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A compact double-band planar printed slot antenna for sub-6 GHz 5G wireless applications

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Abstract

A planar rectangular slot antenna with dual-band operation and realized higher peak gain is proposed, designed, and fabricated for sub-6 GHz 5G applications. The antenna possesses a rectangular radiating slot with the inverted stub on its upper edge excited simultaneously by a micro-strip feed line having a double folded T-shaped structure. The fabricated design is of compact size with the radiating portion of $0.3\,\lambda_0 \times 0.17\,\lambda_0$ (λ_0 represents free-space wavelength) and profile of $0.009\,\lambda_0$. The measured results show the operating frequency bands of 3.29–3.63 GHz and 4.3–5.2 GHz, with a peak gain of around 7.17 dBi. The higher frequency band is generated by the feed patch and the slot whereas lower resonant frequency band is generated by the stub loaded on the slot. The measured results are in a good agreement with the simulated results. The proposed design is suitable for the International Telecommunications Union sub 6 GHz applications.

Introduction

To meet the huge growth in the data rate of wireless devices and to ensure the mobile connectivity to a huge number of devices, the technology is being shifted towards the fifth generation (5G) which is expected to be commercially out by 2020. The main motive of 5G technologies is to provide around 10 Gbps data rate for the user which is about ten folds the data rate of 4G-LTE. It aims at providing this data rate along with low latencies and good reliability. It is expected that 5G is surely going to make an effective impact on a number of applications in various fields that will improve the lifestyle of the majority of population [1].

While dealing with a number of frequencies, it is assumed that the Radio Access Networks (RANs) for 5G are going to support several 5G bands simultaneously [2]. In order to study the demand for the spectrum required for international mobile telecommunication (IMT), the ITU-R has fixed up some criteria. In recent times ITU-R is almost done with the study for this demand fulfilling the criteria towards 2020 [1]. The proposed antenna covers the 5G frequency bands that include ITU *n*77 (3.3–4.2) GHz and *n*79 (4.4–5) GHz. It has been immensely studied that the frequencies in the lower range are going to provide much good coverage for recent wireless communications. For 5G communication it is not only about getting high data rates but it should also ensure wider coverage area with outside to inside network coverage by using the spectrum bands under 6 GHz [3].

There has been an initiative of deploying 5G commercially in the frequency range of sub-6 GHz. The ITU has declared sub-6 GHz and millimeter wave spectrum for 5G. An ever-growing desire for transmission at high data rates with low power levels and low costs motivated the engineers to make the effective and efficient use of 5G technology by designing the antennas that support almost all such desirable features [1]. A number of sub-6 GHz antenna designs reported in the literature wherein good performances have been shown, largely include the printed antenna technology. The technologies have produced the miniaturized antennas thereby retaining the good efficiency. A large class of these antennas comprises printed microstrip slot antennas [4]. The slot antennas are being employed for a wide range of applications that mainly include WiMAX, WLAN, Bluetooth, 4G LTE, etc. In spite of already reported applications, slot antennas are broadly used for wireless 5G applications that mainly include mobile terminal devices in the recent scenario. The proposed rectangular slot antenna has been mainly designed for sub-6 GHz 5G applications for mobile handheld devices. A number of techniques for slot antenna design is reported in literature comprising cross-shaped slot coupler antenna [5], circular patch antenna with asymmetrical open slots [6], C-shaped coupled fed antenna with L-shaped monopole slot having orthogonal polarization [7], octagonal shaped slot antenna with U-shaped strips for UWB applications [8], a monopole radiator with square slot having L-shaped strips [9], a transformer triple band slot antenna [4], a wideband slot antenna with fictitious resonances [10], a hexagonal shaped slot antenna with U-shaped slot and two split rings [11], inverted F-antennas for dual mode operation [12], antenna with defected ground having F-shaped slots [13], an elliptical patch antenna with