1ICEAA-IEEE APWC 2019, Granada, Spain, 9 – 13 September 2019

A Mobile Terminal Leaky-Wave Antenna for Efficient 5G Communication

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Keywords: *Millimeter wave antenna; 5G antenna; Dual-band antenna; LWA (Leaky wave antenna)*

The millimeter-wave 37 –43.5GHz band is proposed to provide the requested multigigabit-per-second (Gb/s) data rates for future 5G cellular communications [1]. As a total wireless-link gain of 37 dBi may be required, the mobile terminal antennas should provide 12 dBi gain –being the remaining 25 dBi for the base station antennas-[2] [3]. This high gain is linked to the synthesis of narrow directive radiated beam, which must somehow be scanned into space over a wide field of view (FoV), and thus satisfy the mobility and coverage conditions. Such high-gain beam-scanning antenna design is very challenging, taking into account that high radiation efficiency, compact size/volume, and low-cost are key features for mass-market mm-wave applications. In this sense, most of the proposed 5G mobile-antenna solutions are based on phased arrays, which rely on active scanning/beam-forming networks which might be impractical due to an increase cost and manufacturing complexity. However, owning to their characteristics of high-gain, simple-feeding, planar structure, and inherent frequency-beam-scanning behavior, leaky-wave antennas (LWAs) might offer an interesting solution for high-gain low-cost scanning [4].

In this work, we propose a printed-circuit frequency-scanning LWA topology [4], which is applied for 5G mobile terminals operating in the 38 GHz band (37-43.5GHz). Despite its totally-passive simple structure using a long-metallic patch fed by two microstrip ports (see Fig.1a), the LWA exhibits frequency-scanning capability in a FoV as wide as [-57º,+57º] using the recommended four channels in the 37-43.5 GHz band (see Fig.1b). The designed LWA reports a high radiation efficiency above 85% in the complete scanning band, using an aperture length of 35.5mm and reduced width of 1.41mm, and producing directive beams exceeding 12dBi peak gain which is comparable with the array system the 11dBi of the 3 sub arrays of 1x4 elements each at 36GHz [5], and the 10dBi gain of the 2 sub arrays of 1x16 elements each at 28GHz band [6]. The effect of the beam-squint inside the 1 GHz bandwidth associated to each communication channel needs to be evaluated. The proposed simple one-dimensional frequency-scanning topology dispenses for more expensive electronic-scanning techniques, provided that the 5G mobile terminal can use a dynamic channel-allocation scheme when communicating with the cellular base station.

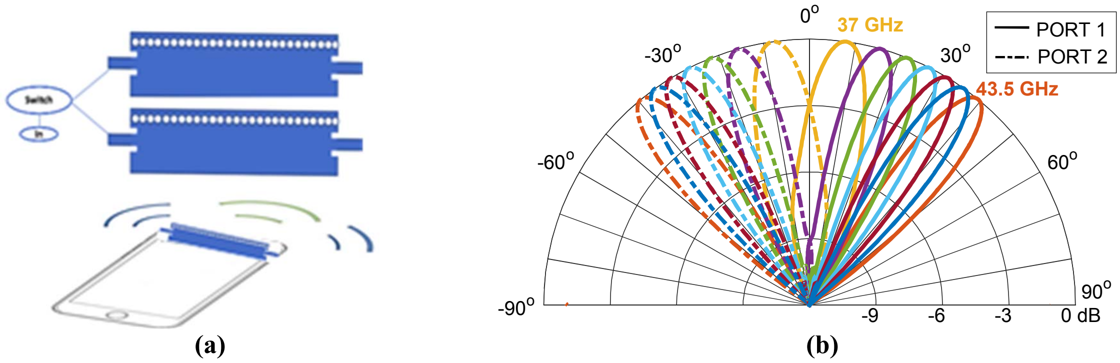

Figure 1. a) LWA design b) Frequency-scanned radiation using the channels available in the 36-40 GHz band

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