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**Topics:** Microstrip antenna, Patch antenna, Coaxial antenna, Turnstile antenna and Monopole antenna

# A NEW COMPACT DUAL-BAND DUAL-POLARIZED MICROSTRIP ANTENNA

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**ABSTRACT:** *A new compact dual-band, dual-polarized microstrip antenna is presented. This antenna resonates at two frequencies with different polarizations: a linearly polarized one for terrestrial communication, and a circularly polarized one for satellite mobile communication. This antenna also provides an area reduction of 70% compared to a standard rectangular patch antenna.* © 2001 John Wiley & Sons, Inc. Microwave Opt Technol Lett 29: 315–317, 2001.

**Key words:** *circular polarization; compact; microstrip antenna*

## 1. INTRODUCTION

In mobile communication systems, circularly polarized antennas find application due to the flexibility in the orientation angle of the transmitter and receiver as they do not need polarization tracking. Multiband, multimode handsets or data transmissions capable of communicating with terrestrial and satellite networks find wide applications in the fast-developing world of mobile communications. A dual-band, dual-polarized antenna capable of receiving both linearly and circularly polarized waves can be used for this purpose. Relatively very few designs are available in the open literature for achieving the above requirement. A rectangular slotted antenna with the above-mentioned characteristics using shorting pins and an integrated capacitor is presented in [1]. A compact drum-shaped antenna with similar radiation characteristics as a rectangular patch antenna is proposed in [2, 3]. In this letter, we present a new compact microstrip antenna having a greater area reduction compared to the antennas proposed above. This arrow-shaped antenna is capable of operating with circular polarization at one frequency and linear polarization at another frequency with a single feed. By trimming a single antenna parameter, this antenna can be made to operate at two orthogonally polarized frequencies or at a single frequency band with circular polarization.

## 2. ANTENNA DESIGN

Figure 1 shows the geometry of the proposed microstrip antenna. This structure consists of an arrow-shaped patch etched on a substrate of thickness $h$ and dielectric constant $\varepsilon_r$. $L$ denotes the length, $W$ the width, $W_{cd}$ is the width of the intruding triangle, $W_{cp}$ is that of the protruding triangle. The antenna is excited by an electromagnetic coupling using a microstrip feedline of length $L_p$ at $F_p$ as shown in Figure 1.

A typical proposed antenna is implemented and investigated. It has dimensions $L = 0.06$ m, $W = 0.04$ m, $W_{cp} = 0.01$ m, $W_{cd} = 0.04$ m, and is fabricated on a substrate of $\varepsilon_r = 4.5$ and $h = 1.6$ mm. A good impedance matching of the two operating frequencies can be obtained by using a microstrip feedline of length $L_p = 0.07$ m and width $W_p = 0.003$ m etched on a substrate of the same thickness and permittivity, and kept below the antenna to provide electromagnetic coupling.

## 3. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 2 shows the measured return loss frequency of the antenna. The antenna is found to be resonating at two frequencies: 1.0336 and 1.394 GHz. An $S_{21}$ measurement with a rotating linearly polarized antenna showed that the radiation at 1.0336 GHz is circularly polarized, and that at 1.394 GHz is linearly polarized. Figures 3 and 4 show the $E$-plane and $H$-plane radiation patterns at the first and second resonant frequencies, respectively. The variation of axial ratio with frequency is shown in Figure 5. The 3 dB axial ratio bandwidth of the antenna is nearly 1%.

The resonant frequencies and the polarization can be changed by varying the values of $W_{cd}$ and $W_{cp}$. Keeping $W_{cp}$ constant and varying $W_{cd}$, two orthogonally polarized frequencies with different frequency ratios are achieved. For a particular value of $W_{cd}$, linearly polarized and circularly polarized bands are simultaneously obtained. Hence, linear or circular polarization can be easily achieved by simply trimming the width $W_{cd}$. The variation of dual frequencies and its polarization with $W_{cd}$ are presented in Table 1. From the experimental observations, it is found that these properties are achieved with a size reduction of $\sim 70\%$ compared to a conventional rectangular patch antenna.

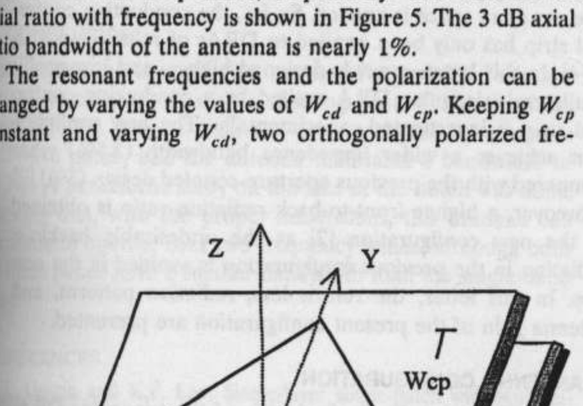


**Figure 1** Geometry of the new compact microstrip antenna

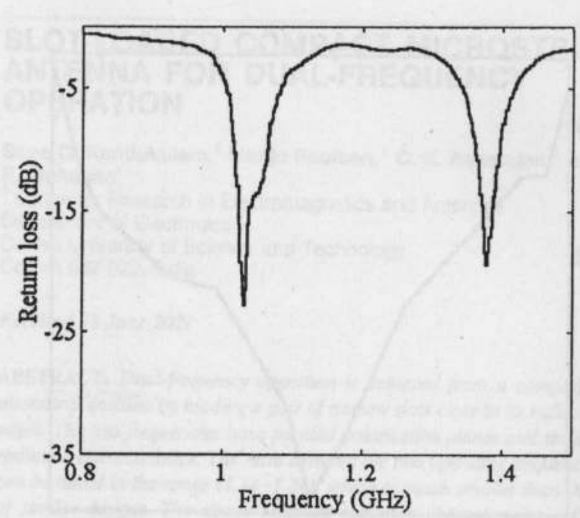


**Figure 2** Variation of return loss with frequency

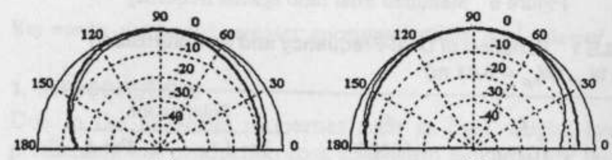


**Figure 3** Radiation patterns of the circularly polarized band (1.0336 GHz). (a) $H$-plane patterns. (b) $E$-plane patterns. —— coplanar, —— cross polar

## 4. CONCLUSIONS

This novel antenna is capable of satisfying the requirements of a data communicator for specific terrestrial and satellite mobile systems. This antenna can also be reconfigured to generate two orthogonally polarized resonant frequencies or a single circularly polarized radiation. Moreover, this antenna has a size reduction of $\sim 70\%$ for the dual-polarized, dual-frequency operation compared to a standard rectangular patch.

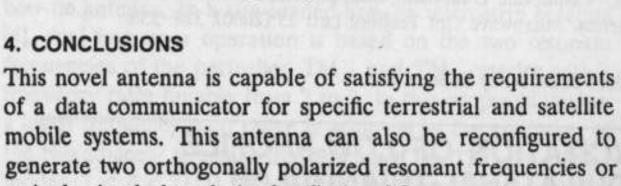


**Figure 4** Radiation patterns of the linearly polarized band (1.394 GHz). (a) $H$-plane patterns. (b) $E$-plane patterns. —— coplanar, – – cross polar

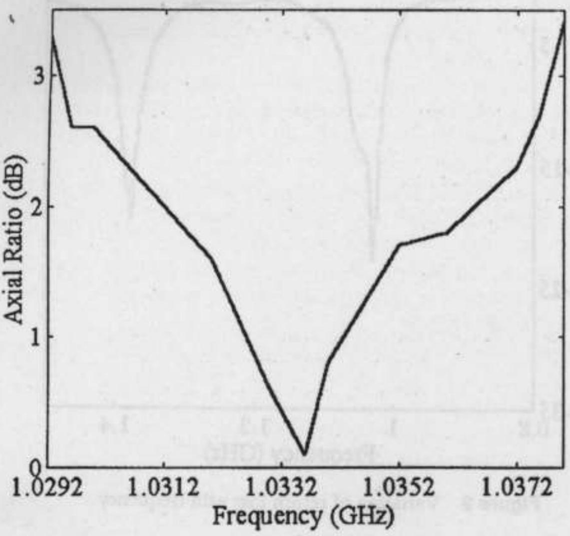


**Figure 5** Measured axial ratio against frequency

**TABLE 1 Variation of Dual-Frequency and Its Polarization with $W_{cd}$ ($W_{cp} = 0.01$ m)**

| $W_{cd}$ (m) | $f_1$ (GHz) | $f_2$ (GHz) | Polarization For $f_1$ | Polarization For $f_2$ |
|---|---|---|---|---|
| 0.02 | 1.3 | 1.535 | Linear | Linear |
| 0.03 | 1.302 | 1.373 | Linear | Linear |
| 0.035 | 1.34 | — | Circular | — |
| 0.04 | 1.0336 | 1.383 | Circular | Linear |
| 0.05 | 0.954 | 1.405 | Linear | Linear |

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