Design a tri-band microstrip antenna for targeting 5g broadband communications

Sociology, Communication

Abstract. This paper presents the design of a Tri-band microstrip antenna for targeting 5G broadband communications, This element antenna has 3×3 rectangular patches the feeding line structures are branched, therefore for radiating elements there are two feeding point, Using technique proximity coupling, and combination feeding structure was used to enhance the bandwidth of antenna. The cover range tri-band frequency is 40 GHz to 70 GHz. The simulation results are compared by measurements the reflection factor has minimal at 45. 3 GHz, 57 GHz, 66. 6 GHz, the total measurement bandwith 11. 5 Ghz. With this combination tecnique, the proposed antenna is a promising candidate for 5G communication systems.

Keywords—5G; millimeter wave; Microstrip antenna; broadband communication.

INTRODUCTION

Wireless data communication is one of the most advanced technologies and its application widely use such as military and commercial application. Furthermore at modern day, mobile communication using 5G employs millimeter wave offers high speed wireless data transfer. Problems arise because the nature of its application. A 5G applications that employs millimeter wave has a very wide frequency spectrum from 30 GHz to 300 GHz [1].

The recent trends show that the wireless communication has evolved in very fast way. 5G wireless standard has evolved to be the most recent technology now-a-days. Various different fields has already adopted the 5G technology

such as Internet of Things (IoT), Smart Cities, Etc [8]. The rapid decrease in the dimensions of the mobile phone also led to the evolution of compact antenna structures. The conventional antennas are replaced by different antenna structures used in mobile communication. Microstrip Patch Antenna shows multi-band characteristics and has a compact structure and hence has emerged as a promising candidate for handheld devices.[2]

In this paper we proposed a microstrip antenna design to be used in millimeter wave frequency for targetting 5G application. Several researches have been made for this particular topic but the closes one is by Bondarik-Sjoberg [3].

MICROSTRIP ANTENNA DESIGN

In this research, we propose designing microstrip antenna based on proximity coupling [10]. Microstrip antenna was design to be following band, first band was 45. 3 GHz, Second Band was 57 GHz, and the third band was 66. 6 GHz. This frequency bands was allocated for the mobile communication following the regulation of the allocation usage designation by the National Telecommunications and Information Administration Office of Spectrum Management USA [9]. The tri-band microstrip antenna design is based on double microstrip antenna that has been reasearch as a milimeter wave application [4].

Design of the Ground Structure

Based on design of the ground structure by Bondarik-Sjoberg, we proposed to applied the same design to couple the patches arranged in a grid on the top antenna side. Fig. 1 we shows proposed ground structure for the designing antenna in this work. Geometry for ground structure antenna design that is L= 10 mm, W = 5 mm. As introduced in that publication, we here would like to make tri-band antenna characteristics and we use also microstrip structure novelty with proximity couple combination design patch grid in the radiating element. The substrate antenna we used Rogers RO3003 (εr = 3, tan δ= 0. 0013) with a thickness of 0. 51 mm.

Design Feeding Structure

The line feeding structures are branched, therefore for radiating elements there are two feeding point. Fig 2 shows the feeding element structures. Using double-fed proximity coupling, the double feeding structure was used to enhance the bandwidth of antenna structures [5, 6]. In this antenna design also, we applied stub in feeding system to supporting the multiband characters of the antenna system. Also the stub at the feeding structure has function as a capacitive stub branches antenna feeding, [7]. The design fork-like structure, stub of length l3 = 0. 38 mm and width w2= 0. 25 mm is used. The additional dimensions for the feeding structure are given in Table 1.

Design of the Patch Layer 2 Structure

On the top layer, the radiating elements structures are multiple rectangular patch antennas design. These elements are located in the top layer. This element has 3×3 rectangular patches with no interconnected between

patched. The complete antenna system is constituted by two layers. On the bottom layer, the feeding structure is connected by a 50 Ω microstrip line that feeds the rectangular patches.

SIMULATION AND MEASURED RESULTS

In this research, we simulated the new antenna system design with ANSY Electronic Desktop HFSS version 16. Fig. 4 shows a simulation result for the three dimensional radiation pattern calculated by HFSS. The obtained gain is around 5. 66 dBi

The result measurement for the antenna system is shown in Fig. 6. The calculated reflection factor (solid curve) has minimal at 45. 3 GHz, 57 GHz, 66. 62 GHz, the total measurement bandwith 11. 5 Ghz. Comparison of the calculated simulation result (dashed curve) has minimal at 41 GHz, 50 GHz , 57 GHz , 63. 2 GHz. from simulation and measurement reflection factor comparison results can be seen for the right and left frequencies there is a shift of about 3 GHz. Frequency shifts usually occur because when dimensions fabrication is not matching the simulation and from the inaccuracy in placing the upper layer in the prototype during measurement.

CONCLUSION

A reflection factor measured be produced tri-band microstrip antenna was proposed for working at three frequency regions of 45. 3 GHz, 57 GHz, 66. 62 GHz. The antenna has wide total bandwidth of about 11. 5 GHz. The patches are proximity coupled combination tuning stub for achieving the required

bandwidths in the working frequencies. We see for the right and left frequencies there is a shift of about 3 GHz. Frequency shifts usually occur because when dimensions fabrication is not matching the simulation and from the inaccuracy in placing the upper layer in the prototype during measurement., use techniques stubs in the design antenna can produce of multi frequency. This antenna produces gain about 5. 66 dBi.