A New Compact Multi Resonance H-Patch Filtenna

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***Abstract*— in this paper, new compact H-slot patch microstrip filtenna configurations have been analyzed, investigated and optimized using the CST_MWS. The proposed H-slot patch filtenna has been mounted on FR-4 substrate having either full ground or defective ground with a single rectangular slot. Our filtenna configurations resonate at multi-frequencies of different narrowband and/or broadband. The presented filtenas are very simple structures and cover the 3G/4G wireless frequency band.**

I. INTRODUCTION

Microstrip antenna configurations have numerous benefits in wireless communication and radar systems applications. This is due to its small size, low cost, less weight, easy fabrication, and excellent compatibility with the typical manufacturing process of MMIC planar circuits [1-3]. Filtenna is a planar antenna plus built-in filter and it is employed to relieve the necessity of a band pass and/or band rejection filter in the receiver front end [4-6]. A proposed compact narrowband and/or broadband microstrip H-slot patch filtennas are analyzed, investigated, optimized and presented in this paper. Section II presents a detailed description of the proposed H-slot patch microstrip filtenna configurations. Simulation results of our filtenna configurations are discussed and presented in section III. Finally, section IV concludes the presented paper.

II. DESCRIPTION OF THE PROPOSED H-SLOT PATCH FILTENNA CONFIGURATIONS

Two proposed antenna configurations have been analyzed and investigated. The first one is referred to as H-slot patch filtenna with a full ground plane (Hslot_Filtenna1) as illustrated in Fig.1. The patch with H-slot consists of three slots, two vertical slots and one horizontal slot. In general each slot has different width and length. The slots dimensions, locations and orientations etched on the patch are used to control the number of filtenna resonances. The second antenna configuration is referred to as H-slot patch filtenna with defective ground of a single slot under the patch (Hslot_Filtenna2). The dimension of the ground slot (L_{gslot} &W_{gslot}) and its location are used to control the required frequency band where, the antenna can resonate. A single FR-4 substrate (ε_r= 4.6, 1.6 mm height, and tangential loss of 0.02) has been used to mount the H-slot patch. The conductor thickness is assumed to be 0.035mm and the dimensions of the substrate are L_{Sub}=50mm, and W_{Sub}=40mm. The basic patch dimensions are L_P=30mm and W_P=20mm. The patch is fed by transmission line of 50 Ohm. A conventional patch antenna "CP" with the same patch dimensions and full ground plane has been used as reference to compare the performance of our propose filtenna structures. Another important issue in our design is the feeder position and orientation. Therefore, the final objective of our work is to end up with optimum filtenna dimensions. These dimensions depend on the number of antenna resonance and the depth of each resonance frequency (below -20dB).

. III. SIMULATION RESULTS

A conventional patch antenna "CP", has been used as a refence in this paper. Simulation results of CP with two different feeder configurations are presented in Fig.2. This includes vertical feeder and horizontal feeder. Effect of feeder position moves the location of the patch resonance as it is clear

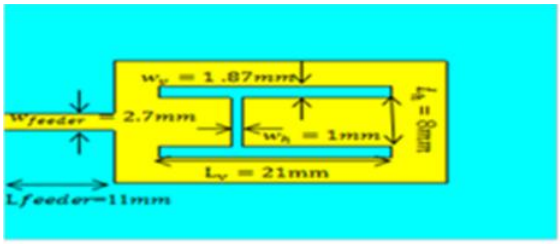

Fig. 1 Optimum dimensions of Hslot _Filtenna1

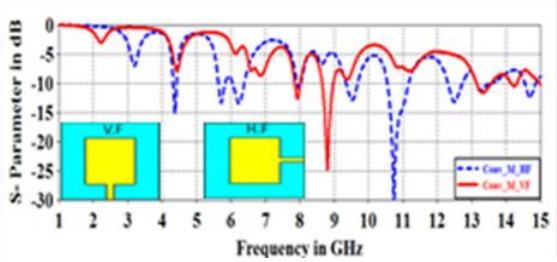

Fig. 2 $|S_{11}|$of CP for vertical & horizontal feeder.

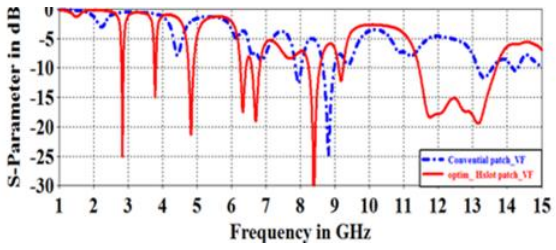

Fig. 3 $|S_{11}|$ for optimum design Hslot_Filtenna1

from Fig.2. To improve the patch performance, an H-slot has been added to the CP patch. This has the effect to create multi-resonance frequencies depending on the H-slot dimensions, location, and orientation. The optimum dimensions of the slot are illustrated in Fig.1. The s- parameter of Hslot_flitenna1 as compared to the CP is shown in Fig.3 (vertical middle feeder). The Hslot_Filtenna1 resonates at 2.9, 3.9, 4.9, 6.3, 6.6, 8.3GHz and a broadband start from 11.5GHz up to 13.5GHz. A ground slot has been inserted for the second filtenna (see Fig.5). This slot acts as a built-in filter. Filtration is highly dependent on the slot dimensions (W_{gh} and W_{gv}). The optimum design for the Hslot_Filteann2 is shown in Fig. 4. Effects of horizontal and vertical gabs are presented in Fig.5 and Fig.6. The obtained results show how the frequency band of the filtenna can be controlled using the ground slot (fixed vertical gab and W_{gh}=4mm). Finally, standing wave for both H-slot Filtenna1 and Filtenna 2 are shown in Fig.7. It represents the stop band and the pass band of our proposed H-slot filtenna structures.

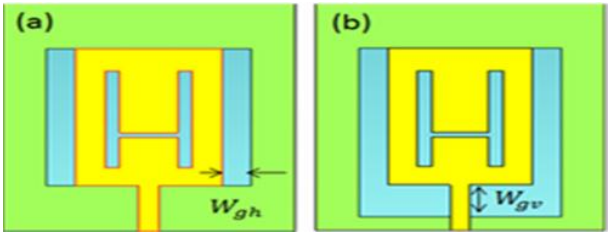

Fig. 4 The optimum of Hslot _Filtenna2

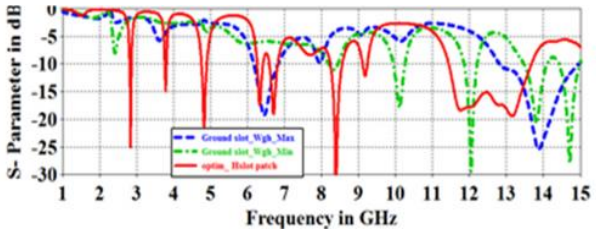

Fig. 5 $|S_{11}|$ of Hslot _Filtenna2 for $W_{gh.}$

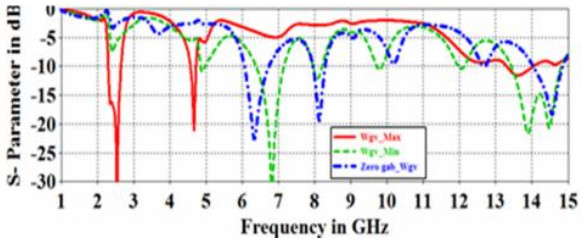

Fig. 6 $|S_{11}|$ of Hslot _Filtenna2 for W_{gv}

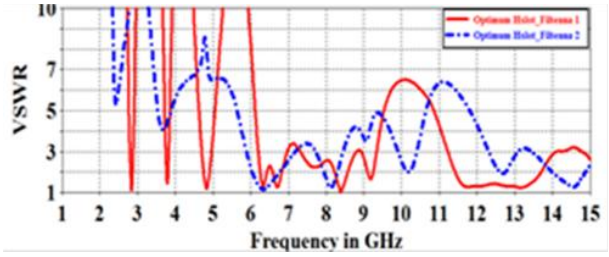

Fig. 7 VSWR for optimum Hslot Filtenna1& Filtenna2

IV. Conclusion

In this paper, new compact microstrip H-slot patch filtennas have been proposed and presented. Two controlling parameters have been investigated in our filtenna design. The first one represents the dimensions of the H-slot in case of full ground. These dimensions have a major impact on the number of antenna resonances. The second parameter is the dimension of ground slot in case of defective ground. It has the effect of filtration of the antenna band. In fact, based on the location of the ground slot as well as its dimension, this slot acts as built-in filter type (low pass, high pass, etc). The optimum design of the H-slot patch depends on the required number of resonance frequencies and their depth. Future work will include analysis and design MIMO filtenna

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References

[1] Woon-Gi Yeo, Tae-Yoon Seo, Jae W. Lee, and Choon Sik Cho, "H-Plane Sectoral Filtering Horn Antenna in PCB Substrates Using Via Fences at Millimetre-Wave," Proceedings of the 37th European Microwave Conference in Munich Germany, pp. 978-2-87487-001-9, Oct. 2007.

[2] K.H.Badr, Senior Member IEEE, "Design and Implementation of Planner Microstrip Antenna Sub-array for Satellite TV Reception," IEEE APS, Middle East Conference on Antenna and Propagation (MECAP) in Cairo, Vol.103, pp. 68034, Oct. 2010.

[3] Hamada Elsaied, and Maher M. Abd El-Razzak, Senior member IEEE, "Novel Planner Microstrip Low Pass Filters Using Electromagnetic Band GAP (EBG) Structures," IEEE APS, Middle East Conference on Antenna and Propagation (MECAP) in Cairo,Vol.103, pp. 54037, Oct. 2010.

[4] Abbas Abbaspour-Tamijani, Member, IEEE, Kamal Sarabandi, Fellow, IEEE, and Gabriel M. Rebeiz, Fellow, IEEE, "Antenna–Filter Arrays as a Class of Bandpass Frequency-Selective Surfaces," IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 52, NO. 8, AUGUST 2004.

[5] Yingying Lu, Hung-Jui Lam and Jens Bornemann, "Coplanar Printed-Circuit Antenna with Band-Rejection Elements for Ultra-Wideband Filtenna Applications," IEEE by TELUS Research Grant in Wireless Communications. ,PP. 978-1-4244-2042, Aug. 2008.

[6] Jason Leo Durbin, B.S.E.E., "TUNABLE FILTENNA USING VARACTOR TUNED RINGS FED WITH AN ULTRA WIDEBAND ANTENNA," Progress In Electromagnetics Research Letters, Vol. 29, 43-50, Nov.2011.

Biography

Dr. Hussein Ghouz received his Ph.D. degree in electrical engineering from Arizona State University, Tempe in 1996. Dr. Ghouz is working in the area of analysis and design of compact planar filtennas including microstrip, coplanar and stripline circuits for 3G/4G applications.

Reham Zaghloul received the B.SC at AAST in July 2010. Eng. Reham is working in the team of CST-ME as a senior technical Engineers and a project engineer in SmartCom-Me and teacher assistance in AAST as well.