Journal of Network Communications and Emerging Technologies (JNCET) www.jncet.org
Volume 6, Issue 2, February (2016)

Substrate Integrated Waveguide Based Leaky-Wave Antenna

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Abstract – A novel high performance, non-uniform slotted substrate integrated waveguide leaky wave antenna has been proposed. These non-uniform slots are used to reduce the side lobes and to improve the radiation efficiency as well. The proposed structure has enhanced antenna gain and reduced reflection loss also. This leaky wave antenna also works in TE10 mode same as previous LWAs. So, three modes are propagating in the structure; leaky wave mode, proper waveguide mode and surface wave mode. The proposed non-uniform leaky wave antenna also scans efficiently from broadside to near end-fires.

Index Terms – Non Uniform slotted,leaky wave antenaa,side lobes,radiation Efficiency

1. INTRODUCTION

A transverse non-uniform slot antenna is shown in Figure 3.1 which is the part of the structure that clearly depicts the parameters of proposed SIW. The period of the vias (s) is of the order of operating wavelength and length of the slot L is constant, only slot width is varied in geometric progression of ratio 1.01625. The slot width is varied in the central section of 220 mm length of the geometry symmetrically as shown in Figure 3.2. The width of first slot at the left extreme of the guide is 0.30mm. The width of subsequent slots increases in geometric progression to maximum value of 0.60mm at the center (nth slot) and goes on decreasing symmetrically thereafter. The effective width of SIW is near about weff = 9.8 mm.

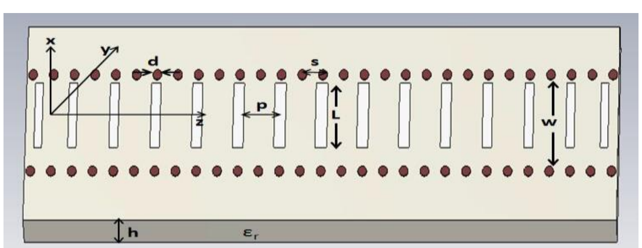

Figure3.1. Part of the transverse non-uniform slot leaky-wave antenna.

2. SIMULATION AND RESULTS

CST Microwave studio has been used to simulate the structure shown in Figure 3.2. The transmission coefficient S21 and reflection coefficient S11 are shown in Figure 3.3. Reflection coefficient S11 lies below -10 dB in the band of interest (from 10.3-12 GHz). The lower cut-off frequency is near 10.3 GHz. S-parameters of proposed LWA has been compared with SIW-LWA [22].

The simulation results depicts that the reflection loss reduces significantly in proposed leaky wave antenna. Since there is a continuous reduction in slot width from centre towards both of the ends which will be liable for impedance matching, and hence reduction in S11. This improves performance of antenna which is qualitatively justified in detail in later part of the chapter. The antenna works in surface wave mode after 12 GHz. As frequency increases further, S21 increases after end-fire scan at 12 GHz. After end-fire scan leaky mode is converted into slow wave mode which does not participate in scanning. Hence beyond 12 GHz, frequency range is not a part of our interest.

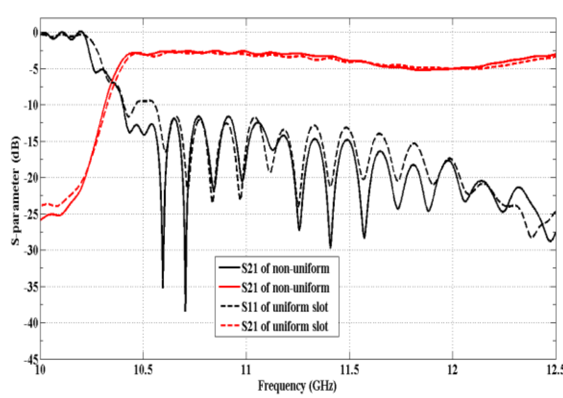

Figure3.2. S-parameters of transverse non-uniform slot LWA and transverse slot LWA

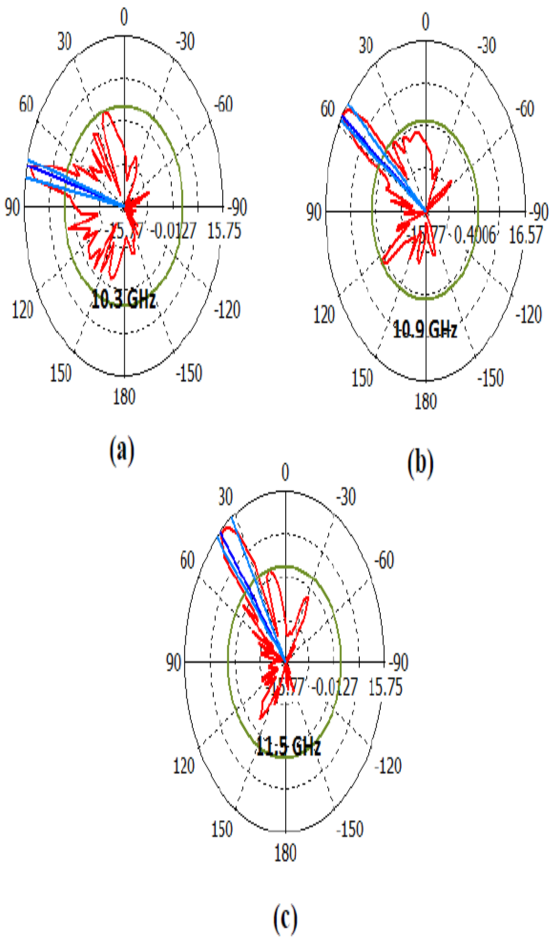

Figure 3.3 Radiation pattern for the structure shown in Figure 2.2 at (a) 10.3 GHz near broadside (b) 10.9 GHz and (c) 11.5 GHz

In Figures 3.3 (a)-(c) the radiation patterns for main beam has been shown. It is seen that the beam scans with change in frequency. The main beam scans from near broadside to near end-fire. At the frequency 10.3 GHz beam starts scanning from near broadside. At 10.3 GHz near broadside, As frequency increases beam scans in same quadrant and reaches near 400 as shown in Figure 3.3(b). When frequency increases up to 11.9 GHz beam scans near to end-fire. In frequency range 10.3-12 GHz, beam scanning is shown with the change in frequency. These results are simulated on CST microwave studio. In band of interest, beam scans from near broad side to near end-fire and leakage is only due to fast wave (β<ko). -30-

As frequency increases leaky mode scans very close to end-fire, the main beam of leaky mode is converted into surface wave mode, which is slow in nature (β>ko). The slow wave or surface wave does not participate in radiation.

3. CONCLUSION

A high performance leaky wave antenna based on SIW withnon-uniform array of slots has been proposed and investigated. Proposed structure improves the side lobe level, gain and radiation efficiency while maintaining the other characteristics of SIW-LWA. The performance is enhanced but there is small increment in beam width. Directivity is also reduced near end-fire frequency range. The proposed leaky wave antenna scans from near broad side to end-fire as frequency increases. The non-uniform slot also improves the radiation efficiency and achieves more than 80% radiation near end-fire scan. Besides, there is improvement in reflection coefficient S11.

REFERENCES

[1] John L. Volakis, Antenna engineering handbook, McGraw-Hill 2007.
[2] C. A. Balanis, Antenna engineering handbook, chapter11; Leaky wave antenna, John Wiley & Sons, 2012.
[3] Dominic Deslandes, Ke Wu," Design Consideration and Performance Analysis of Substrate Integrated Waveguide Components".
[4] Y. Cassivi, L. Perregrini, P. Arcioni, M. Bressan, K. Wu, and G. Conciauro, "Dispersion characteristics of substrate integrated rectangular waveguide," *IEEE Microw. Wireless Compon. Lett.*, vol. 12, no. 9, pp. 333–335, Sep. 2002.
[5] F. Xu and K. Wu, "Numerical multimode calibration technique for extraction of complex propagation constants of substrate integrated waveguide," in *Proc. IEEE MTT-S Int. Symp.*, June 2004, vol. 2, pp. 1229–1232.
[6] L. Yan,W. Hong, K.Wu, and T. J. Cui, "Investigations on the propagation characteristics of the substrate integrated waveguide based on the method of lines," *Proc. Inst. Elect. Eng., Microw. Antennas Propag.*, vol. 152, pp. 35–42, Feb. 2005.
[7] F. Xu and K. Wu, "Guided-wave and leakage characteristics of substrate integrated waveguide," *IEEE Trans. Microw. Theory Tech.*, vol.53, no. 1, pp. 66–73, Jan. 2005.
[8] D. Deslandes and K. Wu, "Accurate modelling, wave mechanisms, and design considerations of a substrate integrated waveguide," *IEEE Trans. Microw. Theory Tech.*, vol. 54, no. 6, pp. 2516–2526, Jun. 2006.
[9] D. Deslandes and K.Wu, "Substrate integrated waveguide leaky-wave antenna: Concept and design considerations," in *Proc. Asia–Pacific Microw. Conf.*, Dec. 2005, pp. 346–349.
[10] F. Xu, K. Wu, and X. Zhang, "Periodic leaky-wave antenna for millimetre wave applications based on substrate integrated waveguide," *IEEE Trans. Antennas Propag.*, vol. 58, no. 2, pp. 340–347, Feb. 2010.