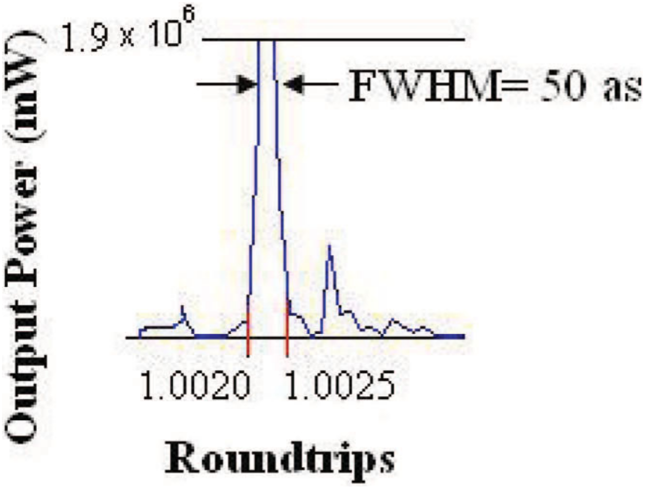

Figure 5 Shows the pulse width expansion of the output pulse in Figure 4(c) with the fraction of time of 10^{-3} of the input power. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

III. CONCLUSIONS

In conclusion, we have proposed the remarkably simple scheme for the attosecond pulse generation using the multistage nonlinear microring devices. We found that the generation of the ultrashort pulse in the range of 50 attosecond and beyond is plausible. However, in practice, the detection device of such a narrow pulse (i.e., short response time) is the problem in the realistic application due to the optical material bandwidth limitation, therefore, the detection technique is become the subject of investigation rather than the device material.

REFERENCES

1. J. Biegert, A. Heinrich, C.P. Hauri, W. Kornelis, P. Schlup, M. Anscombe, K.J. Schafer, M.B. Gaarde, and U. Keller, Enhancement of High-Order Harmonic Emission Using Attosecond Pulse Trains, Laser Phys 13 (2005), 899.
2. M.J. Ablowitz, G. Biondini, S. Chakravarty, R.B. Jenkins, and J.R. Sauer, Four-wave mixing in wavelength-division-multiplexed soliton systems: damping and amplification, Opt Lett 21 (1996), 1646–1648.
3. Y. Huo, Z. Zeng, R. Li, and Z. Xu, Single attosecond pulse generation using two-color polarized time-gating technique, Opt Exp 13 (2005), 9897–9902.
4. P.P. Yupapin, P. Saeung, and W. Suwancharoen, Coupler-loss and coupling-coefficient dependence of bistability and instability in a fiber ring resonator: nonlinear behaviors, J Nonlinear Opt Phys Mater 16 (2007), 111–118.
5. P.P. Yupapin and W. Suwancharoen, Chaotic signal generation and cancellation using a micro ring resonator incorporating an optical add/drop multiplexer, Opt Commun 280 (2007), 343–350.
6. M.F.S. Ferreira, Nonlinear effects in optical fibers: limitations and benefits, SPIE Proc 6793 (2007), 679302.
7. R. Grover, P.P. Absil, V. Van, J.V. Hryniewicz, B.E. Little, O. King, L.C. Calhoun, F.G. Johnson, and P.-T. Ho, Vertically coupled GaInAsP—InP microring resonators, Opt Lett 26 (2001), 506–508.
8. Y. Silberberg, Physics at the attosecond frontier, Nature 414 (2001), 494.
9. J. van Howe and C. Xu, Ultrafast optical delay line using soliton propagation between a time-prism pair, Opt Exp 13 (2005), 1138–1143.
10. T. Pfeifer, L. Gallmann, M.J. Abel, D.M. Neumark, and S.R. Leone, Single attosecond pulse generation in the multicycle-driver regime by adding a weak second-harmonic field, Opt Lett 31 (2006), 975–977.
11. O. Cohen, S. Lan, T. Carmon, J.A. Giordmaine, and M. Segev, Spatial vector solitons consisting of counterpropagating fields, Opt Lett 27 (2002), 2013–2015.
12. V. Van, T.A. Ibrahim, P.P. Absil, F.G. Jhonson, R. Grover, and P. T. Ho, Optical signal processing using nonlinear semiconductor microring resonators, IEEE J Quantum Electron 8 (2002), 705–713.
13. Available at: www.nufern.com/2-50 W CW Fiber Laser Modules.

COPLANAR UWB ANTENNA WITH INCREASED SUPPRESSION CHARACTERISTICS

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ABSTRACT: *The improved band-notch capability of an ultra-wideband antenna in coplanar technology is demonstrated. The printed-circuit element includes not only a slot to attenuate narrowband services but also a coplanar-waveguide filter in the feeding line to aid attenuation level and bandwidth in the same frequency range. The input match of the antenna increases from around 10 dB (VSWR = 2) in the UWB range to −1.29 dB (VSWR = 13.5) in the suppression band. The radiation patterns of the antenna remain largely uninfluenced by the bandstop measures added to the antenna. The performance is validated by comparison with different commercial full-wave field solvers.* © 2008 Wiley Periodicals, Inc. Microwave Opt Technol Lett 50: 3111–3114, 2008; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.23881

Key words: *ultra-wideband antennas; printed-circuit antennas; coplanar waveguide filters; bandstop filters*

1. INTRODUCTION

Ever since the 3.1–10.6 GHz frequency range was assigned for ultra-wideband (UWB) applications, a large variety of printed-circuit antenna concepts both in microstrip, e.g [1–8], and coplanar technology, e.g [9–16] have been proposed. However, any UWB application has to coexist with current (narrowband) services in the same frequency range. Therefore, several attempts have been made to design printed-circuit UWB antennas, which are capable of attenuating one of such narrow frequency bands, e.g [17–22]. It is obvious from these investigations, though, that a single band-notch element within the antenna topology serves only to attenuate an extremely narrowband application in the UWB range. Wider suppression bandwidths with reasonable attenuation require a combination of bandstop elements within the antenna topology.

Therefore, this article aims at increasing both the slopes and attenuation bandwidth of UWB antennas with band-rejection capabilities. Following the basic concept of [22], we are inserting a bandstop filter into the feed line and maintain the use of a slot in the radiating element of the antenna. As an application example for the 3.1–10.6 GHz UWB range, the design focuses on suppressing the 5.15–5.825 GHz frequency range used by IEEE 802.11a for wireless local area networks (WLANs).

2. DESIGN

Figure 1 shows the proposed UWB antenna with increased suppression capability. It uses FR4 substrate with 1.575-mm thickness and a substrate area of 30 mm × 40 mm. The basic design of a similar UWB antenna in coplanar technology has been described in [16] and will not be repeated here. Note that a coaxial-to-coplanar-waveguide transition is included in all simulations to first include the actual coaxial feed and, secondly, provide a connection between the two ground planes.

To attenuate the chosen frequency band of 5.15–5.825 GHz, a bandstop filter is placed in the feed line first (lower inset of Fig. 1). The filter is a modified version of the one presented in [23], and the guidelines in [23] are followed to design the stopband characteristics. Secondly, a straight slot is inserted into the center radiator (upper inset of Fig. 1) similar to an approach proposed in [19]. The length of the slot is designed such that it is approximately half a guided wavelength at midband frequency. The exact location of this slot affects the input match return loss of the antenna and, therefore, this parameter is fine optimized within the final arrangement shown in Figure 1.

To verify the responses obtained with different full-wave field simulators, the input VSWR of a UWB antenna without bandstop elements was simulated by CST Microwave Studio®, Ansoft HFSS®, and MEFiSTo-3D®. The responses are shown in Figure 2 and demonstrate very good agreement over the entire frequency range of 2–11 GHz.

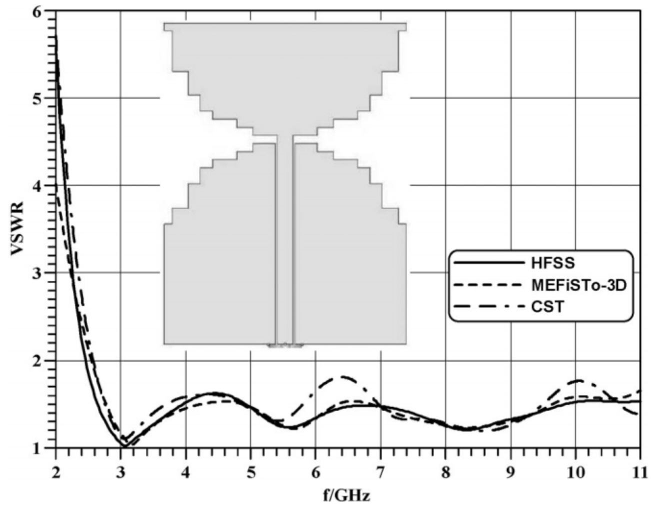

Figure 2 Comparison of VSWR results obtained from CST Microwave Studio, Ansoft HFSS, and MEFiSTo-3D at the example of a UWB antenna without slot or filter. 279 × 215 mm^2 (200 × 200 DPI)

3. RESULTS

Figure 3 shows the input VSWR of the coplanar antenna depicted in Figure 1. Good agreement is obtained between CST and HFSS, thus verifying the design procedure. The VSWR is close to 2 from 2.8 to 4.8 GHz and from 6.2 to almost 10 GHz. The stopband is approximately from 5.1 to 6 GHz where the VSWR is significantly higher than 2. The maximum VSWR is 13.5, corresponding to a reflection coefficient of −1.29 dB. Although this value is slightly below that reported in [19], the bandwidth achieved with our design is much larger than that of [19].

Example radiation patterns for vertical polarization are displayed in Figure 4. In the *H*-plane (*xy* plane in Fig. 1), the pattern is almost omnidirectional [Fig. 4(a)] as expected for this type of antenna. *E*-plane patterns in the *yz* [Fig. 4(b)] and *xz* [Fig. 4(c)] planes resemble, to a certain degree, those of a vertical dipole. In comparison with patterns presented in [16] for a similar antenna without slot or filter, it is seen that the patterns maintain their general characteristics over the entire frequency range and, therefore, neither the slot nor the filter have a serious impact on the wideband radiation patterns outside the stopband frequency range.

Figure 5 shows the maximum gain with and without stopband elements. The effects of the slot and filter are obvious, and the gain drops from 5 dBi to far below 0 dBi in the stopband region. In the remaining parts of the UWB range, the gain is not significantly altered by the slot or filter.

4. CONCLUSIONS

A slot and a filter in the antenna improve the notch attenuation and bandwith of UWB antennas in coplanar technology. The obtained VSWR values in the notched band are reasonable, and the bandwidth is wider that those reported at a comparable VSWR level. The radiation capability in the rest of the UWB range is maintained. These findings are supported by the maximum gain behavior over the UWB frequency range.

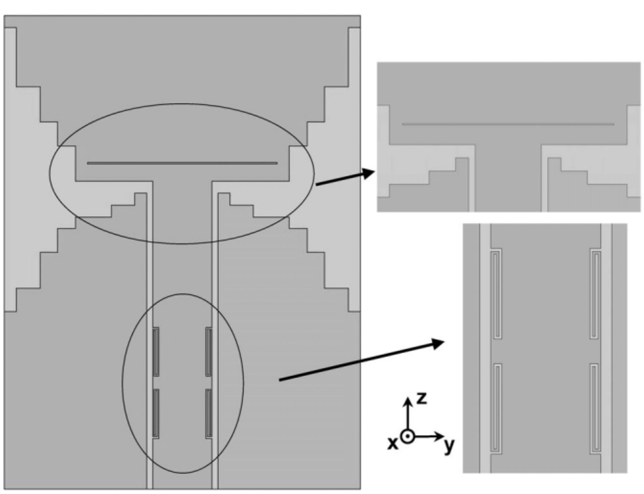

Figure 1 Principle layout and coordinate system of the coplanar UWB antenna with slot and filter

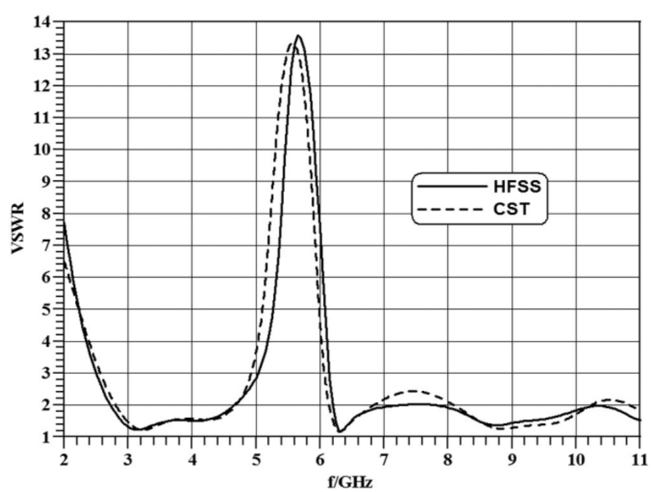

Figure 3 Comparison of VSWR results computed with CST Microwave Studio and Ansoft HFSS for the UWB antenna shown in Fig. 1. 233 × 175 mm^2 (96 × 96 DPI)

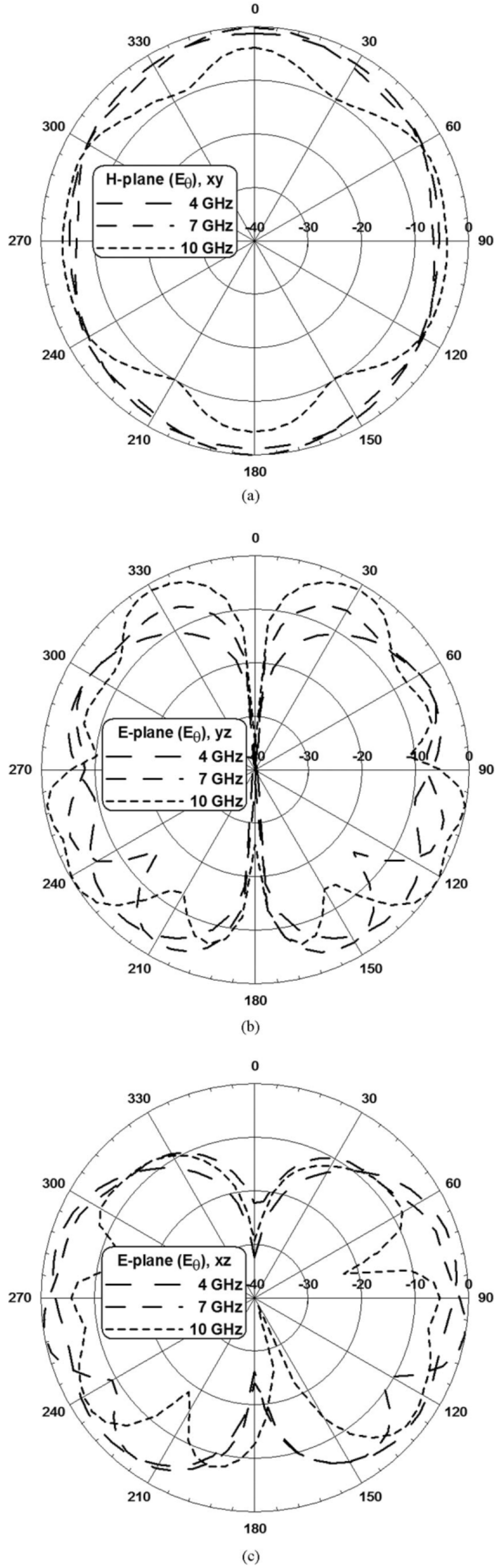

Figure 4 Vertical polarization radiation patterns of the antenna in Fig. 1 at 4, 7, and 10 GHz: (a) *H*-plane (*xy*) pattern. 201 × 198 mm^2 (96 × 96 DPI); (b) *E*-plane (*yz*) pattern. 201 × 198 mm^2 (96 × 96 DPI); (c) *E*-plane (*xz*) pattern. 201 × 198 mm^2 (96 × 96 DPI)

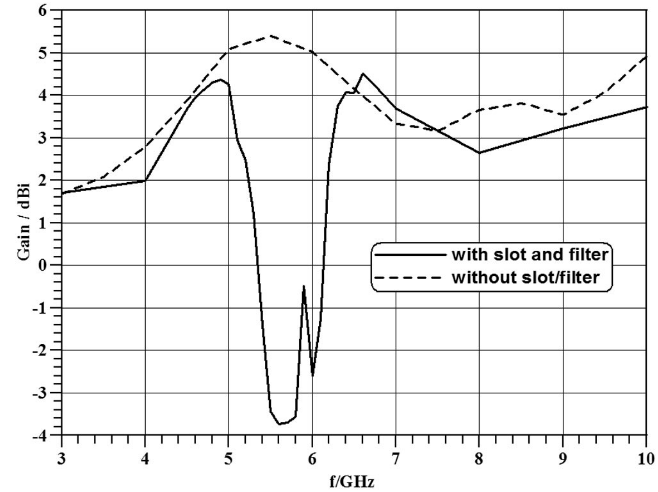

Figure 5 Gain of UWB antenna with and without slot and filter. 230 × 175 mm^2 (96 × 96 DPI)

REFERENCES

1. K. Kiminami, A. Hirata, and T. Shiozawa, Double-sided printed bow-tie antenna for UWB communications, IEEE Antennas Wireless Propagat Lett 3 (2004), 152–153.
2. S.H. Choi, J.K. Park, S.K. Kim, and J.Y. Park, A new ultra-wideband antenna for UWB applications, Microwave Opt Technol Lett 40 (2004), 399–401.
3. J. Liang, C.C. Chiau, X. Chen, and C.G. Parini, Study of a printed circular disc monopole antenna for UWB systems, IEEE Trans Antennas Propagat 53 (2005), 3500–3504.
4. Z.N. Low, J.H. Cheong, and C.L. Law, Low-cost PCB antenna for UWB applications, IEEE Antennas Wireless Propagat Lett 4 (2005), 237–239.
5. J. Liang, C.C. Chiau, X. Chen, and C.G. Parini, Printed circular ring monopole antennas, Microwave Opt Technol Lett 45 (2005), 372–375.
6. C.-C. Lin, Y.-C. Kan, L.-C. Kuo, and H.-R. Chuang, "A planar triangular monopole antenna for UWB communication," IEEE Microwave Wireless Comp Lett 15 (2005), 624–626.
7. H.R. Chuang, C.C. Lin, and Y.C. Kan, A printed UWB triangular monopole antenna, Microwave J 49 (2006), 108–120.
8. K. Rambabu, H.A. Thiart, J. Bornemann, and S.Y. Yu, Ultrawideband printed-circuit antenna, IEEE Trans Antennas Propag 54 (2006), 3908–3911.
9. W. Wang, S.S. Zhong, and S.-B. Chen, A novel wideband coplanar-fed monopole antenna, Microwave Opt Technol Lett 43 (2004), 50–52.
10. H.K. Lee, J.K. Park, and J.N. Lee, Design of a planar half-circle shaped UWB notch antenna, Microwave Opt Technol Lett 47 (2005), 9–11.
11. T.-G. Ma and C.-H. Tseng, An ultrawideband coplanar waveguide-fed tapered ring slot antenna, IEEE Trans Antennas Propag 54 (2006), 1105–1110.
12. E.S. Angelopoulos, A.Z. Anastopoulos, and D.I. Kaklamani, Ultra-wideband bow-tie slot antenna fed by a cpw-to-cpw transition loaded with inductively coupled slots, Microwave Opt Technol Lett 48 (2006), 1816–1820.
13. X.-L. Liang, S.-S. Zhong, and W. Wang, UWB printed circular monopole antenna, Microwave Opt Technol Lett 48 (2006), 1532–1534.
14. J.-S. Sun, Y.-C. Lee, and S.-C. Lin, New design of a CPW-fed ultrawideband slot antenna, Microwave Opt Technol Lett 49 (2007), 561–564.
15. D.-B. Lin, I.-T. Tang, and M.-Y. Tsou, A compact UWB antenna with CPW-feed, Microwave Opt Technol Lett 49 (2007), 564–567.
16. H.-J. Lam and J. Bornemann, Ultra-wideband printed-circuit antenna in coplanar technology, In Proceedings of IEEE EMC-S International Symposium Digest, Honolulu, USA, July 2007, TU-PM-1–7, pp. 1–4.

17. A.M. Abbosh, Design of UWB planar antenna with subband rejection capability, Microwave Opt Technol Lett 49 (2007), 2855–2859.
18. S.J. Kim, H.S. Lee, and Y.S. Kim, A CPW-Fed staircase monopole UWB antenna with band-notched frequency in the WLAN band, Microwave Opt Technol Lett 49 (2007), 2545–2547.
19. J.N. Lee and J.K. Park, Impedance characteristics of trapezoidal ultra-wideband antennas with notch function, Microwave Opt Technol Lett 46 (2005), 503–506.
20. W. Choi, J. Jung, K. Chung, and J. Choi, Compact microstrip-FED antenna with band-stop characteristic for ultra-wideband applications, Microwave Opt Technol Lett 47 (2005), 89–92.
21. X.-R. Yan, S.-S. Zhong, and G.-Y. Wang, The band-notch function for a compact coplanar waveguide fed super-wideband printed monopole, Microwave Opt Technol Lett 49 (2007), 2769–2771.
22. K. Rambabu, M.Y.W. Chia, K.M. Chan, and J. Bornemann, Design of multiple stopband filters for interference suppression in UWB applications, IEEE Trans Microwave Theory Tech 54 (2006), 3333–3338.
23. A. Takacs, H. Aubert, P. Pons, T. Parra, R. Plana, and J. Graffeuil, Miniature coplanar bandstop filter for Ka-band applications based on original resonant coupling irises topology, IEE Electronics Lett 40 (2004), 1274–1275.

HIGH GAIN CAVITY-BACKED SLOT ANTENNA WITH A WINDOWED METALLIC SUPERSTRATE

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ABSTRACT: *A novel technique for gain enhancement of cavity-backed slot antenna is developed and discussed. The high gain radiation of the proposed antenna is achieved by a windowed metallic superstrate above the slot. The parametric studies of the proposed structure are provided, the radiation mechanism of the proposed antenna is investigated, and then the design guidelines for this type of radiators are described. The prototype is fabricated and found to have an impedance bandwidth of 12% and a gain of 12.3 dBi at the center frequency of 2.4 GHz. The characteristics of the proposed antenna have been validated by CST simulation software and experiments.* © 2008 Wiley Periodicals, Inc. Microwave Opt Technol Lett 50: 3114–3118, 2008; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.23880

Key words: *antenna; microstrip antenna; cavity backed antenna; slot antenna; gain enhancement*

1. INTRODUCTION

Cavity-backed Microstrip-fed slot (CBS) antennas have been extensively studied in the past few decades because of their attractive features such as unidirectional radiation, conformability to planar or nonplanar surfaces, and more importantly, compared to microstrip patch antennas, they have the advantages of wider bandwidth, less interaction via surface waves, and less mutual coupling effect, which makes them promising candidates used in phased arrays, spacecraft, and wireless communication systems [1–4]. Recently, a microstrip slot antenna with a super-low cavity was proposed to reduce the height of the cavity greatly [5]. But the gain of the antenna may be not high enough for some applications; thus in [6], a dielectric superstrate was placed above the CBS and a gain up to 7.0 dB at the frequency 5.75 GHz has been achieved.

In this article, a novel technique for gain enhancement of CBS antenna is developed and discussed. The key component that enhances the radiation gain of the antenna is a windowed metallic superstrate above the slot. With the help of simulation software CST, the radiation mechanism of the proposed antenna is investigated and parametric studies of the proposed structure are done for better understanding to the antenna, and then, the design guidelines for this type of antennas are given. With those guidelines, a real antenna working at the center frequency of 2.4 GHz is built and measured. The simulated and measured results show that the center frequency gain of the proposed antenna achieved is 12.3 dBi, which is about 4 dB higher than that of traditional CBS without such a superstrate. As the antenna has a low profile and a high gain, it would be attractive for 2.4 GHz WLAN or other ISM applications.

2. ANTENNA GEOMETRY

A photograph of the proposed antenna is shown in Figure 1 and its configuration is illustrated in Figure 2. The antenna is built on a substrate with relative permittivity of $\varepsilon_r = 2.55$ and thickness of 0.8 mm and size of 150 mm × 170 mm. As shown in Figure 2, from the bottom to top, the components of this antenna are as follows: a rectangular metallic cavity, a slot etched on the bottom side of the substrate, a feeding line on the top side of the substrate connected to the feeding probe of a 50 Ω SMA launcher, and a metallic superstrate with a rectangular window. Except the feed line, all the structures are symmetric with respect to the slot. In this design, the rectangular cavity has a length of $Ca = 130$ mm, a width of $Cb = 84$ mm, and depth of $H1 = 2$ mm, respectively. The width and length of the slot are $W = 2$ mm and $L = 118$ mm, respectively. A 50-Ω microstrip feed line with a width of 2.2 mm locates across the center of the slot, and its end to the slot is $\lambda_g/4$, where λ_g is the guided wavelength at the center frequency, thus the slot can be seen as short fed. The distance from the windowed copper cover to the top side of the substrate is $H2 = 4.6$ mm. The width of the superstrate is $a = 150$ mm, which is the same as the width of the substrate, the length is $b = 146$ mm, and thickness is

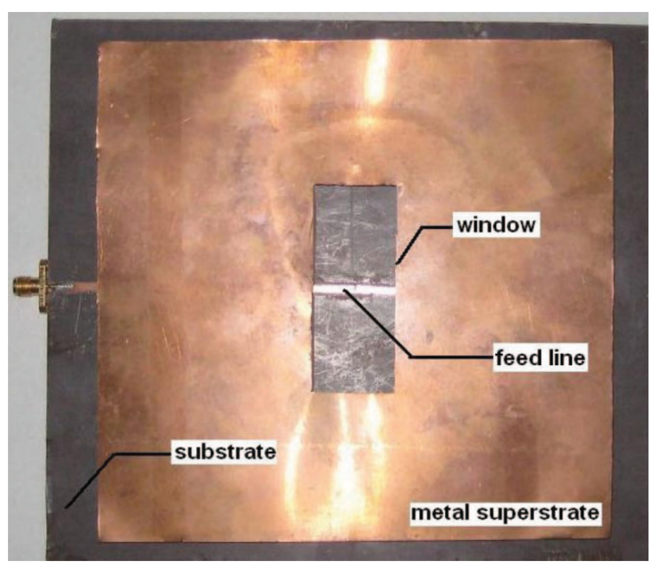

Figure 1 Top view photograph of the proposed antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]