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Research Article

Dual-Beam Leaky-Wave Antenna (Lwa) Based on Microstrip

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ABSTRACT
Second-order higher mode periodic leaky-wave antennas (LWAs) are proposed. The distributed circuit model is used to balance the impudence matching and open stop-band suppression. By loading the longitudinal slots in the unit cell, the leaky-wave antenna produces a dual symmetrical beam that scans from backward to forward. The LWA shows good radiation performance and gain in the scanning region of -500 (backward region) to +500 (forward region).

Keywords: Beam scanning, higher-order modes, open stop-band suppression, LWA

Introduction

Leaky wave antenna falls into the category of traveling-wave antenna, in which electromagnetic energy leaks in the form of radiation and wave travel along with the structure. Planner LWA has the advantage of low profile, easy fabrication, narrow beam, large bandwidth, and low cost. The higher mode leaky-wave antenna presented in the early [1]-[3]. Various methods have been producing to achieve second-order mode excitation in LWA [4]-[8]. Unfortunately, this LWA only produces beam scanning only in the forward quadrant region or limited scanning area. To scan the backward to forward quadrant region, periodicity has been used in LWA [9]. The periodic LWA uses the n=-1 space harmonics instead of fundamental space harmonics (at n=0). However, the PLWA suffers from the open stop band problem in which serious gain occurs at the broadside direction [10]. LWA does not radiate at broadside direction at open stop-band because radiation efficiency becomes very low at the broadside. Several methods have been proposed to eliminate the open stop-band, impedance matching, shorting pins, slots stubs, and CRLH metamaterials [11]. In this paper, balanced transmission line impedance matching technique is used to suppress the OSB problem; distributed model of the unit cell is used to solve the equivalent circuit because, as compared to the lumped model, it is easy to solve and give an approximate solution for a given computational accuracy. The OSB suppressed the beam scan from the backward to forward quadrants without any serous gain degradation at the broadside.

Unit Cell Design of Leaky Wave Antenna and Antenna Configuration

Fig.1(a) shows the unit cell of LWA, and longitudinal slots are employed for the power radiation. The period of unit cell is p, length, and width of the longitudinal slots L and W, respectively. The width of the unit cell is W_S. The equivalent circuit of the unit cell given Fig.1(b). All antenna has design in Ansys HFSS and CST microwave studio. The prototype of LWA has a length of 12λ and LWA printed on FR4 substrate (tan δ= 0.02) with a thickness of 1.6 mm. The length (L) and width (W) of the overall antenna, including the feed network, are 294.5 mm and 45 mm. The antenna presented in Fig.2 and the feed network of LWA, which excite the EH_2, are shown in Fig.3.

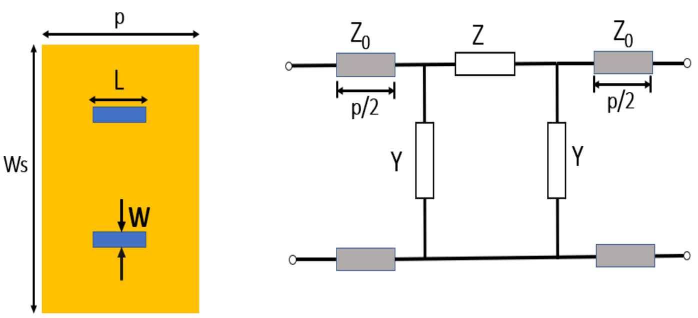

Fig.1: (a) unit cell design (b) equivalent circuit of unit cell

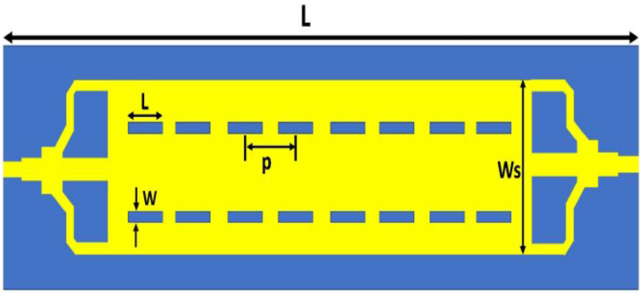

Fig.2: Leaky wave antenna configuration

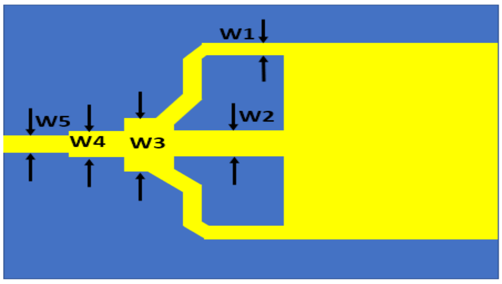

Fig.3: feed network of LWA

Results and Discussion

Fig.2 shows the S parameters results of the proposed EH2 mode-based LWA. As shown in Fig.2 the -10dB bandwidth lies from 4.6 GHz to 8 GHz. The transmission coefficient S21 is well below the -10 dB, which means that not more than 10% of the remaining power reaches the other end of the antenna.

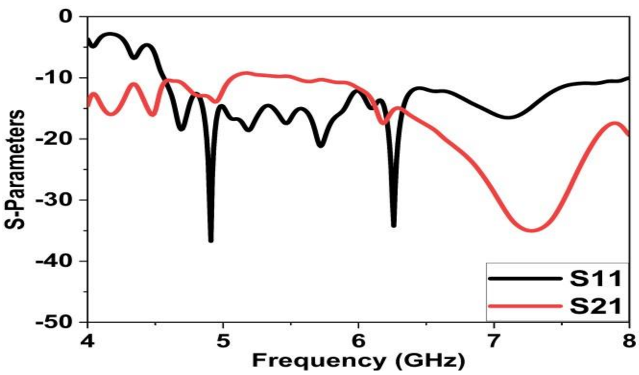

Fig.4: S-Parameters

Fig.3 shows the peak gain performance of the LWA, and peak gain increases with the frequency because the aperture area of antenna with frequency increases. The dimension of the antenna is given in Table 1—dual-beam characteristics of LWA show in Fig.4.

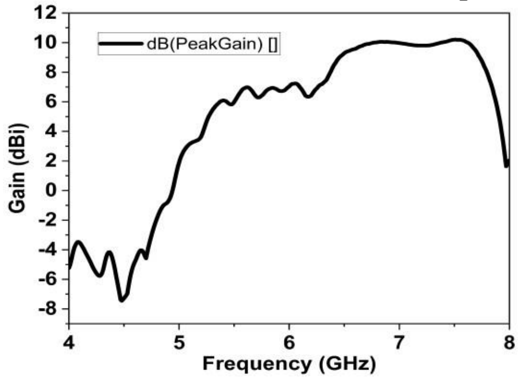

Fig.5: Peak gain of LWA

Table 1: Antenna Dimensions

L	Ws	p	W	W1	W2	W3	W4	W5	Lantenn
20	35	27	1	1.5	3	4.5	3	2.75	294.5

Units: mm

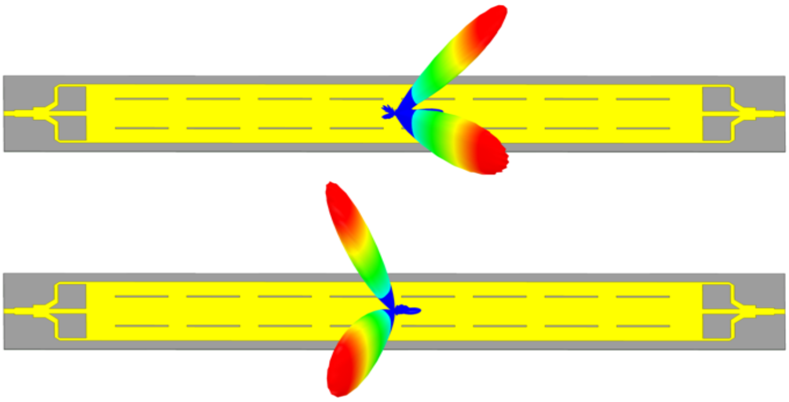

Fig.6: Dual-beam forward and backward direction

Fig.7 shows the radiation pattern of the proposed LWA. As the frequency increase from 4 GHz to 8 GHz, the LWA produces a dual symmetric beam of EH2 modes that scans the backward quadrants to forward quadrants. Radiation beam fix in the E plane which it scans the H-plane with the frequency increases.

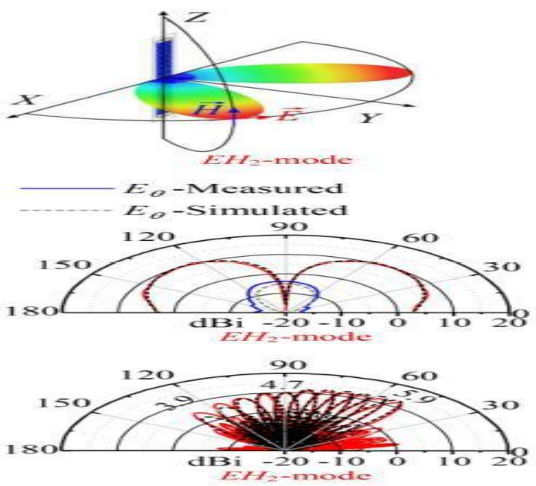

Fig.7: (a) dual symmetric beam with LWA (b) Radiation pattern at E plane (c) Radiation pattern at H Plane with beam scanning with frequency

Conclusions

An EH2-mode microstrip LWA with the loading of longitudinal slots has been proposed with the of backward to forward scanning capability. The balance condition does suppression of open stop- band with the help of distributed model circuits. As the open stop-band is eliminated LWA smoothly can both quadrants, including broadside direction. The proposed antenna could be an essential candidate for tracking applications.

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