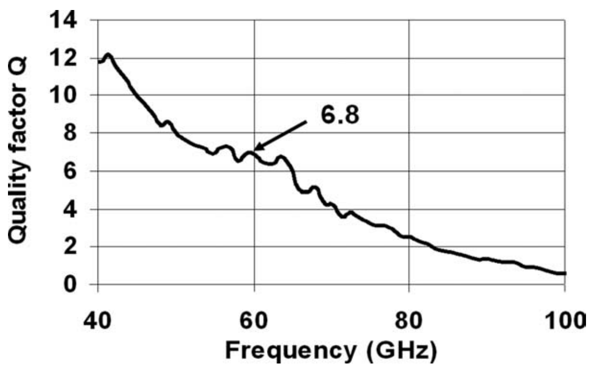

Figure 7 Measured quality factor of the 215 fF MOM capacitors

TABLE 1 Extracted Lumped Elements of MOM Capacitors With the Metal Stack

Dens. (fF/μm^2) + Metals Levels	C_0 (pF)	C_1 (fF)	R_0 (Ω)	L_0 (pH)	$f_{res.}$ (GHz)	Q @ 60 GHz
1 M5/M7	0.129	1.97	0.4	3	160	3.2
1.1 M5/M7	0.215	3.5	0.3	5	110	6.7
3.1 M5/M6	0.629	37	0.45	1	80	9.5
3.2 M1/M6	1.15	44	0.7	1.5	70	10.2
3.1 M1/M6	5.6	195	1	7.4	25	–

close to 60 GHz for different MOM designed in a CMOS 45-nm process. The extracted lumped elements of the designed MOM capacitor are presented in Table 1. It is shown that the quality factor increase with the capacity density.

6. CONCLUSIONS

An innovative structure of 3D MOM capacitor designed in a standard CMOS 45-nm STMicroelectronics process was presented. These MOM capacitors dedicated to mmw applications present high capacitance density from 1 to 3.2 fF/μm^2 and losses lower than 1 dB at 60 GHz. Moreover, the presented MOM capacitors have higher Q (from 3 to 10) than MIM, and lower losses than 3D trench capacitors due to the very low-coupling effect with the substrate, in an advanced CMOS process.

ACKNOWLEDGMENTS

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AN F-SHAPED PRINTED MONOPOLE ANTENNA FOR DUAL-BAND RFID AND WLAN APPLICATIONS

Jyoti Ranjan Panda and Rakhesh Singh Kshetrimayum
Department of Electronics and Communication Engineering, Indian Institute of Technology, Guwahati 781039, India; Corresponding author: krs@iitg.ernet.in

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ABSTRACT: *A simple microstrip fed printed monopole antenna for the radio frequency identification (RFID) and wireless local area network (WLAN) is presented. The antenna has two different resonant current paths (forming an F-shaped structure) that support two resonances at 2.44 and 5.18 GHz, which are reserved for RFID and WLAN applications, respectively. Effectively omnidirectional radiation pattern and large impedance bandwidth has been observed both from simulation and experimental results. Impedance bandwidth for center frequency of 2.44 and 5.18 GHz are 0.65 GHz (2.12–2.77 GHz) and 0.59 GHz (4.91–5.50 GHz), respectively. The proposed antenna is simple in design and compact in size; providing broadband impedance matching, consistent omnidirectional radiation patterns and appropriate gain characteristics (>1.5dBi) in the RFID and WLAN frequency regions.* © 2011 Wiley Periodicals, Inc. Microwave Opt Technol Lett 53:1478–1481, 2011; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.26060

Key words: *F-shaped printed monopole antenna; RFID; WLAN*

1. INTRODUCTION

In recent years, the radio frequency identification (RFID) has received wide spread attention for application in many services such as tracking objects, identifying objects in the manufacturing, and supply chain management systems as well as material flow systems [1]. An RFID system basically comprise of a read/

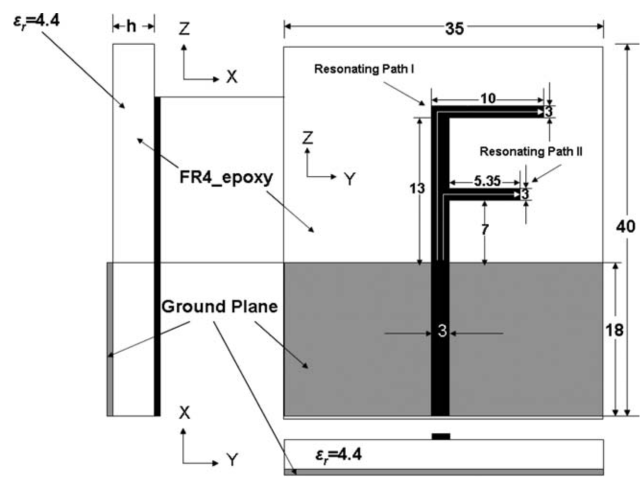

Figure 1 Geometry of the proposed antenna

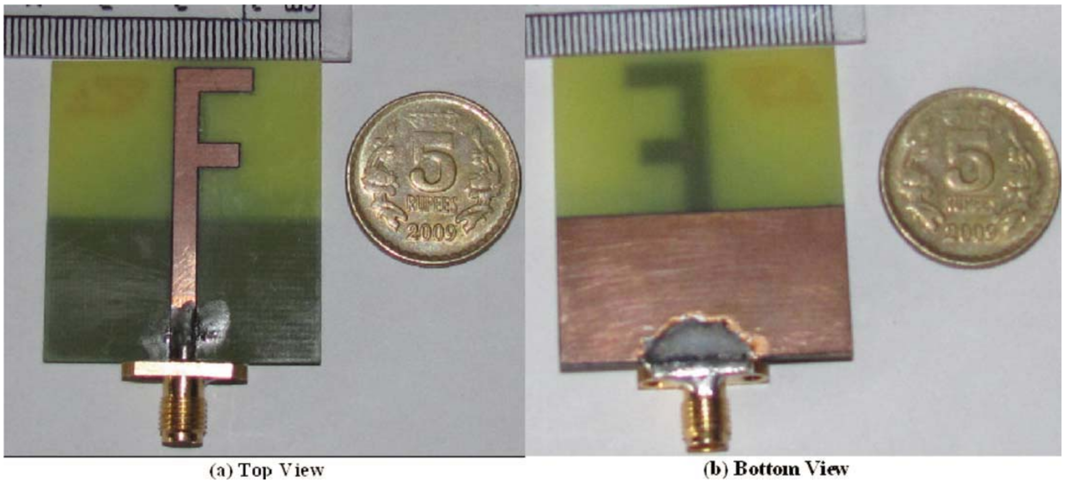

Figure 2 Fabricated prototype of the proposed F-shaped printed monopole antenna: (a) top view; (b) bottom view. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

write mechanism and a tag (transponder). In other words, RFID system consists of a data processing system, transponder (tags), antennas, and readers [2]. The encoded data is transferred between the tag and read/write device by means of electromagnetic waves at the assigned bands of 125 KHz, 13.56 MHz, 869 MHz, 902–928 MHz, 2.45 GHz, and 5.8 GHz. [3]. The tag, which holds the antenna and a microchip transmitter, must be low cost, less fragile, low profile, and generally of small size for the convenient use in the RFID system. Therefore, an efficient antenna with high gain, omnidirectional radiation patterns, and wide impedance bandwidth but with a planar structure becomes more important. Many antenna design for the RFID systems has been reported including coplanar waveguide fed folded slot [4], the aperture coupled structures [5], meander line structures [6], etc. Apart from the above RFID antenna designs, several RFID antenna designs are proposed [7–9] in the literature. However, these designs may be complicated in structure or difficult to fabricate. The aforementioned antennas are either resonates at 2.4 or 5.8 GHz.

In this article, a new printed F-shaped monopole antenna is presented for dual-band RFID applications, which simultaneously resonates at 2.44 and 5.18 GHz, which are the operating bands of RFID and wireless local area network (WLAN) application. Similarly, this design enables the use of one antenna simultaneously at the RFID and WLAN operation bands. The antenna is constructed by a nonconductor backed F-shaped strip with a microstrip feedline. The dual-band performance can be easily obtained for this type of antenna by fine-tuning the lengths of the two resonant paths in the F-shaped strip.

2. ANTENNA DESIGN

Figure 1 shows the F-shaped printed monopole antenna for dual-band RFID and WLAN applications. The F-shaped monopole antenna is printed on a FR4 substrate of relative permittivity 4.4 and thickness 1.6 mm as depicted in the Figure 1. The shape of the antenna element is like the English letter F. A 50-Ohm microstrip line is used for excitation of the antenna. The strip width of F-shaped monopole antenna is 3 mm, same as that of the microstrip line. The remaining antenna dimensions are given in the Figure 1. The proposed antenna was simulated using the IE3D simulator [10].

The F-shaped element provides two different resonant current paths of lengths $L_1 = 24.5$ mm and $L_2 = 15.35$ mm. The resonant path L_1 is chosen as $\sim 0.25\ \lambda_1$ at the resonant frequency of 2.45 GHz and the resonant path L_2 is chosen as $\sim 0.25\ \lambda_1$ at the resonant frequency of 5.2 GHz. By properly varying the lengths

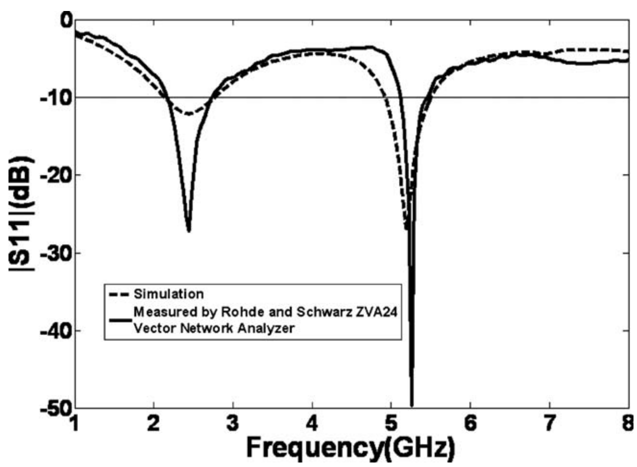

Figure 3 Comparison of the simulated and experimental return loss of the proposed F-shaped printed monopole antenna for RFID and WLAN applications

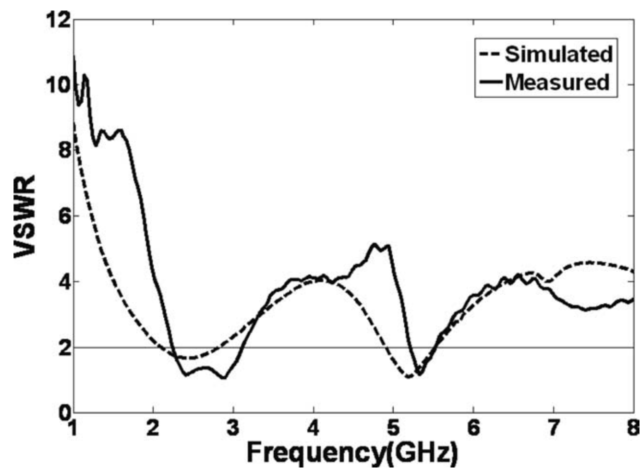

Figure 4 Comparison of the simulated and experimental VSWR of the proposed F-shaped printed monopole antenna for RFID and WLAN applications

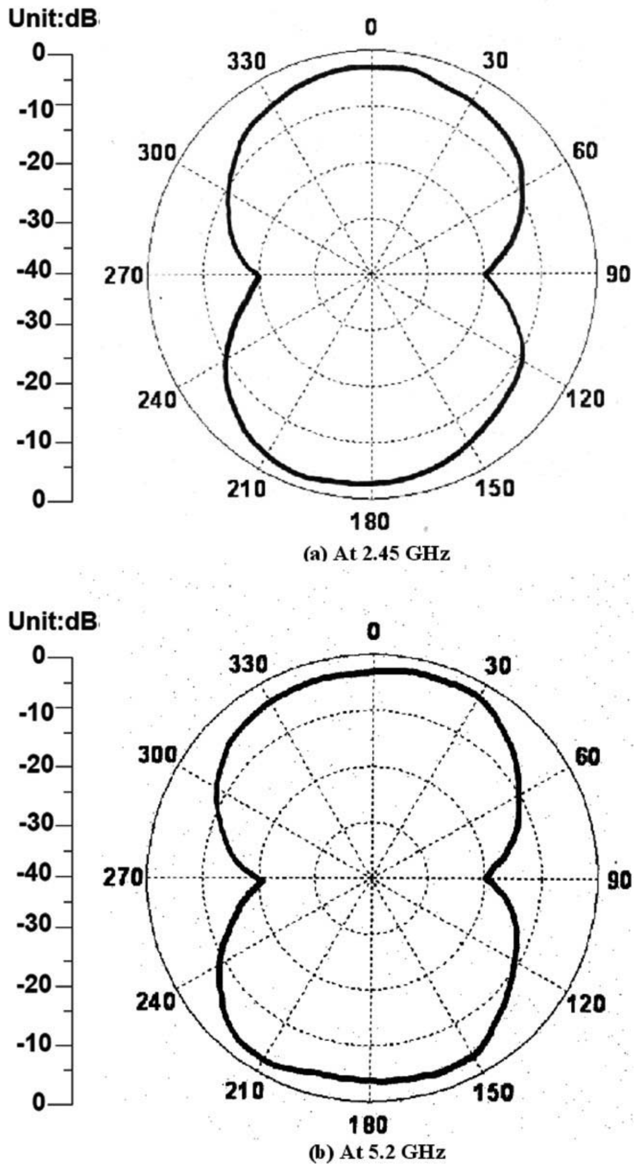

Figure 5 Measured E-plane (Co-pol) radiation patterns at (a) 2.45 and (b) 5.2 GHz

L_1 and L_2, we can fix the antenna resonance at 2.45 and 5.2 GHz, respectively. The overall adjustments of the geometrical parameters are done to improve the impedance bandwidth of the antenna in the 2.45 and 5.2 GHz frequency bands.

3. RESULTS AND DISCUSSION

Figure 2 shows the photograph of the fabricated prototype of the proposed F-shaped monopole antenna for RFID and WLAN applications. Figure 3 depicts the comparison of the simulated return loss ($|S_{11}|$) and the measured return loss of the proposed antenna. The return loss measurement was done using the Rohde and Schwarz ZVA24 vector network analyzer. From the graph, it is quite clear that there is reasonably good agreement between the measured and the simulated return loss. According to the measurements, the first resonance occurs at 2.44 GHz (return loss value of −27.17 dB and percentage bandwidth of 22.49%) and the second resonance occurs at 5.25 GHz (return loss value of −49.58 dB with percentage bandwidth of 6.24%). Figure 4 shows comparison of the simulated voltage standing wave ratio (VSWR) and the experimental VSWR of the proposed F-shaped monopole antenna for RFID and WLAN applications. From the graph, it is also clear that there is good agreement between the measured and the simulated VSWR, as expected.

The gain increases smoothly with the frequency. The gain at 2.45 GHz is 1.87 dBi and the gain at 5.18 GHz is 2.88 dBi. The proposed antenna provides sufficient and appropriate gain required for the operation in the RFID (2.45 GHz) and WLAN (5.2 GHZ) bands. The proposed F-shaped antenna exhibits highest gain of 2.89 dBi at 5.2 GHz.

The measured copolarized E-plane and H-plane radiation patterns of the F-shaped monopole antenna at 2.45 and 5.2 GHz are shown in the Figures 5 and 6, respectively. It can be observed that E-plane radiation pattern is of the shape 8 in the two frequencies. At 5.2 GHz, the shape of the E-plane radiation pattern is slightly distorted. The H-plane radiation pattern on the other hand is purely omnidirectional pattern at the two frequencies, i.e., at 2.45 and 5.2 GHz. Hence, this F-shaped monopole antenna demonstrates a consistent radiation pattern in the desired band of frequencies.

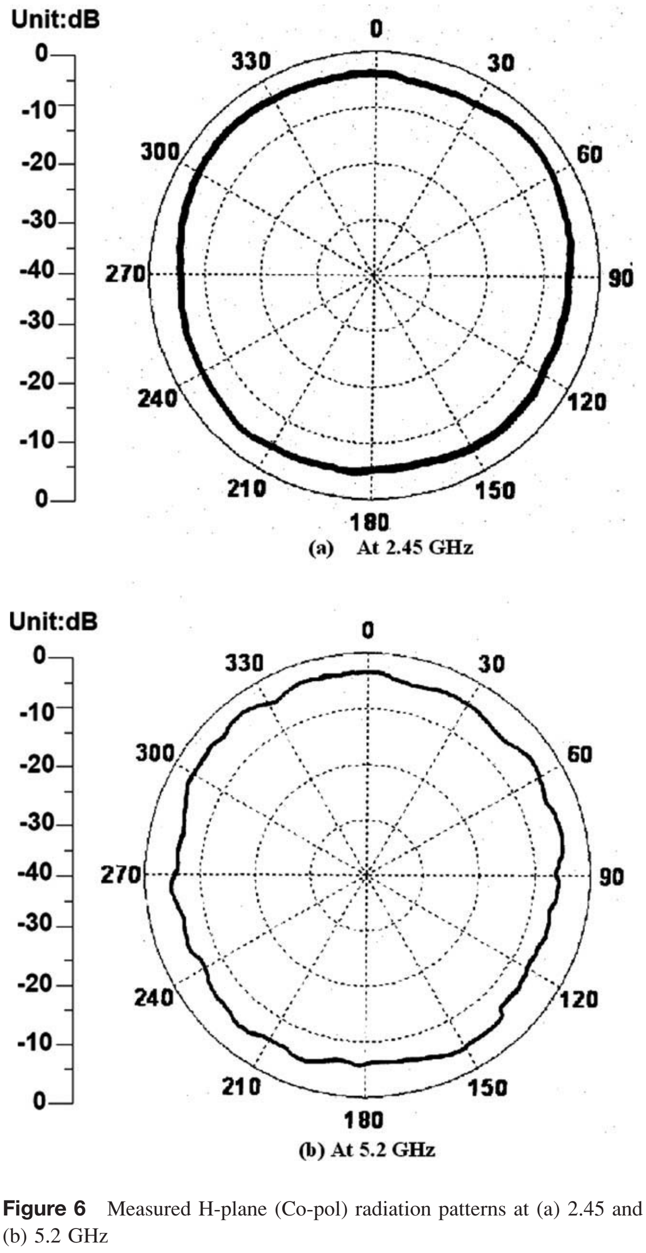

Figure 6 Measured H-plane (Co-pol) radiation patterns at (a) 2.45 and (b) 5.2 GHz

4. CONCLUSION

A printed F-shaped monopole antenna for RFID and WLAN operation has been presented. Satisfactory dual-band operation for RFID and WLAN applications can be easily achieved by the F-shaped configuration, which provides two resonant current paths of different lengths for excitation of the two resonant frequencies. The proposed antenna is simple to design and compact in size. It provides broadband impedance matching, consistent omnidirectional radiation patterns and appropriate gain characteristics (>1.5dBi) in the RFID and WLAN frequency region. Hence, the proposed antenna may be a suitable candidate for dual-band RFID and WLAN operations.

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COMPACT CPW-FED PRINTED MONOPOLE ANTENNA WITH SUPER-WIDEBAND PERFORMANCE

Mohammad Akbari,[1] Mohsen Koohestani,[2] Changiz. Ghobadi,[1] and Javad Nourinia[1]
[1] Department of Electrical Engineering, Faculty of Engineering, Urmia University, Urmia, Iran
[2] Faculty of Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran; Corresponding author: koohestani.telecome@gmail.com

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ABSTRACT: *This letter presents a new printed monopole antenna with super-wideband performance useful for various ultra wideband communication applications. The antenna has a compact structure, and the total size is 24 × 24 × 1.6 mm^3. The antenna structure consists of a hexagonal patch radiator with a modified 50 Ω coplanar waveguide line for excitation. By using a trident shaped feed line structure the super wide bandwidth is obtained. Measurement results show that the impedance bandwidth for S11 ≤ −10 dB is enhanced largely to more than 174%. Radiation patterns are given at 4, 6, and 9.5 GHz.* © 2011 Wiley Periodicals, Inc. Microwave Opt Technol Lett 53:1481–1483, 2011; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.26090

Key words: *super-wideband antenna; CPW-fed; trident shape feed line*

1. INTRODUCTION

The rapid development of wireless communication arouses the need of ultra wideband (UWB), dual-band or multiband antennas. UWB antennas are of interest for a variety of applications such as radars, mine detection and portable devices. The interest in UWB technology has increased after the U.S. Federal Communications Commission (FCC) allocation of the frequency band of 3.1-10.6 GHz for commercial use [1]. A suitable UWB antenna needs to fulfill requirements set by UWB technology and by portable devices alike, such as hold a reasonable impedance match, omni-directional radiation patterns, constant gain and group delay over the entire band, high radiation efficiency, and have electrically small size. Microstrip antennas due to offer antennas with attributes of low profile, light weight, low cost and ease of fabrication are popular. Recently, planar UWB antenna fed with a microstrip line or a coplanar waveguide (CPW) has received much attention due to its advantages such as wideband matching bandwidth and good radiation characteristics. The CPW feeding has many attractive features, such as no

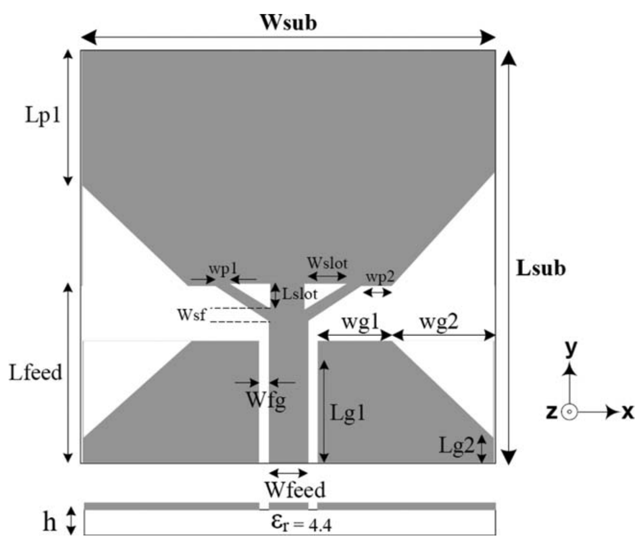

Figure 1 Antenna geometry

TABLE 1 Parameter Values of the Fabricated Antenna (in mm)

Wsub	Lsub	Wp1	Wp2	Wslot	Lp1	Lslot	Wsf
24	24	0.5	0.7	2	7.5	1	0.35
Wg1	Wg2	Lg1	Lg2	Wfeed	Lfeed	Wfg	h
2.4	8.2	9	4	1.6	10.5	0.6	1.6