lower frequency. Therefore, the proposed filter has the advantages of low radiation loss, simple fabrication, and small size.

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A NOVEL METHOD FOR SHORT LEAKY-WAVE ANTENNAS TO SUPPRESS THE REFLECTED WAVE

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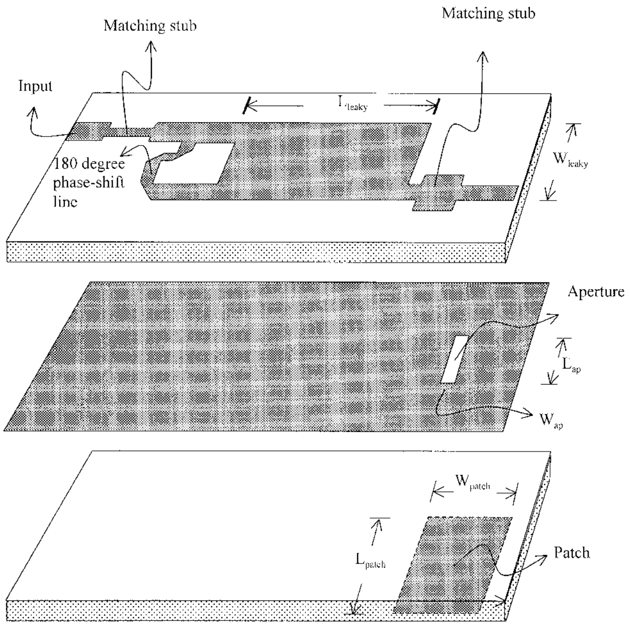
ABSTRACT: *A method to suppress the back lobe of a short leaky-wave antenna (LWA) by using an aperture-fed patch antenna on the backside is demonstrated in this paper. The aperture-fed patch antenna is connected to the open end of the LWA. This design offers another radiation path of the reflected wave and creates another radiation pattern on the back plane of the substrate. Experimental results show that the suppression of the reflected wave can be 10 dB at 10.0 GHz with an LWA length of 6 cm (2 wavelengths). Compared to the conventional design, this novel structure can radiate as efficiently as LWA at a length of 4 wavelengths. The two radiation patterns on different planes have great potential in many applications and can provide more flexibility to traditional designs.* © 2003 Wiley Periodicals, Inc. Microwave Opt Technol Lett 36: 129–131, 2003; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.10696

Key words: *reflected wave; back lobe; aperture-coupled patch antenna*

1. INTRODUCTION

The leaky phenomenon from higher-order modes in microstrip lines has been applied in many applications since the pioneering work was created by Oliner [1]. The leaky-wave antenna (LWA) is one of these applications. LWAs possess advantages such as lower profile, less weight, simple fabrication, and ease of matching. In addition, narrow beamwidth and frequency-scanning characteristics are the extraordinary properties of the antenna's physical behavior. Recent efforts [2–4] include active integrated LWAs, which show great potential in microwave frequencies.

A major problem of the LWA is the long length of its structure. Generally speaking, the length of the LWA acquires 4 wavelengths to radiate effectively; otherwise, its open end results in the large reflection power of microwave signals. For example, with a strip length of 10.0 cm (3.33 wavelengths), the reflection power was 35%, while 65% of the total power was radiated. As a result, the reflection power would cause undesired interference in communications systems. The taper-loaded leaky-wave antenna end [3] has been investigated to suppress the reflected wave. The topology can suppress the back lobe to be −15 dB with antenna length of 9.0 cm (3 wavelengths). In [4], an array topology to suppress the back lobe has been developed. This design can suppress the back lobe to 10.5 dB with antenna length of 6.734 cm. However, these designs need a large area. Here, an alternative method is introduced to suppress the back lobe for the reduced area (2 wavelengths) of the LWAs. By using an aperture-fed patch antenna on the backside of the LWA, we can suppress the back lobe effectively. The aperture can induce the reflection power to the patch on the backside and the residual power will radiate out.



$L_{leaky} = 60mm$, $W_{leaky} = 11mm$, $L_{ap} = 4.2mm$, $W_{ap} = 0.5mm$, $L_{patch} = 10.6mm$, $W_{patch} = 8.6mm$

Figure 1 The structure of the aperture-fed patch antenna connected to the LWA

2. CIRCUIT DESIGN

Figure 1 shows the proposed circuit configuration of the X-band leaky-wave antenna. The configuration consists of three parts: a leaky-wave antenna, an aperture, and a patch antenna on the backside. The circuit is fabricated on the RT/Duroid substrate with a dielectric constant of 2.2 and thickness of 0.508 mm. The length and the width of the leaky-wave antenna are chosen to be 6.0 cm and 1.1 cm, respectively. The 180° phase-shift line is applied to ensure the excitation of EH1 first higher order mode [2] for the CPS-fed LWA. The aperture etched on the ground plane is designed to couple the remaining power of the LWA into the patch antenna on the backside of the substrate. The length of the aperture is approximately one-third of the wavelength and the width of the aperture is one-tenth of the aperture length. The patch antenna is designed to radiate the power coupled from the aperture. In this experiment, the length and the width of the patch antenna are 10.6 mm and 8.6 mm, respectively. The length of the patch antenna can

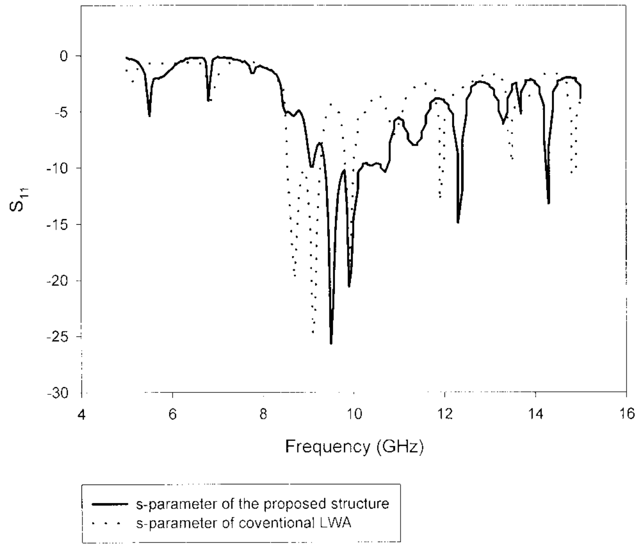


Figure 2 The comparison of the measured S-parameter (S_{11}) of the proposed LWA and the conventional LWA

be designed to be longer than the width for the purpose of impedance matching.

3. THEORETICAL AND EXPERIMENTAL RESULTS

Figure 2 shows a comparison of the measured S-parameter (S_{11}) of the proposed and conventional LWAs. The result indicates that the backside patch antenna indeed enhances radiation efficiency. Figure 3 illustrates the radiation patterns (H-plane) of the proposed and conventional LWAs (2 wavelengths) without the aperture-coupled patch antenna on the backside at 10.0 GHz. The back lobe of the proposed design is suppressed to be -10 dB below the main beam while the back lobe of conventional LWA is large—3-dB less than the main beam. Comparing the proposed structure and the conventional LWA without an aperture-fed patch antenna, we observe that the proposed design can suppress the reflected power by 7 dB at 10.0 GHz. The main beam steers toward the end-fire direction when the operating frequency increases. The measured radiation patterns are shown in Figure 4. The angles of the main beam are at 65°, 55°, and 45° at 9.0 GHz, 9.5 GHz, and 10.0 GHz,

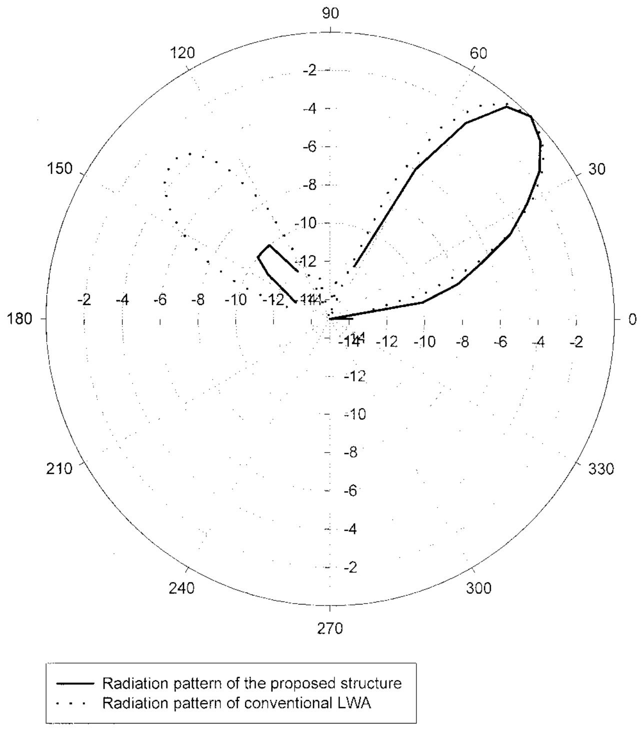


Figure 3 The radiation patterns of the proposed and conventional LWAs

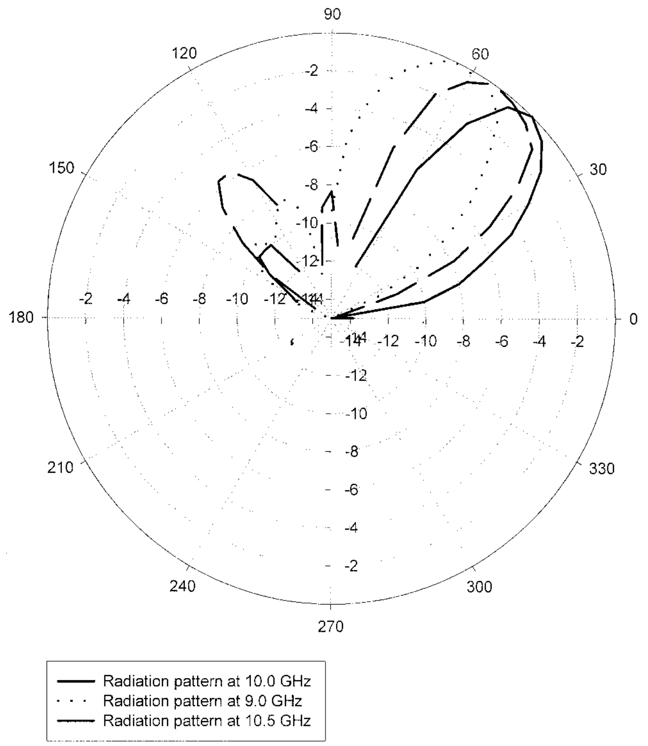


Figure 4 The measured radiation patterns of the proposed LWA structure at 9.0 GHz, 9.5 GHz, and 10.0 GHz

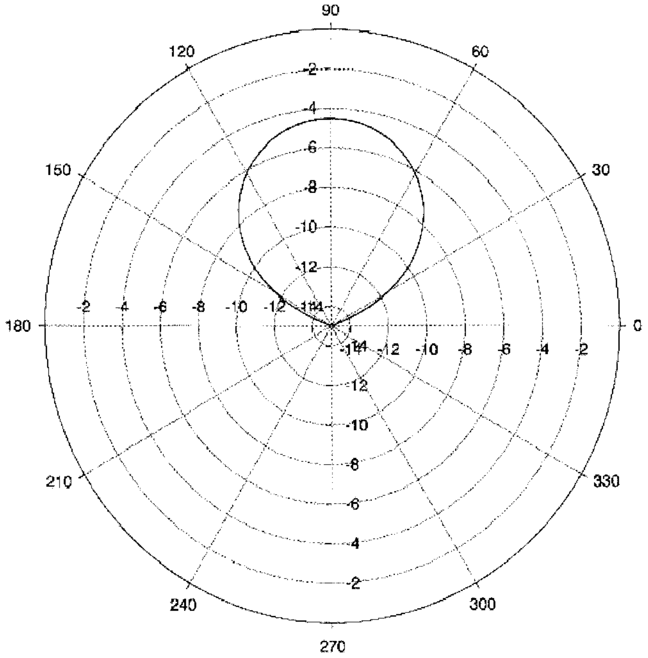


Figure 5 The measured radiation pattern of the aperture-coupled patch antenna at 10.0 GHz

respectively. The scanning angle of 20° can be achieved. Figure 5 shows the radiation pattern of the aperture-coupled patch antenna.

4. CONCLUSION

We have successfully employed the aperture-fed patch antenna to suppress the reflected power. Even though the short leaky-wave antenna (2 wavelengths) is used in the systems, only a little amount of power would reflect. This design is beneficial in diverse applications. By reusing the reflected power, two antenna modes, including a leaky mode and a patch mode, have been created on the top and bottom plane of the substrate. This novel design provides more flexibility and can be utilized in military and commercial communications.

ACKNOWLEDGMENT

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INVESTIGATION OF INPUT POWER DYNAMIC RANGE ENHANCEMENT OF A CROSS-PHASE MODULATION WAVELENGTH CONVERTER BY PRE-AMPLIFICATION

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ABSTRACT: *The performance of a pre-amplified cross-phase modulation (XPM) wavelength converter has been theoretically investigated. We showed that the pre-amplifier enhances the input optical power dynamic range by 3 dB. The additional 4-dB improvement of the power penalty in wavelength conversion obtained through BER simulation shows that integrating a pre-amplifier enables the accommodation of a relatively small input optical power.* © 2003 Wiley Periodicals, Inc. Microwave Opt Technol Lett 36: 131–134, 2003; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.10697

Key words: *XPM; wavelength converter; pre-amplifier; dynamic range; SOA; MZI*

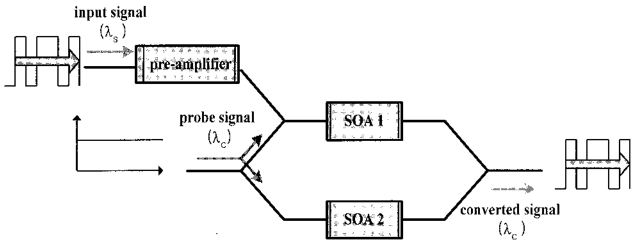

Figure 1 Schematic of an XPM wavelength converter with an additional pre-amplifier

1. INTRODUCTION

Optical wavelength converters provide both flexibility and efficiency for wavelength-division multiplexed (WDM) networks due to their ability to allocate wavelengths on a link-to-link basis, which in turn relaxes the requirements for wavelength management and precision. This has consequently brought considerable attention to wavelength converters. Although many all-optical wavelength converters have been proposed, currently, the most practical all-optical wavelength conversion scheme is considered to be cross-phase modulation (XPM) in an interferometer equipped with semiconductor optical amplifiers (SOAs), because of its conversion efficiency, extinction ratio enhancement, and low-chirp characteristics [1]. However, one of the concerns regarding the interferometric wavelength converter is its relatively small input-power dynamic range of 4–5 dB at 10 Gb/s. A large dynamic range is essential, because the signals experience different attenuation through the network with subsequent variations in input power to the switch blocks. Thus, XPM wavelength converters with a monolithically integrated pre-amplifier were experimentally reported [2, 3]. These schemes increase the input-power dynamic range of the XPM wavelength converter, but detailed analysis on this matter is still needed.

In this paper, we analyze the performance of an XPM wavelength converter integrated with a pre-amplifier by comparing its output signal forms and BER to those of conventional XPM wavelength converters. The bit rate for simulations was set at 10 Gb/s, and all devices were assumed to be monolithically integrated. Additional losses, such as coupling loss, were thus neglected in simulation.

2. SIMULATION AND DISCUSSION

We have used a transfer matrix method (TMM) for investigating the performance of SOAs and wavelength converters. In this method, SOAs are divided into many subsections. In each subsection, the changes of gain, carrier state, and ASE are calculated. Figure 1 shows a schematic of the device, where the input dynamic range of an XPM wavelength converter can be controlled by the biasing current of the pre-amplifier. The operating condition of SOAs inside the Mach–Zehnder Interferometer (MZI) was set as the optimal state found in the former simulation [4] of a conventional XPM wavelength converter, with biasing current of 140 mA and SOA length of 800 μm.

The noise in the ON state of the signal is larger than that of the OFF state, because of the signal-spontaneous beat noise, which is the dominant noise of a SOA. A beat noise appears as a multiple of another optical frequency during the optical-electrical conversion, due to the nonlinear characteristics of photodetectors. The thermal noise, shot noise, spontaneous-spontaneous beat noise, and signal-spontaneous beat noise are taken into account in the simulation. All noises were assumed to be white Gaussian noise having