Experimental Study of Large Bandwidth Three-Offset Microstripline-Fed Slot Antenna

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***Abstract*—The proposed novel three-offset shaped microstripline-fed slot antenna has a radiation pattern similar to the conventional microstrip slot antenna and the advantage of more bandwidth. The measured bandwidth is approximately 1.796 octave (VSWR $\leq$ 2.0). Experimental results for the impedance loci and the radiation patterns are also presented.**

***Index Terms*—Bandwidth, feed line, microstrip antenna, offsets, slot antenna.**

I. Introduction

MICROSTRIP antennas offer the advantages of thin profile, light weight, low cost, and conformability to a shaped surface and compatibility with integrated circuitry. The slot antenna has been investigated since at least the 1940s [1], and is treated in many electromagnetic textbooks [2], but the major drawback of microstrip antenna in its basic form is its inherently narrow bandwidth. The narrow bandwidth of these antenna is a major obstacle that restricts wider applications. In general, transverse or slanted slots are cut in the ground plane of a microstrip line and present series impedance to the feed line. Y. Yoshimura [3], D. M. Pozar [4], and Sarrio *et al.* [5] demonstrated simple techniques of narrow band (a few percent of the bandwidth [5], [6]) matching of the slot radiator. In order to overcome this difficulty, Y. Yoshimura shifted the feed point from the center of the slot and short-circuited the feed microstrip through the dielectric substrate with the slot side, which is located further from the feed input. A similar technique of feed-point shifting close to the slot end was used by D. M. Pozar. In both cases, the offset of the feed point leads to perfect impedance matching in a narrow frequency band. Therefore, a number of techniques for widening the microstrip antenna bandwidth have been proposed. Bandwidths of 47% for b-directional slot and 24% in the case of the cavity-backed radiator were observed [7]. Recently, microstripline-fed slot antennas with 60–70% bandwidth have been investigated [8], [9].

In this letter, we present the characteristics of the three-offset microstripline-fed single-layer single-slot antenna. Measured 2 : 1 VSWR bandwidth is 1.796 octave, which is considerably larger than previously achievable [3]–[9]. The three-offsets and other design parameters of the antenna lead to the impedance matching in a wide frequency band. This single-layer, single-slot microstrip antenna retains the thin profile characteristic. As will be seen, it is easily implemented at microwave frequencies and exhibits extremely broadband performance.

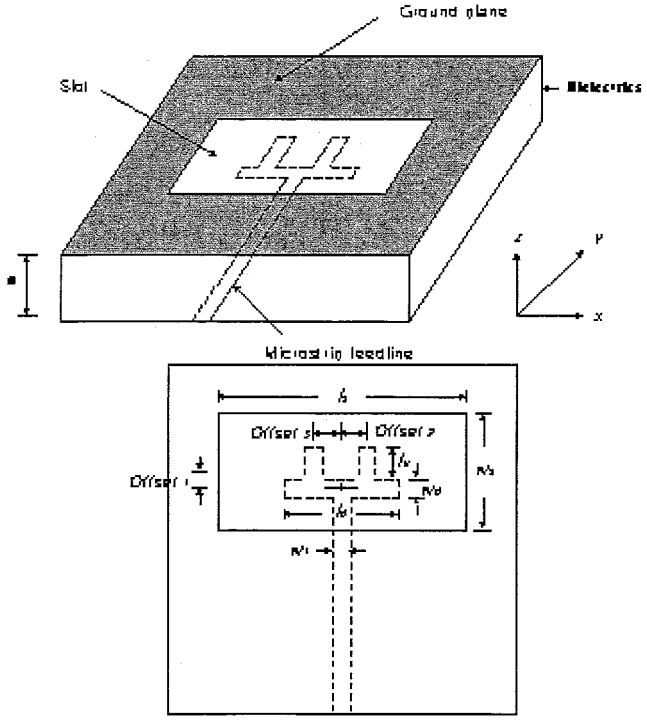

Fig. 1. Structure and design parameters of antenna.

II. Antenna Structure and Experimental Results

Design parameters of the antenna are shown in Fig. 1. The slot length and width are l_s and W_s. The x-directed feedline section has length l_d, and l_u is the length of y-directed stubs. The location of these stubs relative to the center of the slot is specified by $offset_1$, $offset_2$, and $offset_3$, as shown in Fig. 1. The microstrip feedline width is W_f the width of line. When W_f is 4.796 mm at the center frequency 3.5 GHz, the guided wavelength $(1\lambda_g)$ is 62.524 mm. The fabricated antenna dimensions are $l_s = 50$ mm $(0.8\lambda_g)$, $W_s = 32$ mm $(0.51\lambda_g)$, $\varepsilon_r = 2.2$, $h = 1.578$ mm $(0.025\lambda_g)$, $W_f = 4.796$ mm $(0.077\lambda_g)$, $l_d = 23$ mm $(0.368\lambda_g)$, $l_u = 10$ mm $(0.16\lambda_g)$, $offset_1 = 9.0$ mm $(0.144\lambda_g)$, $offset_2 = 5.0$ mm $(0.08\lambda_g)$, $offset_3 = 3.0$ mm $(0.048\lambda_g)$. The characteristics of the antenna are sensitive to the antenna design parameters $(l_s, W_s, l_d, l_u, W_f)$, and depend highly on $offset_1$, $offset_2$, $offset_3$. The input impedance and the VSWR of the antenna is measured with an HP8510 network analyzer.

The measured VSWR result against frequency is shown in Fig. 2. The bandwidth is approximately 1.796 octave

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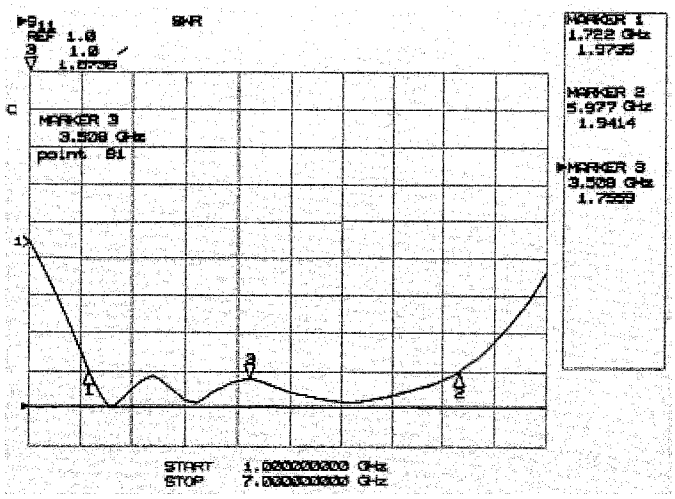

Fig. 2. Measured VSWR.

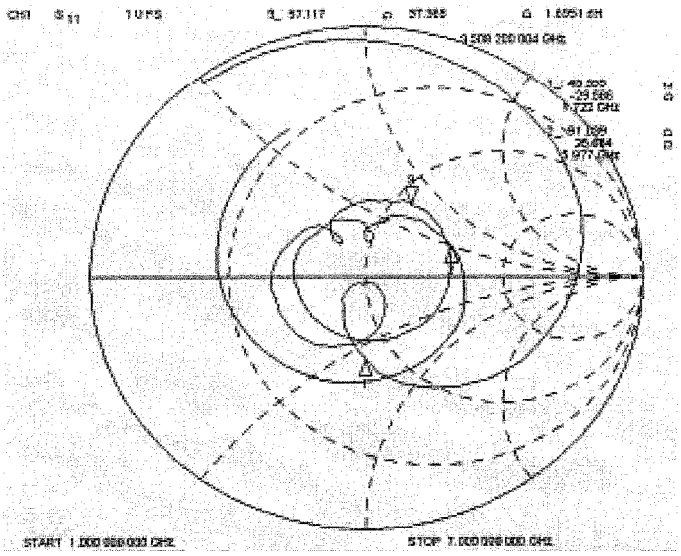

Fig. 3. Measured impedance locus.

(1.722–5.977 GHz) for a VSWR less than 2.0. In this case, we obtained the measured result, exhibiting three-resonances characteristic, which can be contrasted with that of slot antennas having a conventional microstripline-fed structure. This is also due to be the effect of the broad band of the antenna.

Fig. 3 shows the measured impedance loci exhibiting a multi-looped characteristic, which is to be contrasted with the conventional microstripline-fed structures having a single loop.

Fig. 4 presents the measured pattern in x–z plane at 3.5 GHz. After the calibration using a horn antenna, I have been measured the radiation pattern of the far field.

Fig. 5 shows the measured pattern in y–z plane radiation pattern at the same frequency. The pattern in the x–z and y–z plane is symmetrical with respect to zenith ($\theta = 0$). The half-power beam widths are 60° in the x–z plane and 68° in the x–z plane at 3.5 GHz.

III. Conclusion

In this letter, we studied a three-offset microstripline-fed printed slot antenna having large bandwidth. The characteristics of the antenna depended highly on the design parameters. This single-layer single-slot microstrip antenna retains the thin profile characteristic, and it is easily implemented at microwave frequencies and very broadband. The experimental bandwidth is 1.796 octave (1.722–5.977 GHz) for a VSWR less than 2.0. As this antenna has the characteristics of broad bandwidth, low profile, and lightweight, it may find applications in PCS, IMT-2000, mobile communications, satellite communication, and wide-band communication system.

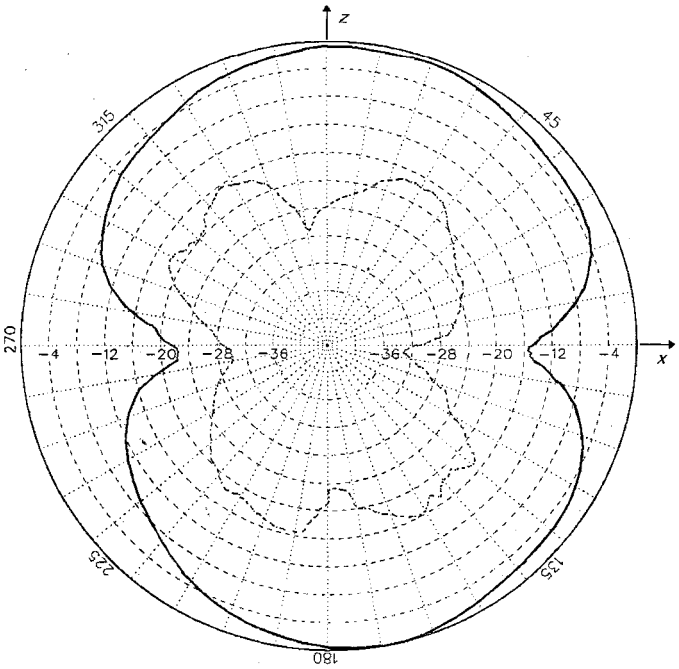

Fig. 4. Measured radiation pattern in x–z plane at $f = 3.5$ GHz, - -: Cross-Polarization, —: Co-polarization.

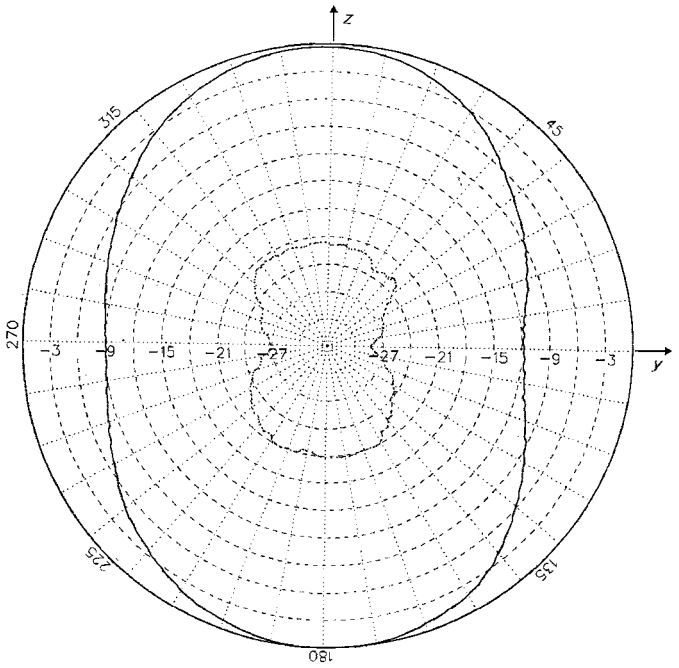

Fig. 5. Measured radiation pattern in y–z plane at $f = 3.5$ GHz, - -: cross-polarization, —: co-polarization.

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