IMSEC 2018 3rd International Mediterranean Science and Engineering Congress (IMSEC 2018)
Çukurova University, Congress Center, October 24-26, 2018, Adana / TURKEY
Pages: 310-312, Paper ID:105

Conference Paper
Oral Presentation

CPW-FED UWB Textile Antenna Design for Wearable Aplications

Alparslan Cinar[1], Gulnaz Gunes[2], S. Cumhur Basaran[3*]

[1]Elmali Vocational School/Akdeniz University, Turkey; alparslancinar@akdeniz.edu.tr
[2]Department of Electrical-Electronics Engineering/Akdeniz University, Turkey; gulnazgunes123@gmail.com
[3]Department of Electrical-Electronics Engineering/Akdeniz University, Turkey; cbasaran@akdeniz.edu.tr

Abstract

A ultra-wideband co-planar waveguide (CPW)-fed printed antenna with full-ground plane is presented for wearable applications. Two concentric split ring (SR) elements with parasitic patches are used as main radiator of the antenna to achieve compact antenna configuration providing ultra-wideband (UWB) performance. A full ground plane is maintained on the opposite side of the substrate to suppress antenna loading from the underlying biological tissues and back radiation directed towards the human body. The proposed split-ring textile antenna (SRTA) has multilayered structure and provides UWB band performance between 3.178 GHz and 11.000 GHz. Also, the antenna exhibits uniform radiation patterns at almost all related band considered. Analysis and design of the proposed antenna is carried out by means of CST Microwave Studio Suite.

Keywords: textile antenna, wearable antenna, ultra wideband antenna, split ring elements.

1. INTRODUCTION

The use of textile antennas has been increasing rapidly in wearable body-centric applications. A body centric wearable antenna is meant to be a part of the clothing used for communication purposes including tracking and navigation, mobile computing and public safety. UWB communication potentially offers several advantages with respect to conventional narrowband ones, such as higher achievable data rates and increased immunity to interference due to lower spectral power density. Also for body-centric communication, the advantages of UWB are particularly appealing, and this stimulated extensive research on novel UWB wearable textile antennas during the last decade [1-4].

In this paper, we introduce a novel CPW-fed multilayer antenna with a full ground for UWB wearable operation, which was inspired by stacked antenna design proposed in [1]. Different from the design reported in [1], main radiator of the proposed design in this study is composed of two concentric split-ring elements and metallic paths inserted between the rings. Split-ring elements were first introduced as the building blocks of metamaterial structures [5, 6] and they were utilized in various types of antenna design reported in [7-12]. As well known, split-ring resonators can exhibit resonant behavior for wavelengths that are much larger than its size. Thus, they are considered very good candidate for miniature antenna design of electrically small antennas having dual-band or wideband operation. On the other hand, rectangular parasitic patches in middle plate of the proposed design are used for bandwidth enhancement. In addition, a full ground plane is maintained on the opposite side of the bottom substrate to suppress antenna loading from the underlying biological tissues and back radiation directed towards the human body. The proposed antenna is excited by CPW line technique. This feeding technique has several attractive features, including a simple, easy-to-manufacture topology using a single metallization layer on a substrate. Moreover, complex interconnections with vias and solder pads are eliminated, resulting in a much reduced coupling with nearby components active devices may also be easily integrated onto the antenna board.

2. UWB TEXTILE ANTENNA DESIGN

The proposed SRTA configuration with its design parameters is depicted in Figure 1 and the parameters values are given in Table I. As seen, the SRTA has stacked configuration with three layers. Main radiator of the antenna in the top plate consists of two concentric SR elements and metallic loadings appropriately placed between the rings. Two rectangular parasitic patches connected by thin printed line together is added beneath the top plate for band enhancement purpose. In addition, a full ground plane is directly used underneath the bottom layer as a reflector to avoid the influence of the human body on the antenna.

The conductive components of the antenna such as SR elements, parasitic patches and ground plane are built using ShieldIt conductive textile having a thickness of 0.17mm and

*Corresponding authour
Email: cbasaran@akdeniz.edu.tr

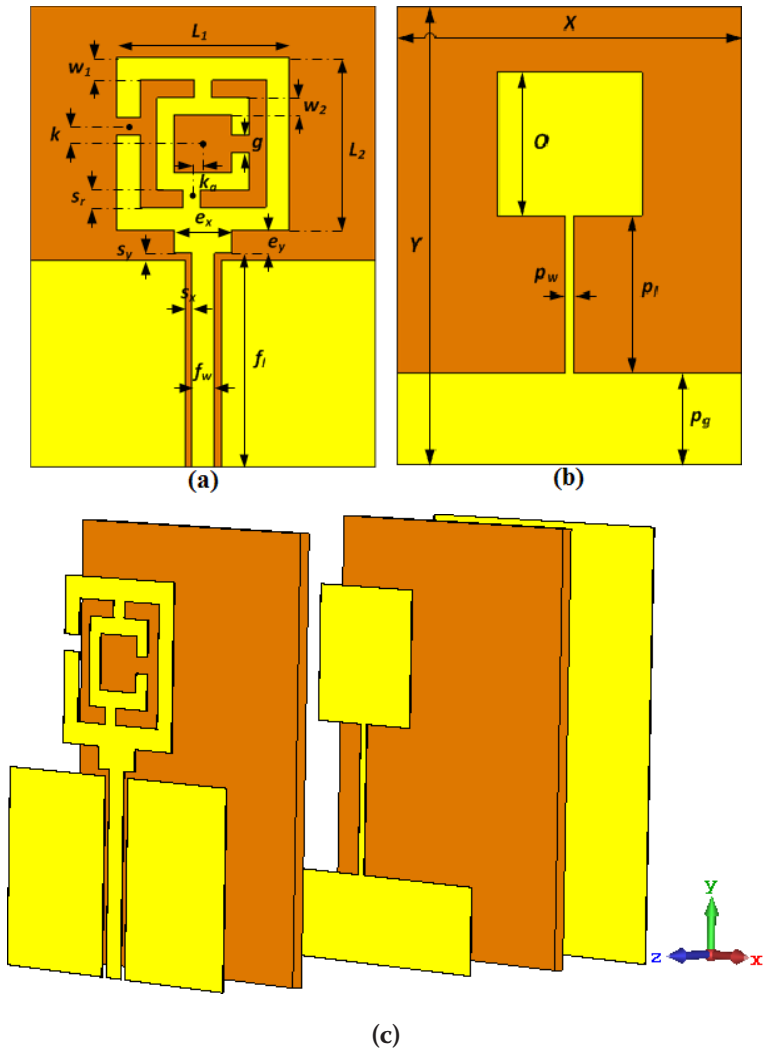


Figure 1: Proposed SRTA design with optimal parameters a) front view in top plate b) parasitic patches in middle plate c) stacked layer configuration.

an estimated conductivity of 1.18 × 10^5 S/m. The proposed antenna is excited by CPW feed line in the top layer and its underneath. Also, a thermally isolating material namely Felt with relative permittivity ε_r of 1.45 and a loss tangent tan δ of 0.044 is used as dielectric substrate layers of the antenna.

Table 1 Parameters And Values of SRTA Design.

Parameter	Value (mm)	Parameter	Value (mm)
X	60	k	3
Y	80	k_a	2
L_1	47	p_g	13
L_2	26	p_l	31.5
O	17	p_w	0.6
e_x	14	s_r	2
e_y	3	s_x	0.3
f_l	37	s_y	0.3
f_w	3	w_1	4.8
g	3	w_2	2.54

3. SIMULATION RESULTS

Analysis and design of the SRTA were conducted via CST microwave studio based on time domain integral technique. The return loss performance of the design is shown in Figure 2. As seen, the SRTA provides ultra wideband performance from 3.1 GHz more than 11 GHz. Thus, the SRTA offers a coverage of all UWB frequency allocated by FCC (3.1-10.6 GHz).

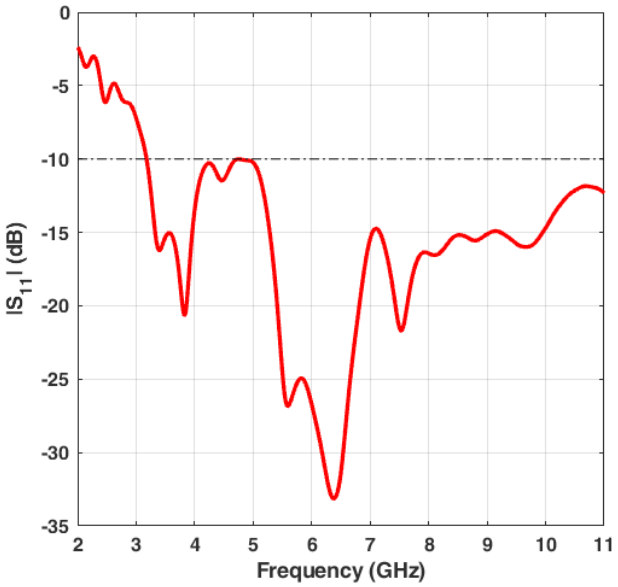


Figure 2: Simulated return loss (S11) characteristics for the proposed SRTA.

Radiation patterns of the SRTA design were also computed and the corresponding polar plots for some particular frequencies (namely, *f*=3.5 GHz, 5.2 GHz,5.8 GHz and 8 GHz) are

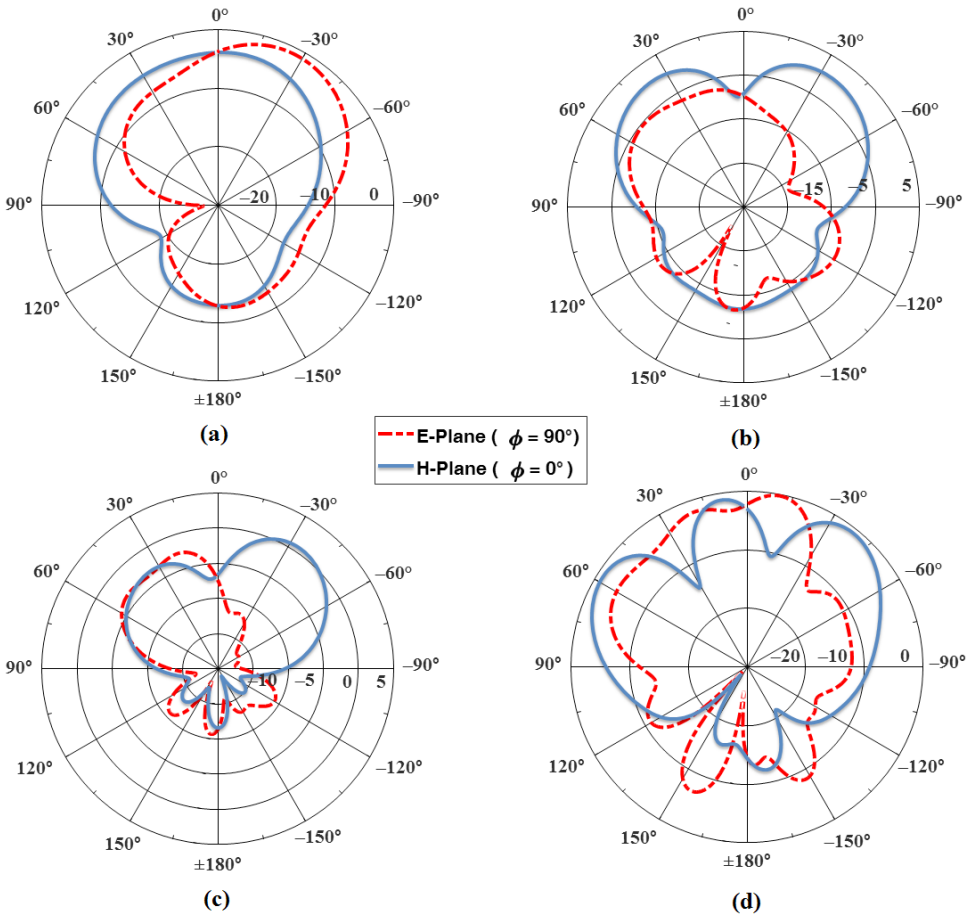


Figure 3: Simulated radiation pattern of the SRTA at dB scale for a) 3.5 GHz, b) 5.2 GHz, c) 5.8 GHz and d) 8.0 GHz.

displayed in Fig. 3. As seen, boresight radiated spectrum is obtained and main beam of the antenna radiates away from the body. In addition, computed maximum antenna gain is −1.241 dB at 3.5 GHz, 2.204 dB at 5.2 GHz, 1.433 dB at 5.8 GHz and 0.964 dB at 8.0 GHz.

4. CONCLUSION

In the paper, we have introduced a UWB textile antenna for body-centric wearable applications. Main radiator of the antenna is concentric split ring elements and parasitic patches are used for bandwidth enhancement purpose. In addition, a full ground plane is employed for isolation between human body and the antenna. The proposed antenna having multilayer structure can cover all UWB (3.1-10.6 GHz) frequency band. In addition, the antenna exhibit uniform radiation pattern characteristic with acceptable gain performances at the related bands.

REFERENCES

[1] Poffelie L. A. Y., Soh P. J., Yan S. and Vandenbosch G. A., (2016) "A high-fidelity all-textile UWB antenna with low back radiation for off-body WBAN applications", IEEE Transactions on Antennas and Propagation, vol.64, pp.757-760

[2] Samal P. B., Soh P. J. and Vandenbosch G. A., (2014) "UWB all-textile antenna with full ground plane for off-body WBAN communications", IEEE transactions on antennas and propagation, vol.62, pp.102-108

[3] Simorangkir R. B., Kiourti A. and Esselle K. P., (2018) "UWB Wearable Antenna With a Full Ground Plane Based on PDMS-Embedded Conductive Fabric", IEEE Antennas and Wireless Propagation Letters, vol.17, pp.493-496

[4] Klemm, M. and Troster, G. Textile UWB antenna for on-body communications. In: Antennas and Propagation, 2006. EuCAP 2006. First European Conference on. IEEE; 2006; p. 1-4.

[5] Pendry J. B., Holden A. J., Robbins, D. J. and Stewart, W. J., (1999) "Magnetism from conductors and enhanced nonlinear phenomena", IEEE transactions on microwave theory and techniques, vol.47, pp.2075-2084

[6] Smith, D. R., Schultz, S., Markoš, P. and Soukoulis C. M., (2002) "Determination of effective permittivity and permeability of metamaterials from reflection and transmission coefficients" Physical Review B, vol.65, pp.195104

[7] Alici K. B. and Ozbay E., (2007) "Electrically small split ring resonator antennas", Journal of applied physics, vol.101, pp.083104

[8] Basaran S. C. and Erdemli Y., (2009) "A dual-band split-ring monopole antenna for WLAN applications", Microwave and Optical Technology Letters, vol.51, pp.2685-2688

[9] Basaran S. C. and Sertel K., (2015) "Dual-band frequency-reconfigurable monopole antenna for WLAN applications", Microwave and Optical Technology Letters, vol.57, pp.55-58

[10] Basaran S. C. and Sertel K., (2013) "Dual wideband CPW-fed monopole antenna with split-ring resonators", Microwave and Optical Technology Letters, vol.55, pp.2088-2092

[11] Joshi J. G., Pattnaik S. S. and Devi S., (2013) "Geo-textile based metamaterial loaded wearable microstrip patch antenna", International Journal of Microwave and Optical Technology, vol.8, pp.25-33

[12] Sabban A. Small wearable antennas for wireless communication and medical systems. In: Radio and Wireless Symposium (RWS), 2018 IEEE. IEEE, 2018. p. 161-164