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A NOVEL SHORT LENGTH HALF-WIDTH MICROSTRIP LEAKY WAVE ANTENNA WITH SUPPRESSED BACK LOBES

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ABSTRACT: *A novel short half-width microstrip leaky wave antenna (MLWA) with suppressed back lobes is introduced. The design contains an oblique shape termination and a linked square metal with a grounded via hole. The oblique shape termination changes the direction of the reflected wave, and a linked square metal with a grounded via hole guides the remainder power of the reflected wave to the ground plane. As a result, the large back lobe of the short half-width MLWA could be suppressed. The measured results show that the proposed design (length of only 1 λ_0) improves the back lobes by 9 dB at 4.7 GHz compared with the original half-width MLWA.* © 2009 Wiley Periodicals, Inc. Microwave Opt Technol Lett 51: 3024–3026, 2009; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.24805

Key words: *half-width; microstrip leaky wave antenna; reflected wave; back lobe*

1. INTRODUCTION

The microstrip leaky wave antennas (MLWA) was first constructed by Menzel in 1979 [1], using an asymmetric feed line to excite the first higher order mode (TE_{01} mode) and adding slits on the antenna to suppress the fundamental mode. The complex propagation constant of the leaky mode was discovered subsequently by Oliner and Lee [2]. The traveling wave in the MLWA would leak power because of a small attenuation constant. In practical applications of the MLWA, it has advantages of simple fabrication, low-profile, narrow beam, and frequency scanning capability. MLWA is suitable for scanning work in the future. The length of MLWA, numbers of wavelength (usually 5 λ_0), is always too long to be applied. A short length ($<5\ \lambda_0$) MLWA cannot leak the power efficiently, and the remainder power will reflect at the open structure end [3]. Consequently, the reflected wave produces a large back lobe in the opposite direction of main beam. Several researches were studied [4–6] to suppress the back lobe. By using an array topology [4] or a taper-loaded antenna end [5] has been developed. Creating a second-radiated path, a two-directional scanned MLWA with aperture-coupled patch antenna arrays has been investigated in Ref. 6.

Recently, one half of the width of the MLWA has been studied in Ref. 7, it's called the ''half-width'' MLWA. Based on the fact that the first higher order mode of the microstrip line is an odd mode, a phase reversal, or null, appears along the centerline of the antenna. The width of conventional MLWA could be reduced half by placing a shorting wall. The back lobe elimination work in the half-width MLWA has also been studied. In Ref. 8, the ''half-width'' MLWA was terminated with a resistive sheet to reduce the back reflection. However, all the methods mentioned earlier still require a long length (about 5 λ_0) of the half-width MLWA.

In this article, an alternative method with the length of 55 mm (about only 1 λ_0) is introduced to suppress the back lobes. By changing the topology of the termination of the half-width MLWA, we can suppress the back lobes successfully.

2. ANTENNA DESIGN

Based on the half-width MLWA, the configuration of the proposed short length half-width MLWA is shown in Figure 1(a) which contained the top and side views. The design contains an oblique-shape termination and a linked square metal with a grounded via hole. The proposed MLWA has the length of $L = 55$ mm (about 1 λ_0) and the width of $W = 7.5$ mm. The whole configuration is fabricated on a substrate of thickness $h = 1.6$ mm and dielectric constant $\varepsilon_r = 4.4$. The shorting wall of the half-width MLWA is realized by a row of grounded via holes. The details of the oblique shape termination and the linked square metal are shown in Figure 1(b), which is a magnified picture of the dash line area of Figure 1(a).

By using the oblique shape termination, the direction of the surface wave could be changed. Such that the reflected wave at the end would not travel straightly along the longitude edge of the proposed MLWA. The current distribution of the original half-width MLWA and the proposed MLWA with the oblique shape termination are shown in Figures 2(a) and 2(b), respectively. It's obvious that the current distribution has been

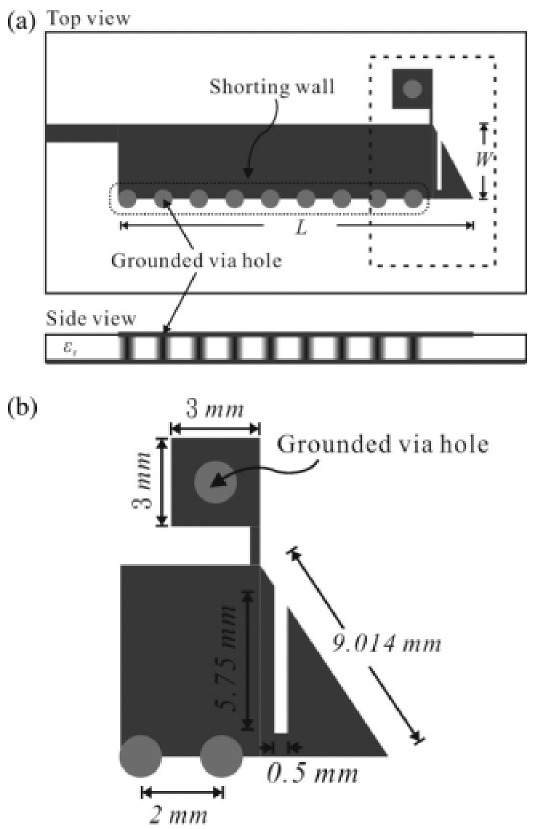

Figure 1 Structure of the proposed short length half-width MLWA

changed at the oblique shape termination of the proposed MLWA.

A square metal with a grounded via hole is linked beside the proposed MLWA, it is used to guide the remainder power to the ground plane. When the remainder power reflected at the oblique shape termination, the reflected wave would be guided to the ground through the linked metal without leakage. One slot at the oblique shape termination is added to ensure that the remainder power is guided to the ground.

By these manners, the reflected wave at the end would not travel straightly and could be guided to the ground plane without leaking to air. The back lobe of the proposed short length half-width MLWA would be suppressed successfully.

3. SIMULATED AND MEASURED ANALYSIS

The simulated radiation patterns of the proposed MLWA compared with the original half-width MLWA at 4.6 and 4.7 GHz are shown in Figures 3(a) and 3(b). The original half-width MLWA has the same shorting wall and length as the proposed MLWA. It's obvious that the back lobes have been suppressed successfully in simulated results, and the measured results of radiation patterns at 4.6 and 4.7 GHz are shown in Figures 4(a) and 4(b), respectively. The gain of the main beam is 13.1 dB higher than the back lobe at 4.6 GHz and 7.2 dB at 4.7 GHz.

It is noticeable to speak of the scanning angle of the main beams about the proposed MLWA and original half-width MLWA. In simulated radiation patterns, the main beams of the proposed MLWA are slightly slanted to broadside direction compared with the original one. It is mainly due to the oblique shape termination. The oblique shape termination destroys the current distribution of the leaky mode of the proposed MLWA [Fig. 2(b)]. Therefore, the scanning region of the proposed MLWA is smaller than the original one but not by much. In the simulated results, the scanning angle of main beam of the original half-width MLWA is 34°, whereas the proposed MLWA is

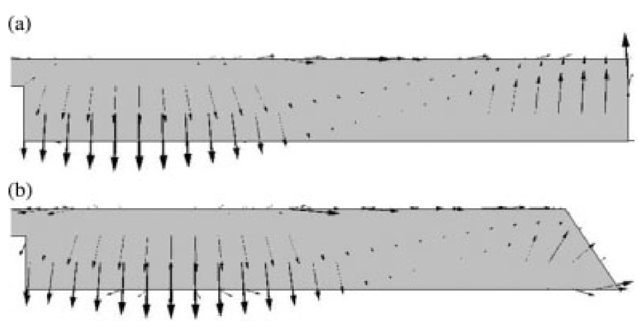

Figure 2 Current distributions, (a) the original half-width MLWA and (b) the proposed MLWA without the linked square metal

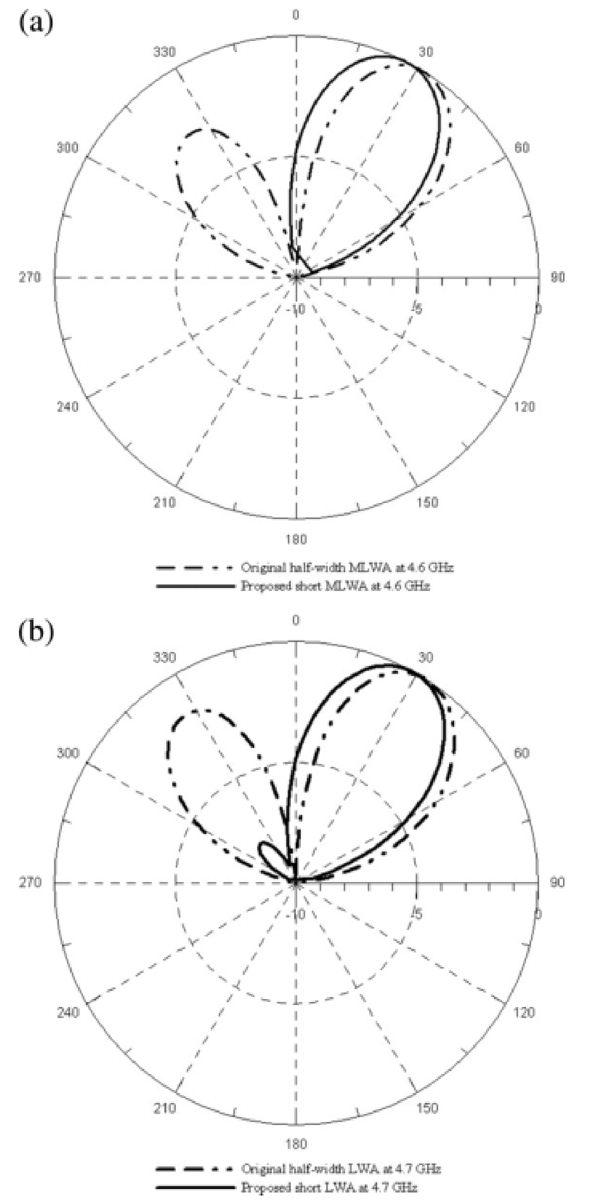

Figure 3 Simulated radiation patterns of the proposed MLWA compared with the original half-width MLWA at (a) 4.6 GHz and (b) 4.7 GHz

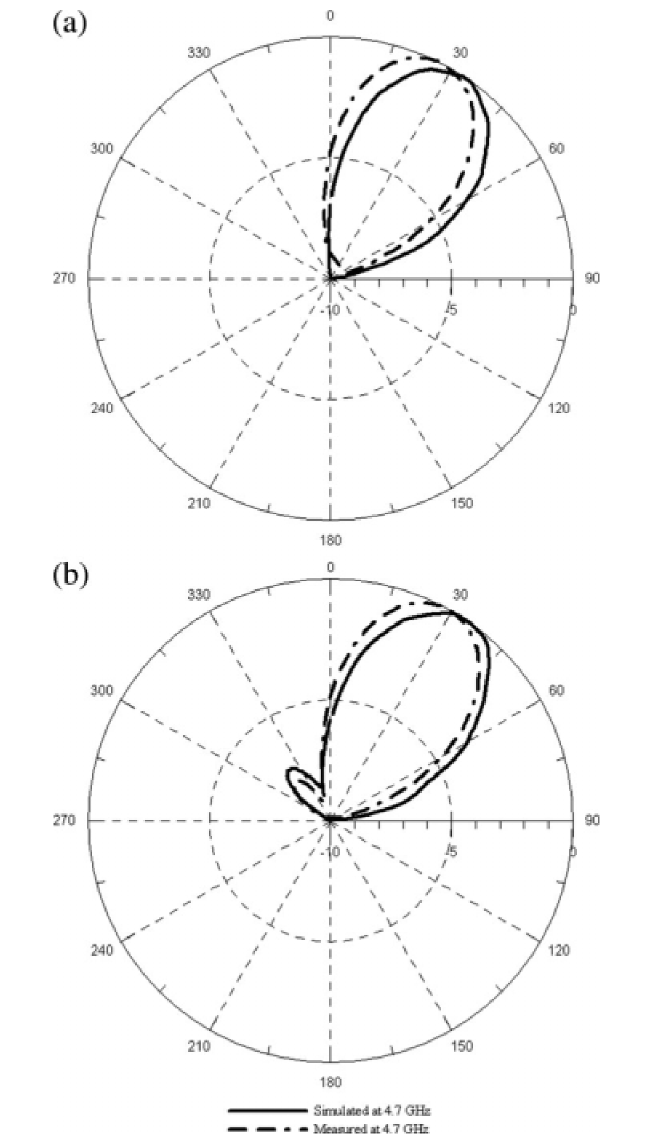

Figure 4 Measured and simulated radiation patterns of the proposed MLWA at (a) 4.6 GHz and (b) 4.7 GHz

30° at 4.7 GHz. There is about 4° difference between the proposed MLWA and the original half-width MLWA.

Although in Figure 3 the main beams of the experimental results are slanted to end-fire direction unexpectedly. An error degree in the spinning mechanism of the measurement may take the blame for this issue. However, the scanning region of the main beams could sweep from 13° to 35° between 4.2 and 4.7 GHz in experimental results.

4. CONCLUSIONS

In this article, a novel short half-width MLWA with an oblique-shape termination and a linked square metal with a grounded via hole is introduced. The oblique-shape termination changes the direction of the reflected wave, and the reflected wave would not propagate straightly along the longitude edge of the proposed MLWA. The linked square metal with a grounded guides the remainder power to the ground. Compared with the original half-width MLWA, the proposed MLWA with a shorter length (only 1 λ_0) has suppressed back lobes. The proposed novel short half-width MLWA can be used in scanning systems.

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MODIFIED SHORT-CIRCUIT QUARTER-WAVELENGTH RESONATORS FOR THE DESIGN OF MICROSTRIP DUAL-PASSBAND BANDPASS FILTER

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ABSTRACT: *In this article, a novel microstrip dual-passband bandpass filter has been proposed and developed. This filter is composed of two modified short-circuit quarter-wavelength resonators with a half-wavelength stepped-impedance resonator. Design procedures and theoretical analysis are provided; the prototypical bandpass filter with dual passbands is fabricated and measured as well. Well matched simulated results and experimental data validate the proposed filter.* © 2009 Wiley Periodicals, Inc. Microwave Opt Technol Lett 51: 3026–3029, 2009; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.24811

Key words: *dual-passband filter; bandpass filter*

1. INTRODUCTION

Microstrip parallel-coupled filters have been one of the most commonly used filters. Particularly, stepped-impedance resonators (SIRs) have been widely used for the parallel-coupled resonators. It is indicated in [1] that SIRs have been widely used for analyzing discontinuity with an impedance step in a transmission line.

Moreover, the design formulas of quarter-wavelength coaxial SIRs were analytically derived and applied to bandpass filters or balun for mobile communication in [2–4]. In addition, among various SIRs, the quarter-wavelength SIRs are more attractive in