Wideband H-Slot Antenna Fed by Substrate Integrated Gap Waveguide for mmWave Arrays

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***Abstract*—This paper proposes a wideband slot antenna design based on the substrate integrated gap waveguide technology for millimetre wave applications. The proposed antenna is realized using the H-shaped slot (H-slot) to improve impedance bandwdith. Simulation results show that the proposed antenna has an impedance bandwidth at $S_{11} \leq -15$ dB from $24-29.5$ GHz resulting in a 20.5% fractional bandwidth. Hence, the designed slot antenna can potentially be used as the radiating element of an array antenna for fixed-beam point-to-point applications.**

***Keywords*—Gap waveguide, millimeter-wave, substrate integrated gap waveguide**

I. Introduction

Microstrip lines have been commonly used in the design of millimetre wave (mmWave) antennas because of their convenient integration with the RF circuitry, and also due to their cost-effective manufacturing [1], [2]. A drawback is that the dielectric losses at mmWave frequencies are high. An alternative is to use metal hollow waveguides as the transmission line since low loss array antennas can be designed at the mmWave bands [3]. However, a good electrical contact is required for the satisfactory performance of a multi-layer antenna resulting in higher manufacturing costs [3]. To address the aforementioned problem, the gap waveguide (GW) has been proposed as an effective transmission line solution for mmWave antennas [4]. The use of the fully metallic GW keep losses at a comparable level with the conventional hollow waveguides, while circumventing the strict electrical contact requirements [4]. However, in practice, it is difficult to maintain a constant air gap height between the layers, which may have a major impact on the performance of the GW [4]. The substrate integrated gap waveguide (SIGW) has been proposed in order to overcome this constant air gap problem by filling it with a substrate [5]. In this paper, we propose an H-shaped slot antenna (henceforth, the H-slot antenna) based on the SIGW technology for mmWave application. The proposed antenna is fed by a T-junction, which design is based on the SIGW technology. The simulated performance of the proposed antenna provides a $S_{11} \leq -15$ dB impedance bandwidth of 20.5% from $24-29.5$ GHz.

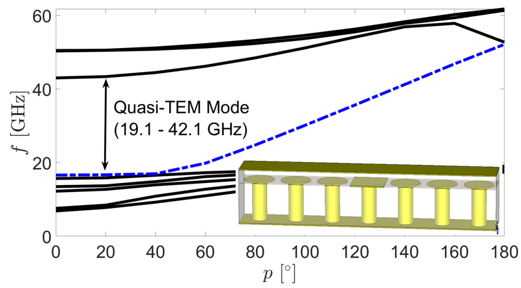

Fig. 1. Dispersion diagram of the designed SIGW, where f is the frequency and p is the phase in degree.

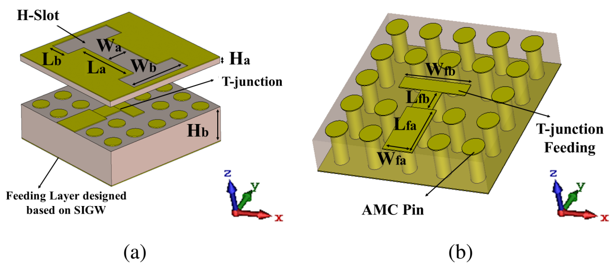

Fig. 2. Explored view of the proposed antenna (a) H-shaped slot antenna fed by SIGW and (b) T-junction feeding designed based on SIGW.

II. SIGW H-slot antenna design and results

In the design of the SIGW antenna it is important to ensure that the artificial magnetic conductor (AMC) pins provides a stop-band over the desired operating frequency [4]. Fig. 1 shows the dispersion diagram of the designed SIGW structure shown in the figure insert. The SIGW consists of a periodic AMC pin realized as the combination of a mushroom patch and metal vias, and the guiding ridge is made of a copper patch and metal vias. As can be seen from the dispersion diagram, only a single propagating mode is possible from $19.1-42.1$ GHz. In this band, the quasi-TEM mode is propagating in the substrate gap between the ridge and the upper copper patch [5]. The completed design of the SIGW is used to realize a T-junction to fed to the H-slot antenna as shows in Fig. 2. As can be seen from Fig. 2, the proposed antenna comprises two layers: the top