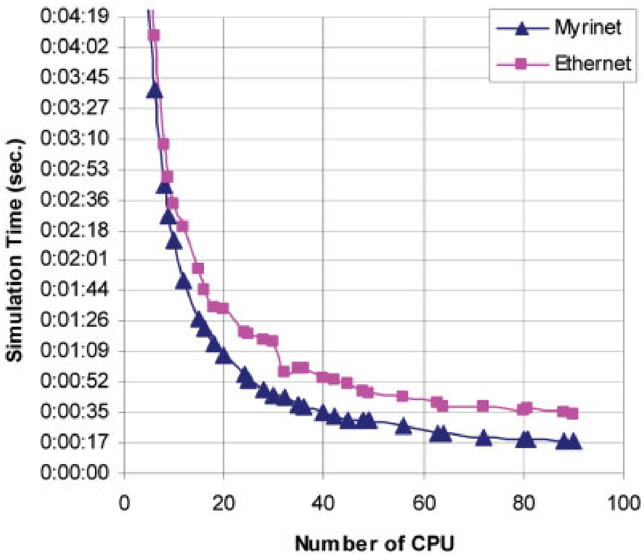

Figure 5 Comparison of simulation time of the BOR-FDTD code for 1000 time steps on the Beowulf cluster using the Ethernet and Myrinet networking systems. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

using is installed with the single-port Myrinet cards. It may be another reason why we can see the efficiency decreases when both processors on a node are involved in the simulation.

As the number of processors increases in the simulation, the simulation time for each step decreases and each processor will communicate with its neighbors, hence, a heavier burden will be pushed on the networking system. Although the data passing amount decreases when the number of processors is large, each processor will establish the communication with its neighbors frequently; therefore, networking system will become a bottleneck of simulation for both the Myrinet and Ethernet, and consequently, the efficiency of the parallel processing will decrease dramatically. Though we did not present the efficiency of a parallel 3-D FDTD code in this communication, the efficiency of a parallel 3-D FDTD code is 30% lower than the BOR-FDTD due to heavier data passing and more delay in the 3-D case.

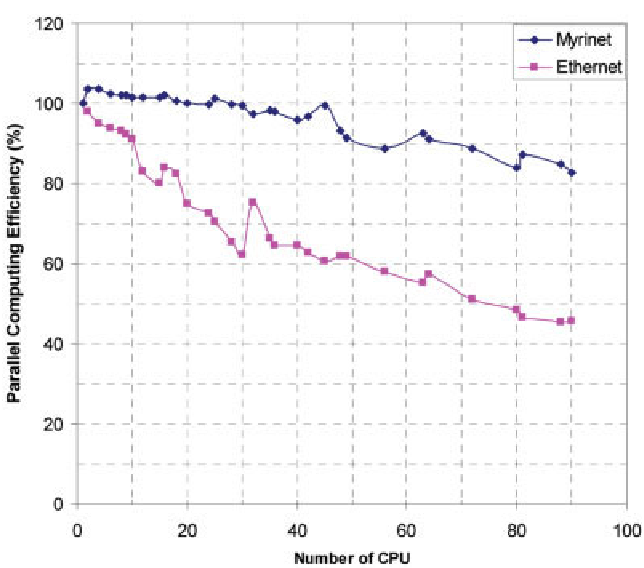

Figure 6 Efficiency comparison of the BOR-FDTD code using the Ethernet and Myrinet. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

5. CONCLUSIONS

In this communication, we have investigated the efficiency of the BOR-FDTD code on a PC cluster using two typical networking systems. Numerical experiments have demonstrated that the efficiency of a parallel code strongly depends not only the method and code structure but also on the type of networking system. A reflector antenna is used to verify the parallel code we developed.

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SMALL BROADBAND DISK-LOADED MONOPOLE ANTENNA WITH A VERTICAL GROUND PLANE

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ABSTRACT: *A small broadband monopole antenna with a vertical ground plane and an electromagnetically coupled feed is presented in this paper. The antenna was formed by positioning a probe with a folded stripline under a shorted square disk. A resonance of the shorted square disk was coupled to a resonance of the probe with a folded stripline, so that the antenna had a wide bandwidth of about 37% at the center frequency of 2.313 GHz based on a VSWR ≤ 2. The antenna had dimensions of 11 mm × 11 mm × 11 mm and rectangular slits were inserted into the vertical ground plane to improve distortion of the radiation pattern.* © 2007 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 1401–1405, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22422

Key words: *small antenna; broadband antenna; disk-loaded monopole antenna; electromagnetically coupled feed*

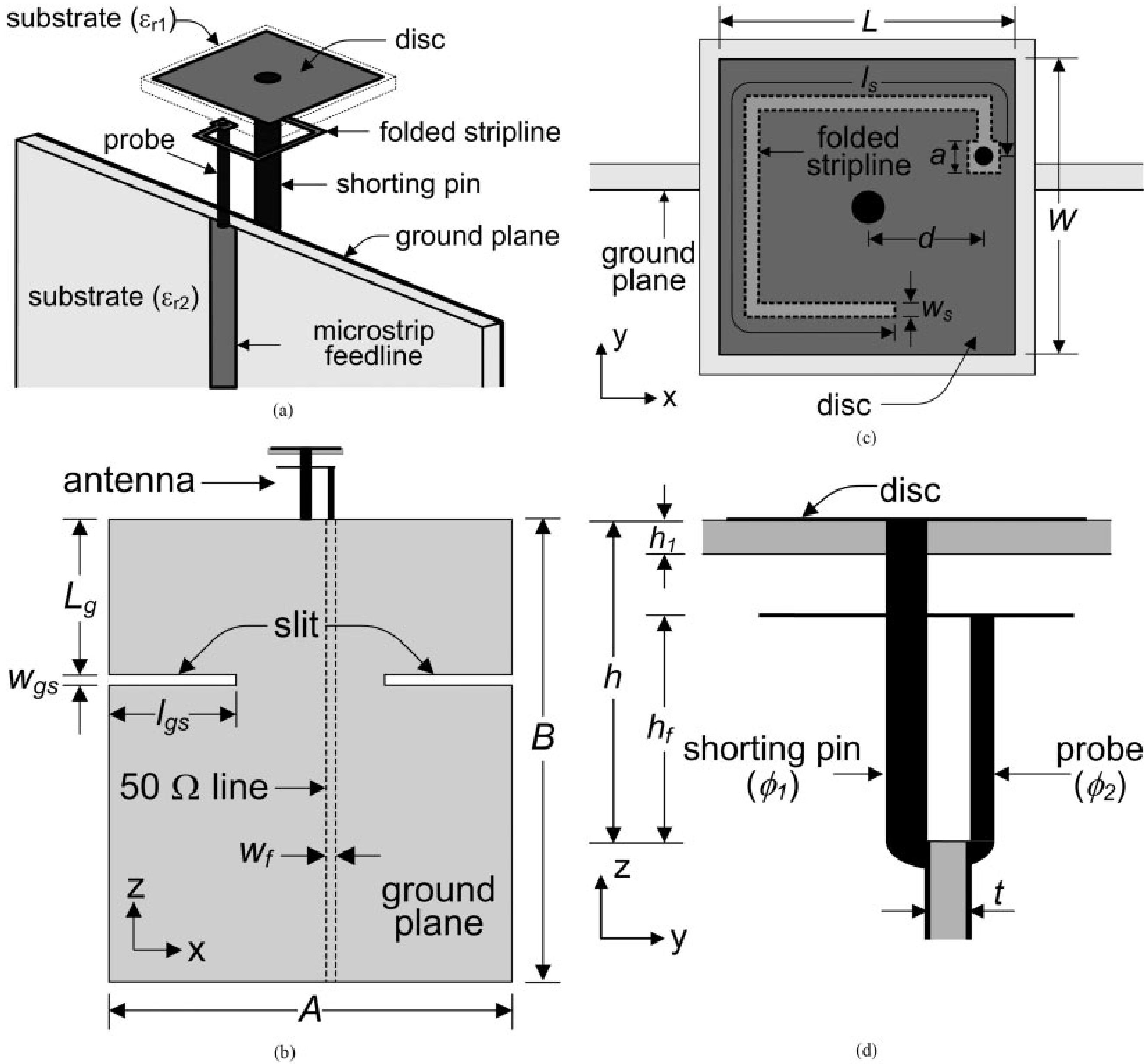

Figure 1 Proposed antenna structure: (a) perspective view, (b) front view, (c) top view, (d) side view

1. INTRODUCTION

With the recent development of various kinds of broadband wireless communication services, small and broadband antennas have become necessary for the handheld transceiver units capable of operating on wideband communications [1, 2]. The most widely used antennas for handheld transceiver units are planar inverted-F antennas [3, 4] and monopole antennas [5, 6]. A planar inverted-F antenna can be made in a compact form, but has a narrow bandwidth and a broadside radiation pattern that may introduce directional sensitivities for signal reception. A monopole antenna, on the other hand, has an omnidirectional radiation pattern that is suitable for receiving signal from any direction. However, the length of the conventional monopole antenna makes it too long for internal use. Folding and meandering schemes are commonly used techniques for making monopole antennas more compact, so that they can be used as an internal antenna in handheld transceiver units. However, as the physical size of the antenna decreases with these methods, the bandwidth of the antenna becomes narrower.

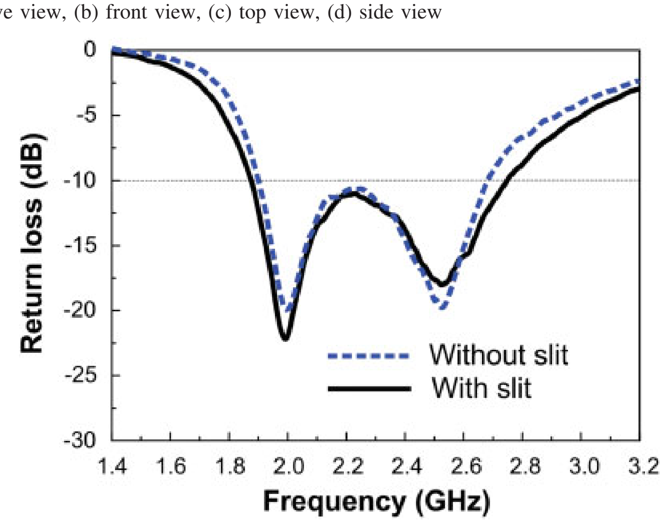

Figure 2 Measured return loss of the antenna with and without slits on the vertical ground plane. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

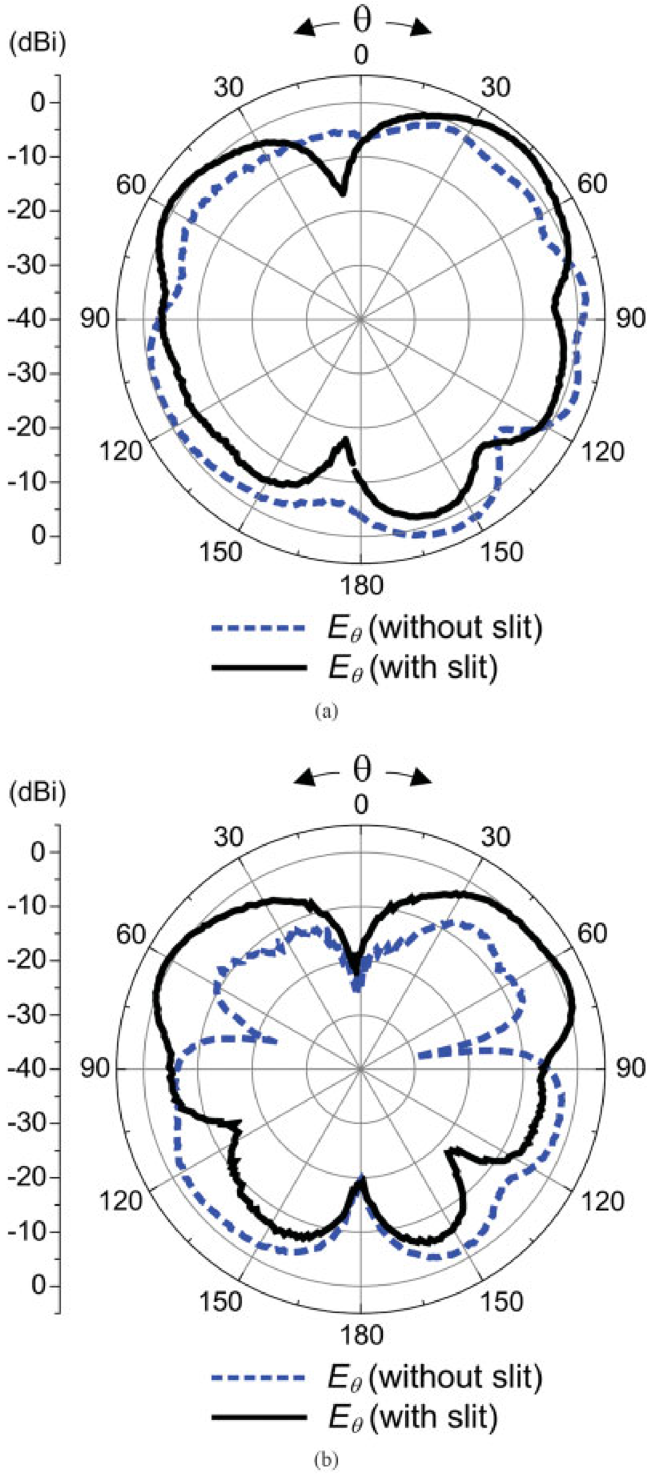

Figure 3 Measured radiation patterns of the antenna with and without slits on the vertical ground plane at 2.0 GHz: (a) *x–z* cut and (b) *y–z* cut. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

Thus, folded and meandered monopole antennas are unsuitable for a wideband communication and are used for dual- and triple-band antennas by connecting these monopoles that have different resonance lengths.

Recently, it was shown that the bandwidth of the small monopole antenna can be improved by introducing a mutual coupling between two radiators located in close proximity [7]. In this article, a small electromagnetically coupled broadband monopole antenna in a vertical ground plane was designed by using this technique. Measurements show that the antenna with dimensions of 11 mm × 11 mm × 11 mm had 870 MHz of the impedance bandwidth for VSWR < 2 with the center frequency of 2.313 GHz, which is ~37% of the fractional bandwidth. Rectangular slits were inserted in the vertical ground plane to improve the radiation pattern.

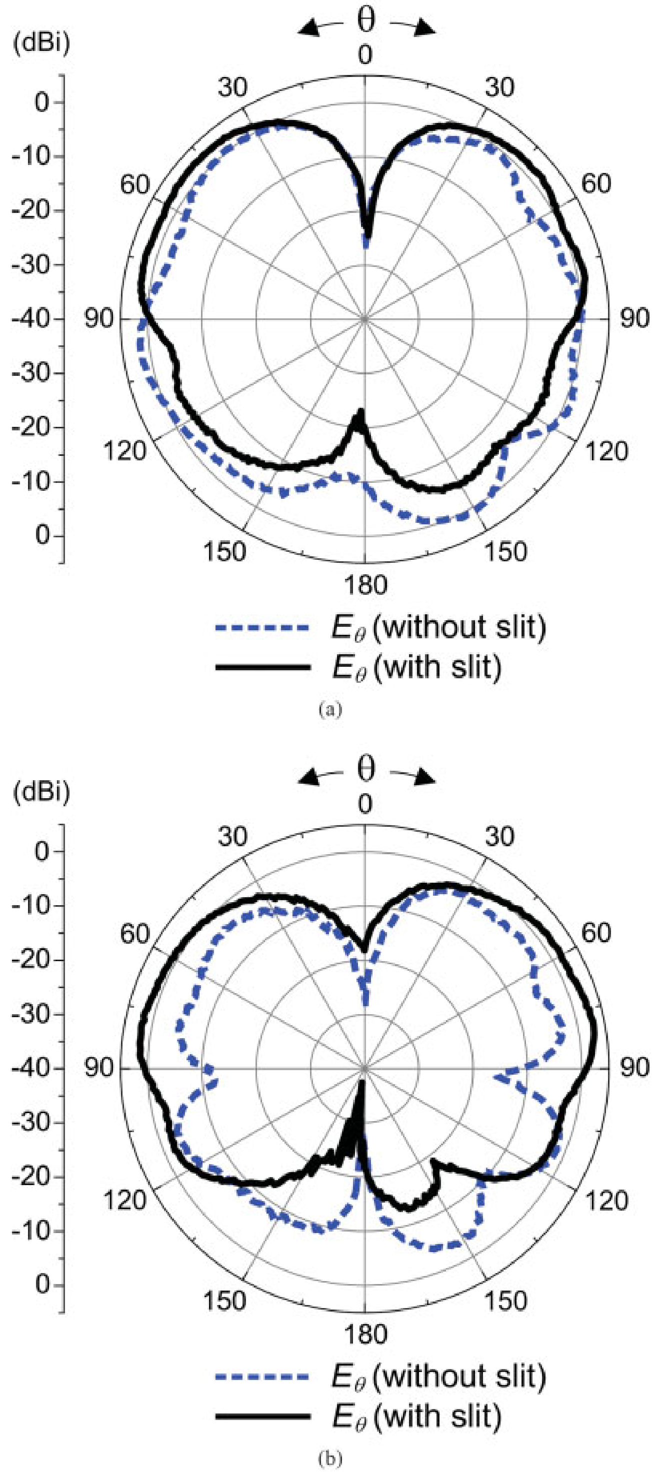

Figure 4 Measured radiation patterns of the antenna with and without slits on the vertical ground plane at 2.3 GHz: (a) *x–z* cut and (b) *y–z* cut. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

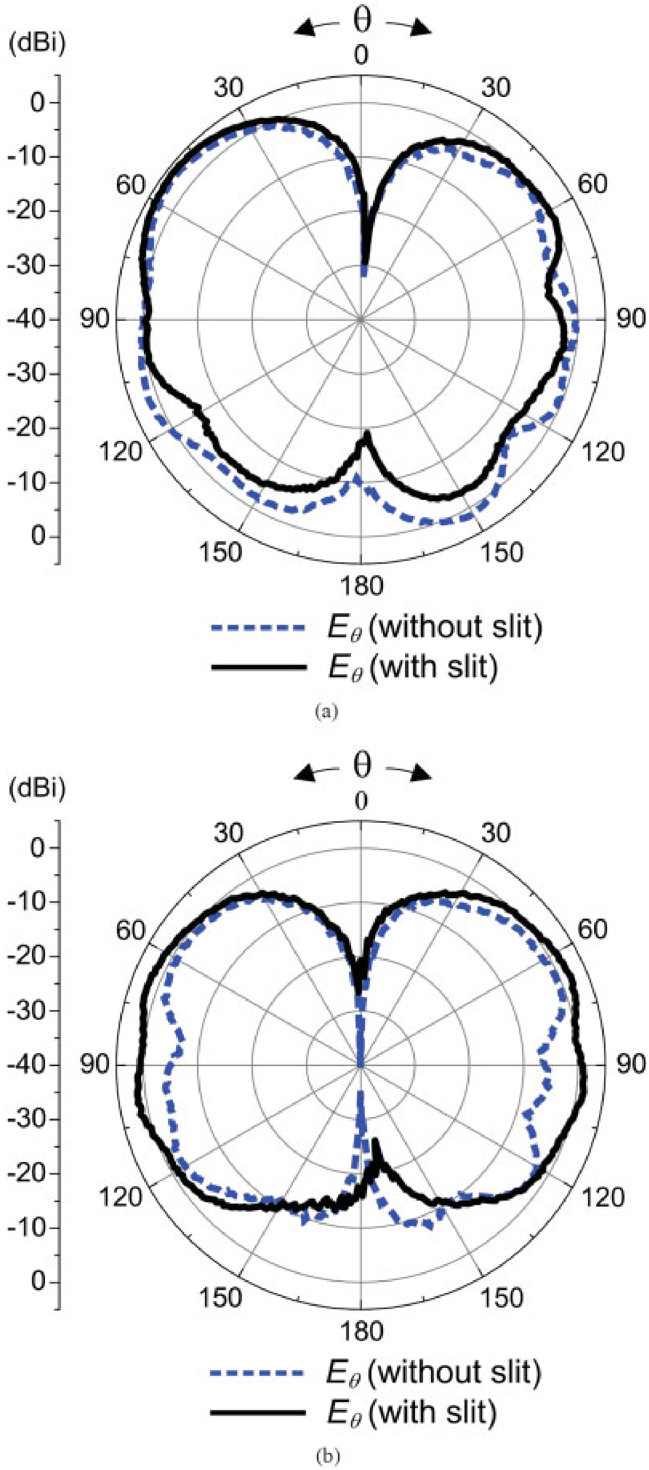

Figure 5 Measured radiation patterns of the antenna with and without slits on the vertical ground plane at 2.6 GHz: (a) *x–z* cut and (b) *y–z* cut. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

Measurements showed that the radiation in the direction of the ground plane is reduced significantly when slits are introduced into the vertical ground plane.

2. ANTENNA STRUCTURE AND CHARACTERISTICS

Figure 1 shows the structure of the proposed antenna. A rectangular disk of length $L = 11$ mm and width $W = 11$ mm was placed at a height $h = 11$ mm from the top edge of the vertical ground plane. The rectangular disk was connected to the vertical ground plane with a shorting pin of diameter $\phi_1 = 1.6$ mm The antenna was excited with a 50-Ω microstrip feedline of width $w_f = 1.2$ mm through a probe pin with a diameter of $f_2 = 0.86$ mm, which was in turn connected at the end of the folded stripline located at a height of $h_f = 8.5$ mm from the top edge of the ground plane. The length and width of the folded stripline were $l_s = 21.9$ mm and $w_s = 0.3$ mm, respectively. A small square patch with size $a = 1.4$ mm was formed at the end of the folded stripline to connect with the probe pin. The shorting and probe pins were spaced $d = 4.8$ mm apart. The rectangular disk was placed on a substrate with a dielectric constant of $\varepsilon_{r1} = 10.2$ and a thickness of $h_1 = 1.27$ mm (RT Duroid 6010). The size of the substrate was 13 mm ×13 mm. The substrate for the ground plane had a dielectric constant of $\varepsilon_{r2} = 3.38$ and a thickness of $t = 0.81$ mm (RO 4003). The size of the ground plane was chosen to be $A = 80$ mm and $B = 90$ mm. The length and width of the slit were $l_{gs} = 25.5$ mm and $w_{gs} = 2.5$ mm, respectively. Slits were symmetrically positioned with respect to the *z*-axis, and located $L_g = 30$ mm below the top edge of the vertical ground plane.

Figure 2 shows the measured return loss of the antenna with and without slits on the vertical ground plane, which was measured using an HP 8510C network analyzer. The measured bandwidths of the antenna with and without slits were from 1.90 to 2.682 GHz and from 1.878 to 2.748 GHz, respectively. As the figure shows, the return loss value did not change appreciably in the presence of the slits on the vertical ground plane.

Figures 3–5 show the measured radiation patterns for three different frequencies within the bandwidth of the antenna. The solid line denotes the measured results for slits on the vertical ground plane and the dotted line shows the measured results for no slits. The radiation pattern in the *xz*-plane did not vary significantly with frequency. However, the radiation pattern in the *yz*-plane did change significantly for the antenna without slits on the vertical ground plane. Especially, at 2.0 GHz, the radiation was very high in the direction of vertical ground plane. The radiation pattern in the *yz*-plane was distorted by a return current that formed on the vertical ground plane. To remedy this problem, narrow slits are added to the vertical ground plane so that the return current was concentrated on the ground plane above them. As shown in the figures, the addition of slits greatly improved the characteristics of the radiation pattern. The measured gain of the antenna in the direction of maximum radiation was about 2.6 dBi within the bandwidth.

3. CONCLUSION

A small electromagnetically coupled broadband disk-loaded monopole antenna in a vertical ground plane has been presented. It has a very small size, a broad bandwidth, and a relatively high gain. The effects of the vertical ground plane on the radiation pattern were studied, showing that the addition of slits on the vertical ground plane greatly improves the radiation characteristics of the antenna.

ACKNOWLEDGMENT

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A WIDEBAND CIRCULARLY POLARIZED 2 × 2 SEQUENTIALLY ROTATED PATCH ANTENNA ARRAY

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ABSTRACT: *A wideband circularly polarized 2 × 2 sequentially rotated patch antenna array is presented. This array applies the wideband circularly polarized elements to the sequential rotated feeding to realize wide bandwidth by a simple structure. A measured −10-dB return loss bandwidth of 102% and an AR < 3-dB bandwidth of 43.7% are obtained.* © 2007 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 1405–1407, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22409

Key words: *circularly polarized antenna; antenna array; sequentially rotated*

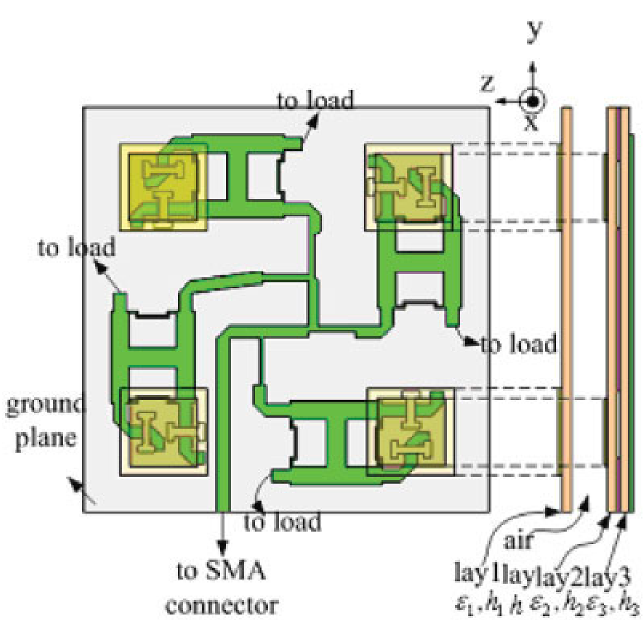

Figure 1 Geometry configuration of the proposed antenna array [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

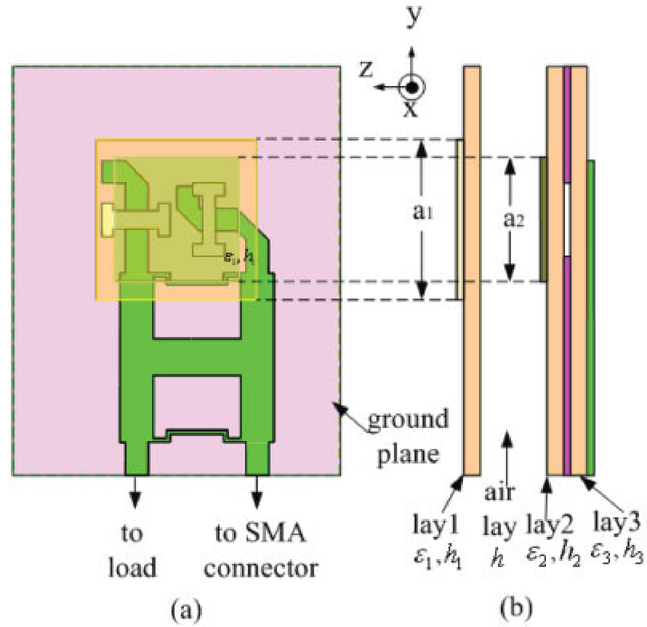

Figure 2 Geometry configuration of the wideband radiating element [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

1. INTRODUCTION

Circularly polarized (CP) microstrip antennas are widely used in a number of radar, navigation, satellite, and mobile systems because they can combine the good characteristics of microstrip antennas and CP waves, such as light weight, low profile, simple structure, ease of construction, the ability to reject multipath reflections, and rain interference. One drawback of the CP microstrip antennas is their limited bandwidth. Sequential rotation feeding technology has been shown to increase both the impedance and the circular polarization bandwidths [1–8]. However, previous applications of sequential rotation have been focused on narrow band radiating

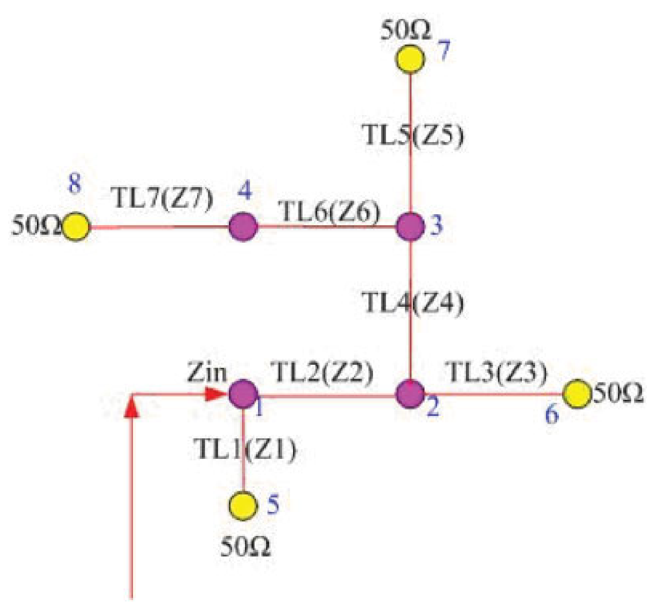

Figure 3 Equivalent circuit of the serial feeding network [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]