8 and 2.4 GHz. In this design both resonant frequencies are managed by the distance of the microstrip line termination from the slot and by the meander slot width. The second design was accomplished by the use of a coplanar patch-slot antenna (CPA) fed by a coplanar waveguide (CPW). This second design is easily tuned to operate at 2.45 and 5.75GHz, with wide impedance bandwidth. By make variations in patch dimensions the operating frequency is controlled. For this analysis Advanced Design System (ADS) is used which is based on the method of moment (MoM) technique.

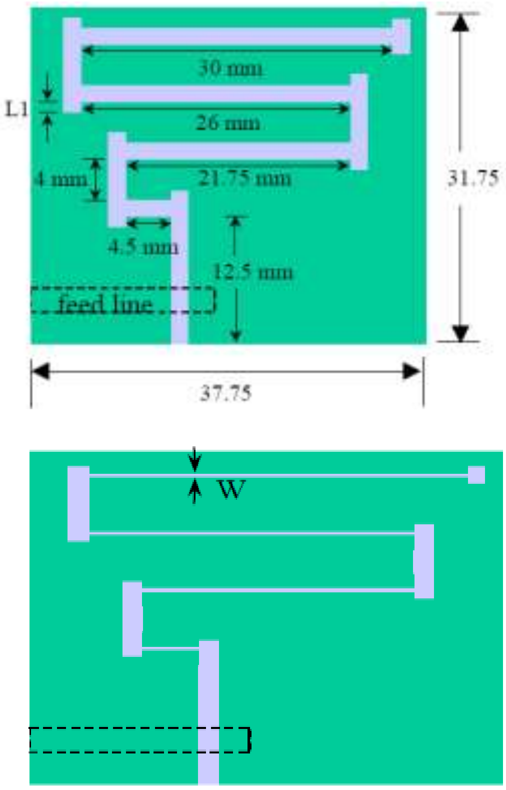
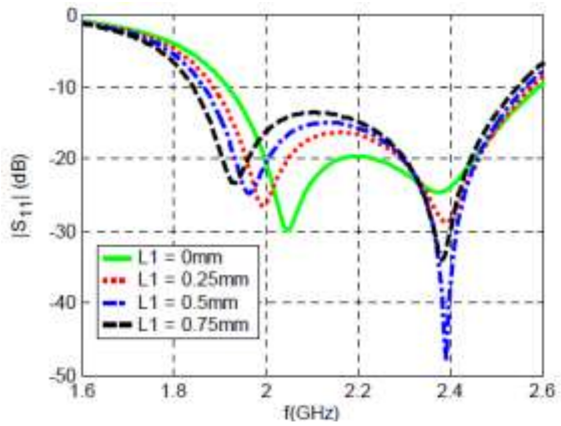
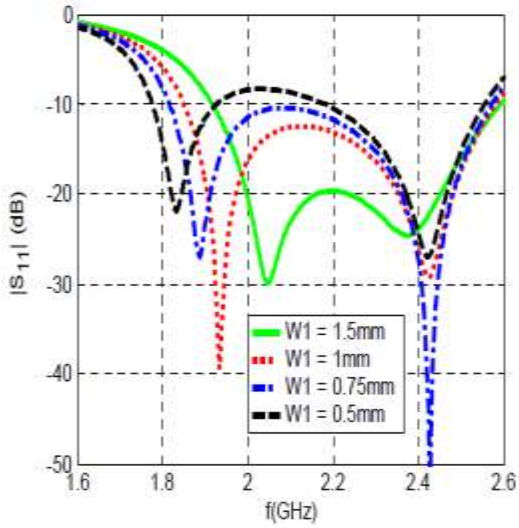


Fig. 1: Geometry of the tapered meander slot

antenna (a) Front view (b) Bottom view and (c) With variation in slot width [7]



(a)



(b)

Fig. 2: Simulated Return Loss of tapered meander slot antenna (a) With variation in Length and (b) With variation in slot width [7]

Yazhou Dong et al [8] proposed a uniplanar bow-tie shaped meander slot antenna fed by CPW (coplanar waveguide). The radiator and feeding system are fabricated on a single planar structure. The proposed antenna is based on a bow-tie shaped meander slot and an 180^o uni-planar hybrid-ring coupler using CPW and slot lines. The simulated results revealed that the proposed novel structure provides low profile, small size, wide impedance bandwidth, stable radiation pattern etc. The investigational results show that 9.8% impedance bandwidth (VSWR ≤2) is achieved at a central frequency of 11.5 GHz.

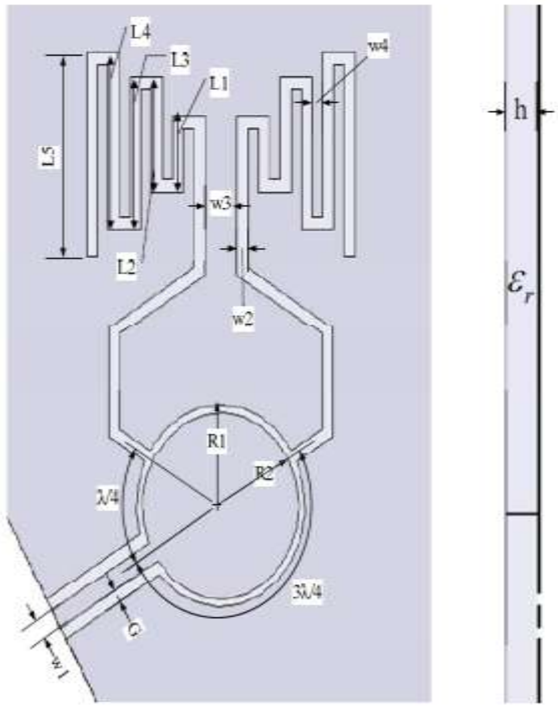


Fig. 3: Configuration of Uniplanar bow-tie shaped meander slot antenna [8]

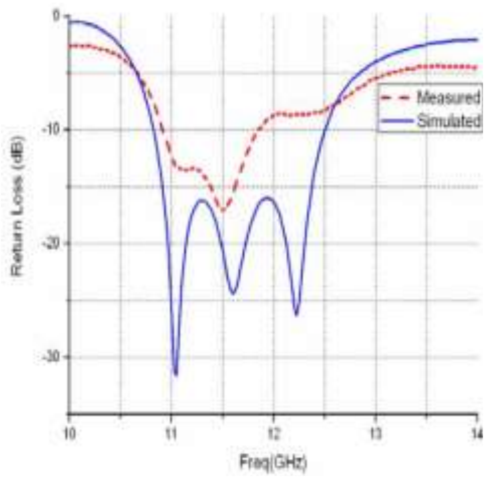


Fig. 4: Return Loss of Uniplanar bow-tie shaped meander slot antenna [8]

Yazi Cao, Bo Yuan, and Gaofeng Wang [9] proposed Compact Multiband Open-Ended Slot Antenna for Mobile Handsets. The multiband antenna formed by two printed open-ended slots, one is a T-shaped slot and another is an E-shaped slot, cut at the edge of the ground plane of the mobile handsets. To reduce the size and to realize multiband characteristics, these monopole slots are series-fed by a 50 ohm microstrip feed line printed on the top side of the ground plane. The antenna can generate five resonant frequencies to cover up GSM-900, DCS-1800, PCS-1900, UMTS and WLAN. These five resonant modes can be controlled independently by the five respective open-ended slots of different lengths. The simulated result of antennas was obtained by using ANSYS HFSS Simulation software [9].

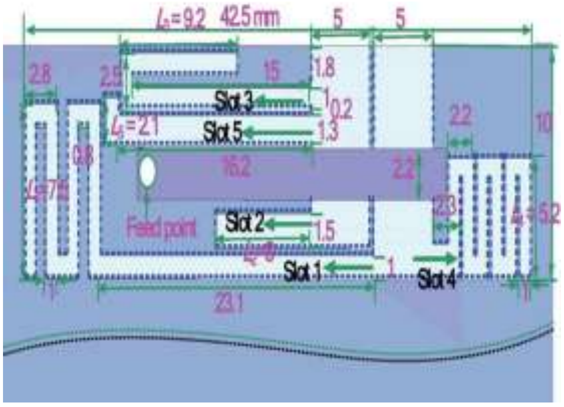


Fig. 5:Configuration of theOpen-Ended printed slot antenna[9]

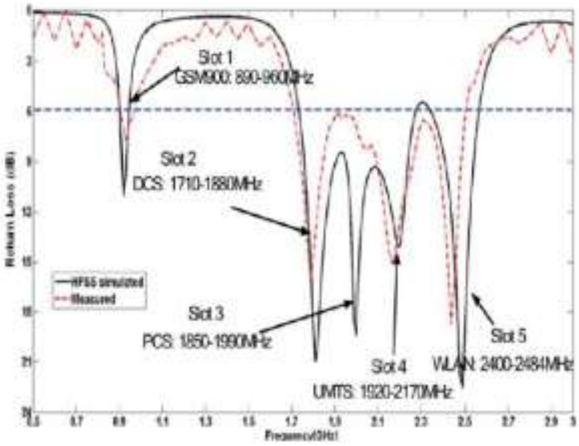


Fig. 6:Measured and simulated return loss for the Open-Ended printed slot antenna[9].

Pingan Liu, YanlinZou, BaorongXie, Xiang long Liu, and Baohua Sun et al [10] proposed a compact tri-band printed antenna for WLAN and WiMAX applications. This antenna consists of a modified rectangular slot, Y-shaped monopole radiator with a meander split-ring slot and a couple of symmetrical inverted-L strips. Tuning the locations and the sizes of all these geometries, three independent frequency bands exists at 2.5, 3.5 and 5.8 GHz with impedance bandwidth of 430MHz, 730MHz & 310 MHz respectively which can cover both the WLAN and the WiMAX .The designing and the numerical analysis are performed by using ANSYS HFSS simulation software [10].

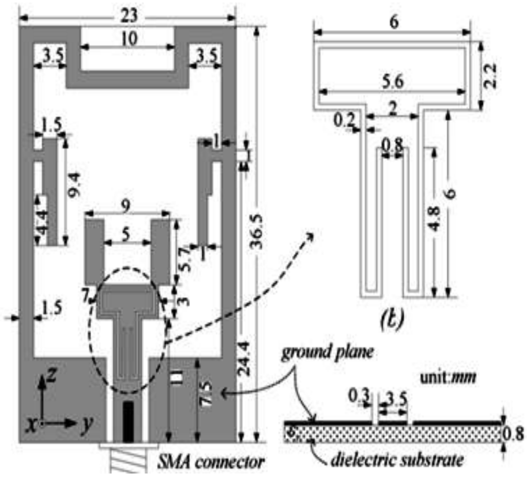


Fig 7:Geometry of tri-band printed antenna. (a) Front view. (b) Geometry of splitringslot. (c) Bottom view [10]

The simulated and measure return loss against frequency, with and without split-ring slot, are shown in Fig 9, which reveals that the split-ring slot could improve the band-notched performance at 3-GHz band.

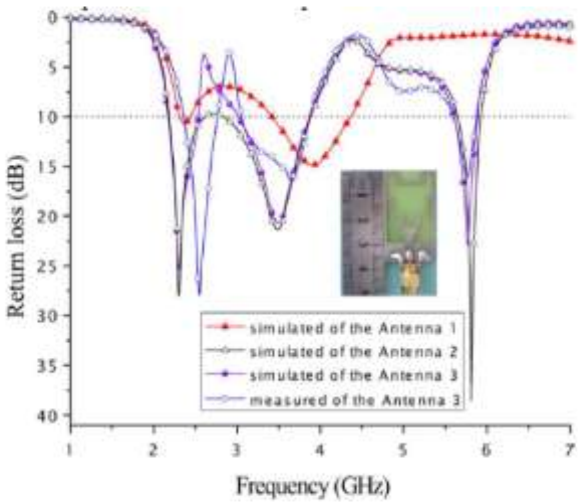


Fig 8:Measured and simulated results for tri-band printed antenna[10].

M. Z. A. Abd Aziz et al [11] proposed two microstrip meander slot antenna with dual and triple meander slot for WLAN application. The proposed antenna is also capable to be used as receiver antenna for energy harvesting system. The proposed antenna geometry consists of a RMSP element with meander slots. The parametric study is carried out to inspect the characteristic of microstrip patch antenna with double and triple meandered slots. Proposed antenna with dual meander slot can achieve return loss until -24.54 dB. However the gain of the antenna, 1.46 dBi is lower than proposed antenna with triple meander slot which is 4.28 dBi. CST software is used for simulation work.

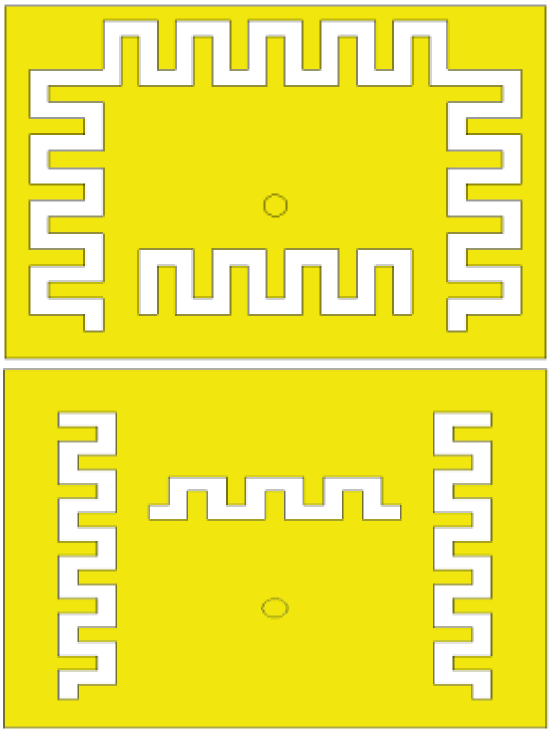


Fig. 9: Configuration of the Dual and Triple meander slot antenna[11]

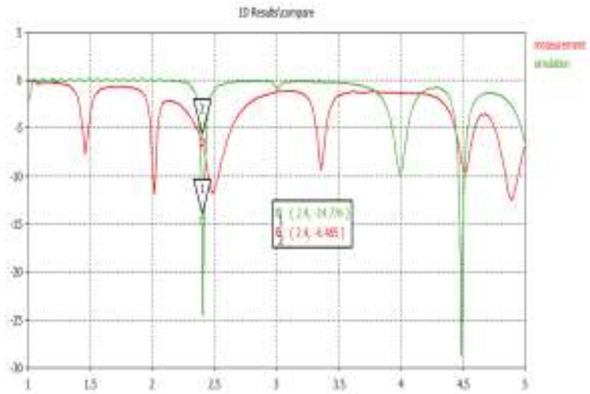


Fig.10: Return Loss result for the Dual meander slot antenna[11]

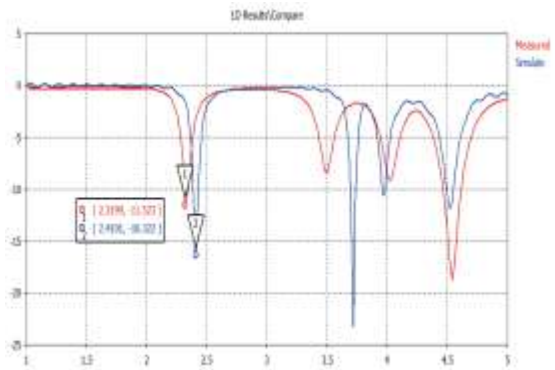


Fig. 11: Return Loss result for the Triple meander slot antenna[11]

N. A. Zainuddin et al [12] proposed a microstrip meander slot antenna with a various number of meander slots for Wireless Local Area Network application. The proposed antenna comprises a RMSP element embedded with a numbers of meander slots in many positions. The parametric study is carried out to inspect the characteristic of microstrip patch antenna with Six and Seven meandered slots. Antenna with seven meander slots has the most size reduction of approximately 23% of the original size. The investigation of proposed antenna is useful in designing the RF energy harvesting and continual development for WSN and RFID applications.

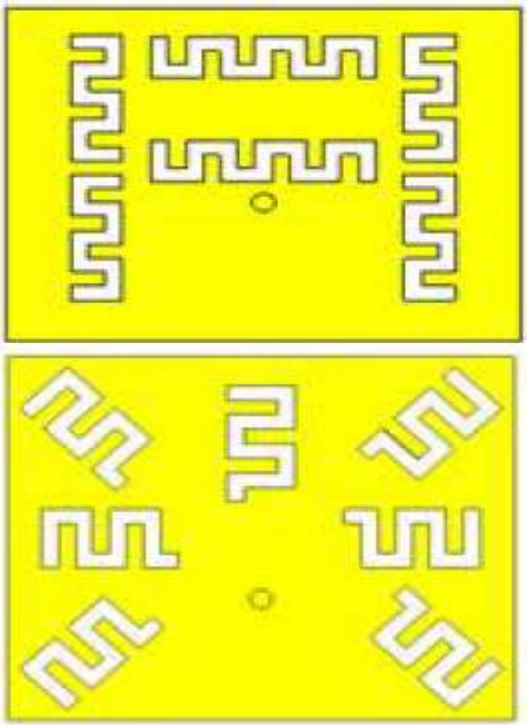


Fig. 12: Configuration of the six and seven meander slot antenna[12]

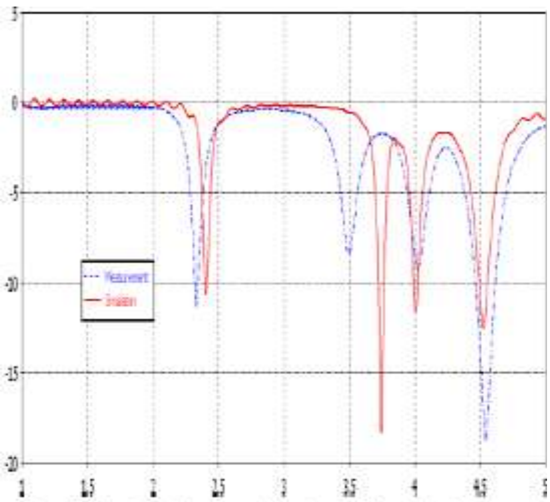


Fig. 13: Simulated and measured return loss results for 6 Meander slot antenna [12]

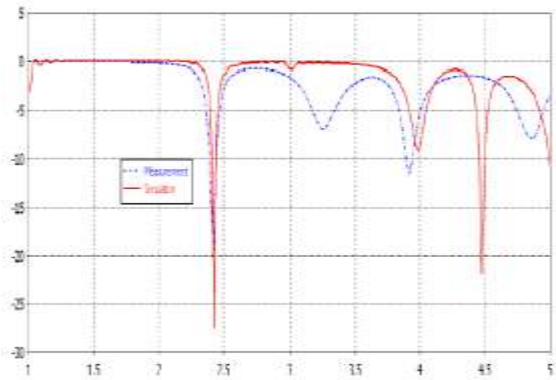


Fig.14: Simulated and measured return loss results for 7 Meander slot antenna [12]

Nassrin Ibrahim Mohamed Elamin et al [13] proposed a new concept, the slot meander patch (SMP) design to construct two different antennas. Slot meander patch antennas are designed for fourth-generation Long-Term Evolution (4G LTE). The proposed antenna structure are used for different bands belongs to LTE-TDD and LTE-FDD. The first antenna is designed to operate in a wide frequency range of 1.68–3.88 GHz to cover eight LTE-TDD bands. Another antenna which is operated at three distinct frequencies bands (0.5–0.75, 1.1–2.7, and 3.3–3.9 GHz), covers eight LTE FDD bands including the lowest and the highest bands. Also investigations results shows that the antenna with unequal meander widths designed have a higher efficiency as compared to antenna with equal meander width.

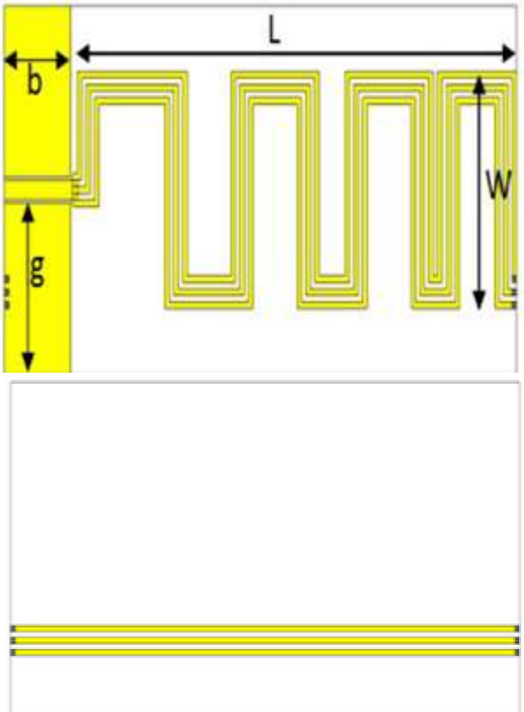


Fig. 15: Geometry of the slot meander radiator. (a) Front view and (b) Back view of simulated wideband antenna [13]

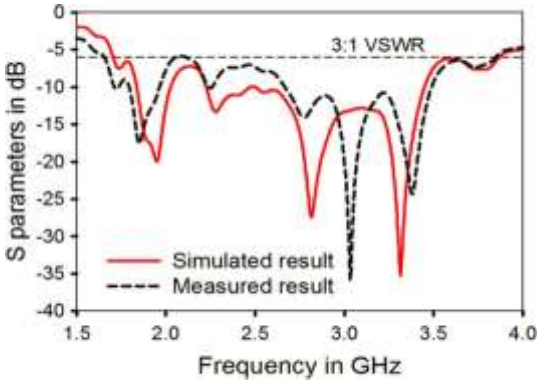


Fig. 16:Simulated and measured return loss result for the wideband SMP Antenna1 [13]

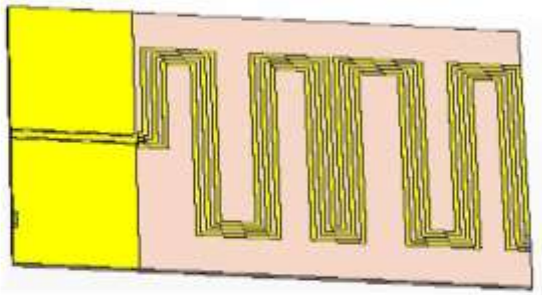


Fig. 17:Geometry of the wideband SMP Antenna 2 [13]

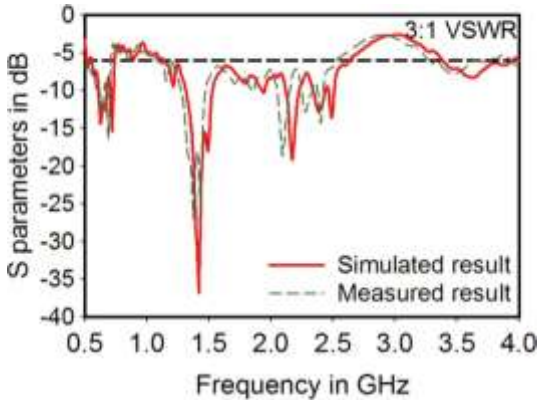


Fig. 18: Simulated and measured return loss result for wideband SMP Antenna 2 [13]

PrasetiyonoHariMukti et al [14] proposeda compact dual-band antenna for 2.3/3.3 GHz WiMAX Application, which uses Coplanar Waveguide (CPW) configuration on a substrate with thickness and relative permittivity of 1.6 and 4.3 mm, respectively. The overall antenna dimensions are only 30mm X 40mm, approximately. With the aim of obtaining the desired frequency bands at 2.3/3.3 GHz, a dual meander slot is embedded to rectangular monopole patch. The antenna is fed by a 50 ohm microstrip line. The analysis shows that the proposed dual band antenna works very well at operating frequencies of 2.3 GHz and 3.3 GHz with impedance bandwidth of 10.046% and 4.935%, and gain of 2.162 dBi and 1.924 dBi, respectively.

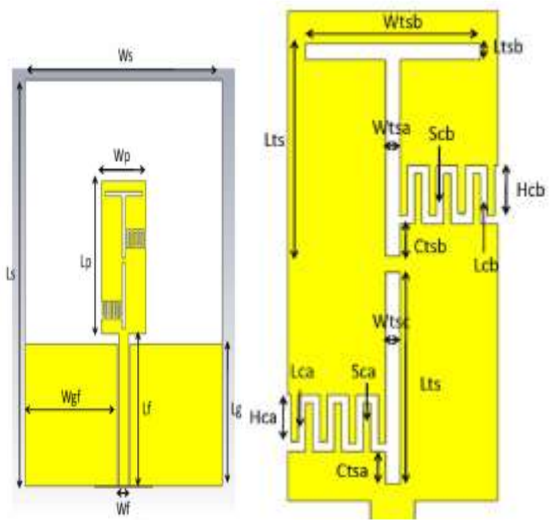


Fig. 19: (a) Geometry of the dual-band antenna (b) Patch geometry with dimensions [14]

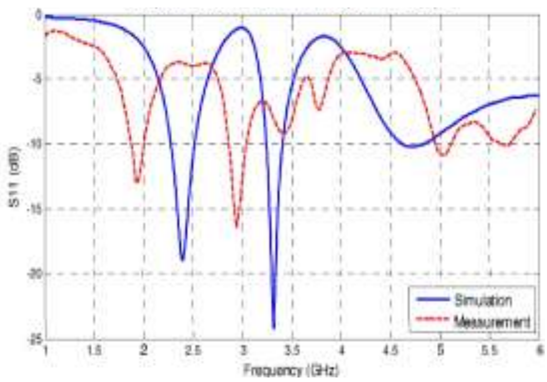


Fig. 20: Return Loss of the proposed dual-band antenna [14]

M. GulamNabiAlsath et al [15] proposed an approach to enhance isolation in microstrip patch antenna arrays by creating a band notch function defect to introduce meander line resonator. An isolation improvement of 16 dB is provided with reduced edge to edge spacing of 7 mm. The resonator is designed to block the surface current at the resonant frequency of the two patch antennas link up along H-plane and perform operation at 4.8 GHz frequency.

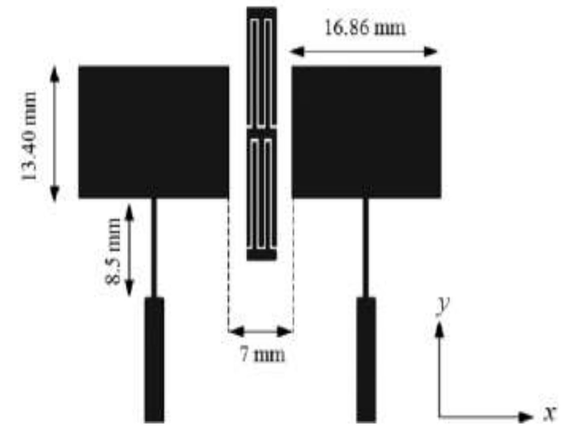


Fig. 21:Proposed SMLR decoupling unit sandwiched between two patch antenna elements [15]

Gouravkumar Mehta et al [16] proposed a Quadruple Microstrip Meander slot Antenna is for Wireless application. The Antenna also has the capability to use as the receiving antenna in an energy scavenging system. The antenna is designed to operate at four bands which are functional for wireless applications. Microstrip meander slot antenna with quadruple behaviour of antenna achieves better return loss of -13.7db at 2.28 GHz frequency. HFSS software is used for simulation.

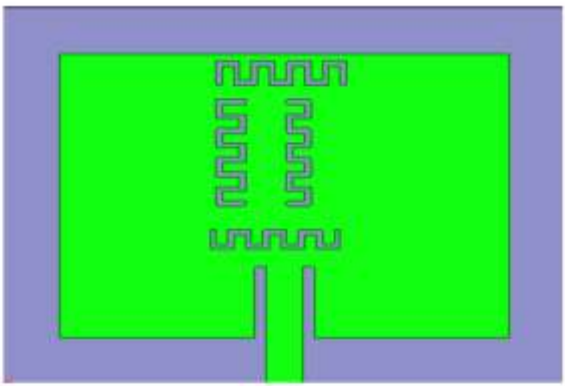


Fig. 22: Design of Quadruple Microstrip meander slot antenna [16]

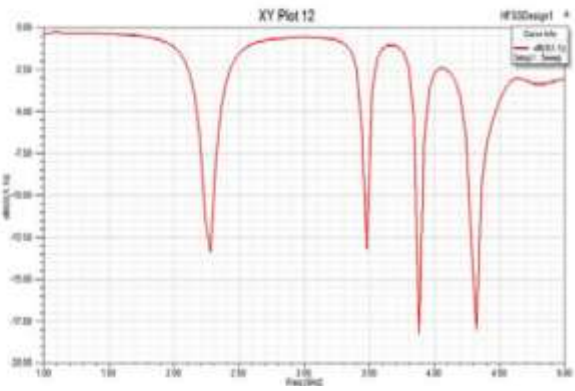


Fig. 23: Return Loss of Quadruple Microstrip meander slot antenna [16]

COMPARATIVE ANALYSIS OF DIFFERENT TECHNIQUES

S No.	Paper Name	Year	Remark
1	Slot Antennas for Dual and Wideband Operation in Wireless Communication Systems	2002	First design gives operation at 1.8 and 2.4 GHz & second design operate at 2.45 and 5.75GHz, with wide bandwidth
2	Uniplanar Bow-tie Shaped Meander Slot Antenna Fed by CPW	2008	Size reduction with wide bandwidth about 9.8% at a frequency 11.5 GHz.
3	A Compact Multiband Open-Ended Slot Antenna for Mobile Handsets	2011	Five resonant modes cover GSM900, DCS1800, PCS1900, UMTS & WLAN bands.
4	Compact CPW-fed tri-band antenna with meandering split-ring slot for WLAN/WiMAX applications	2012	Impedance BW of 430MHz, 730 MHz & 310 MHz cover both WLAN and WiMAX.
5	Investigation of Dual and Triple Meander slot Microstrip Patch Antenna	2013	Dual meander slot antenna achieves S_{11} of -24.54 dB. However the gain of the antenna, 1.46 dBi is lower than triple meander slot antenna which is 4.28 dBi.
6	Investigation of Meander Slots To Microstrip Patch Antenna	2013	Antenna with 7 slotted meander lines has size reduction of approximately 23% for resonant frequency 2.4GHz.
7	New Adjustable Slot Meander Patch Antenna for 4G Handheld Devices	2013	First antenna operates in a wideband of 1.68–3.88 GHz to cover 8 LTE TDD bands & second antenna operates at 3 distinct frequency bands (0.5–0.75, 1.1–2.7, and 3.3–3.9 GHz), to cover 8 LTE FDD bands.
8	A Compact Dual-band Antenna Design using Meander-line Slots for WiMAX Application in Indonesia	2014	Antenna works at 2.3 and 3.3 GHz with impedance BW of 10.046% and 4.935%, & gain of 2.162 dBi and 1.924 dBi respectively.
9	Implementation of Slotted Meander-Line Resonators for Isolation Enhancement in Microstrip Patch Antenna Arrays.	2014	Provided an isolation improvement by 16 dB with reduced edge to edge spacing of 7 mm.
10	Design of Quadruple Meander Slot Microstrip Patch Antenna for RF Energy Scavenging System	2015	Operates at four bands with quadruple behaviour& achieves return loss of -13.7dB at 2.28 GHz frequency.

TABLE 1: COMPARATIVE ANALYSIS OF DIFFERENT TECHNIQUES

III. CONCLUSION

This paper shows the review and survey of techniques and design for the designing of efficient compact micro strip meander slot antenna for multiband application. Compared to antennas explained in [9, 10] the other antennas in has simple structure and suitable forfrequency bands of Wi-MAX and WLAN applications.This survey is done on some characteristics implemented through differenttechniques. Some efficient techniques are come to know in this review like Implementation of resonators for isolation to improve return loss and size reduction. Also different types of geometries are also come to know like Tapered, Bow tie, Split Ring etc. But there are lot of solutions still to find that problems like complexity of structure,reduction of gain, reduced bandwidth, etc. Hence, the further research and more work are needed in this area. Compared to regular micro strip antenn as the meander slot antenna fed by microstripor coaxial line has bettercharacteristics, including wider bandwidth, low lossand improved isolation between the radiating element and feedingnetwork.

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