iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.51911

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

A Review Paper on Horn Antenna Using SIW Technology

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Abstract: In this paper, we review, Micro-strip patch antenna and Substrate Integrated Waveguide Technology (SIW). Horn Antennas have become attractive due to their inherent feature of being one of the solutions to many requirements associated with high-frequency bands. This paper presents a comparative study of different horn antennas, their operating frequencies, associated parameters and applications in terms of frequency bands also using the SIW technique, the construction of planar horn antenna is studied at K band and X band frequencies.
Keywords: Horn, X-Band, 5-G, K-Band, SIW, HMSIW, meta- metarials

I. INTRODUCTION

At microwave and millimetre frequencies, horn antennas are frequently used as feeders for reflector antenna systems. Due to the enormous size of horns constructed from metallic waveguides, planar horn structures with ignoble profiles are chosen because they are practically useful in communication systems.

The planar horn antennas are appropriate for numerous applications and are compatible with microwave and millimetre wave circuits. Because horn antennas offer superior radiation properties like symmetry patterns, high gain, easy fabrication, and more bandwidth, they are frequently used in a variety of applications. However, their implementation in planar form appears to be challenging due to the weighty geometry, particularly the 3D horn sizes.

The most effective application of SIW techniques can overcome these challenges by increasing the beam's radiation effectiveness and directivity. To convert the wave's abrupt discontinuity into an incremental change, the waveguide needs to have an enlarged aperture. so that all of the energy moving forward is efficiently radiated, a process known as flaring. The best electronic gadgets for the same are horn antennas. The horn antenna is utilised at microwave frequencies and has a unique design that sets it apart from many other types of antenna.

Planar structure antennas are the finest solutions for these applications. This type of antenna has high losses, particularly close to bends and discontinuities as frequency increases, much like microstrip antennas do. Even though numerous planar antennas have been studied for Ka-band communication and radar systems, the radiation effectiveness decreases as frequency increases because of intrinsic losses on the microstrip feeding network. The non-planar structure is an alternative to the planar construction that has good power handling capability and minimum losses. However, transforming the non-planar structure into planar active components is very difficult. SIW was suggested as a solution to the issues raised. Along with having non-planar features, it also has the advantages of being compact, affordable, light, and easy to manufacture using the PCB technique and other planar processing technologies. A wideband and uni-planar transition makes it straightforward to connect to a coplanar waveguide.

These approaches are used to develop and produce a variety of devices since the SIW structure is made up of arrays of metallic posts made on a flat substrate. So, the horn antenna is one of the key uses of this technique. Since it is straightforward, has a large bandwidth, and has a high gain, it has many applications. Nevertheless, as frequency rises (due to the shorter wavelength), the antenna's size decreases. It needed to be made via micromachining.

II. DIFFERENT APPROACHES AND CONFIGURATIONS

Many designs & techniques have been studied & proposed in literature to achieve multiband property of a horn antenna with high gain, high bandwidth & high efficiency.

In [1], The suggested antenna has a 1.6 mm thickness and is designed for a frequency of 24 GHz on a ROGERS RT/DUROID 5870 substrate. The Simulated result for the plot of Return loss versus frequency has -10.3 dB and -19.0956 dB at 24.97 GHz and 25.81 GHz frequencies respectively with a bandwidth of 920 MHz, where the measured results are - 23.73 dB at 18.5 GHz and -18.48 dB at 24.7 GHz frequencies. VSWR for the simulation is 1.08 and 1.23 at 24.79 GHz and 25.81 GHz frequencies respectively whereas the measured VSWR results by VNA are 1.25 at 18.5 GHz and 1.36 at 24.7 GHz frequencies.

[2] presents a simple approach for the design of a substrate-integrated waveguide (SIW) horn antenna with constant gain. Direct coaxial feeding is the basis for the straightforward design process. By positioning a metallized through $\lambda g=4$ distance away from the aperture, matching is accomplished..

[3] suggests an H-plane horn antenna with a substrate-integrated waveguide (SIW) that has approximately symmetric beam widths in the H-plane and E-plane. Measurements on a made-up prototype antenna are made to verify simulation results and analyse radiation patterns. A symmetric beam is produced by adding two rectangular slots to the top metallization of the H-plane horn antenna.

[4] outlines the design process and simulation results for a SIW horn antenna operating at the K-band and Ka-band. For synthesis in the K and Ka bands as well as at even higher frequencies, the suggested antenna is a superb option. Incorporating CSRR into SIW-based horn antennas results in a better gain and wider bandwidth, according to the proposed designs.

A substrate-integrated waveguide (SIW) H-plane horn antenna designed specifically for the X-band is described in [5]. Metamaterial is incorporated to enhance the performance of the proposed antenna. For applications where high gain is needed but the size is not an issue, the SIW H-plane horn antenna with metamaterial is a practical choice. In applications where compactness is necessary, the half-mode horn antenna with metamaterial can be used with a somewhat lower gain.

[6] describes the design of a particular type of horn antenna operating in the Ku band (12.25–12.75GHz) with a square waveguide and cone aperture. The conventional Cone antennas with square waveguides and square-cone apertures work well in real-world applications. The size of the horn antenna with cone aperture developed in this study is equivalent to that of the conventional one. The horn antenna developed in this study has a similar gain to the classic one through simulation with HFSS, but its return loss is lower than the traditional one. It implies that the upgraded horn antenna performs better than the conventional one. This paper's concept served as a useful guide for the practice.

[7] discusses the design analysis of microstrip antennas with rectangular and square shapes. For feeding purposes, both antennas made use of a microstrip line. In comparison to rectangular microstrip, the square microstrip antenna offers wider bandwidth and adequate return loss. The small antenna is intended to operate in the X band of frequencies. A wide bandwidth of 500 MHz and a the significant return loss of -24 dB is displayed by the suggested microstrip antenna. This extensive bandwidth offers its value in numerous wideband X- band uses.

According to [8], SIW technology, which serves as a link between planar and non-planar technology, is a very strong contender for the creation of components that operate in the microwave and millimetre wave bands. In light of this, SIW antennas and arrays benefit from both traditional metallic waveguide, which has high gain, high power capacity, low cross-polarization, and high selectivity, and planar antennas, which have a low profile, lightweight, inexpensive fabrication, compliance to planar or bent surfaces, and simple incorporation with planar circuits.

The development of a tiny horn antenna that will be suited for astronomical application in the L-Band uses the design considerations of a horn antenna, which are fundamental concepts, in [9].

All things considered, it is essential to specify the crucial factors upon which such a design would be based, such as the cut-off frequency, thus the bandwidth of the horn antenna, the physical length dimensions, the distance and depth of the dipole, and the hood size, when deciding on the intended frequency of operation. Making wise choices regarding these characteristics is essential for any competent design to actualize any sound horn antenna with an acceptable beam pattern.

[10] analyses the characteristics of the ridge waveguide and horn ridge concerning the antenna construction and then presents a design strategy for a broadband double-ridge horn antenna. In response to real-world demands, a dual-ridge horn antenna that operates in the 20GHz–26GHz frequency spectrum was developed. Additionally, HFSS was applied to model the antenna's electromagnetic characteristics. The results show that at 24 GHz when the gain is greater than 18 dB, the principal flap of the three-dimensional gain pattern becomes uncracked.

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