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Compact CPW-Fed ultrawideband MIMO antenna using hexagonal ring monopole antenna elements

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ABSTRACT

In this paper, a compact coplanar waveguide (CPW) fed ultra-wide band (UWB) multi input multi output (MIMO) antenna is proposed. The antenna consists of two antiparallel hexagonal ring monopole elements. Circular arcs shaped grounded stubs are used to enhance the isolation, both the arcs are connected through stub to make common ground. Tapering of the slots of CPW feed line at feed point, and grounded slots are introduced for impedance matching over UWB. The proposed antenna is fabricated and impedance bandwidth, isolation, radiation pattern, and gain are measured. Moreover, envelop correlation coefficient (ECC) results are given. Proposed antenna structure operates in the frequency range 3–12 GHz with a fractional bandwidth of 120% keeping isolation better than 15 dB. The antenna has a compact size of 45 × 25 mm^2.

1. Introduction

Permission of unlicensed use of 3.1–10.6 GHz spectrum by Federal Communications Commission (FCC) [1] creates large interest on ultrawideband (UWB) technology. This technology has vast applications in short range high data rate communication with low power level. For improvement of UWB systems multiple-input-multiple-output (MIMO) technology is now incorporated to increase data rate further and to reduce multipath fading effect [2]. In MIMO systems, multiple antennas both at transmitter and receiver are placed in close proximity in portable devices. In portable device, it is a challenge of designing MIMO antenna to keep low mutual coupling between closely separated antenna elements.

Many UWB MIMO antennas are presented in [3–14]. To achieve good isolation, grounded stub [3], and grounded slot [4] are used between radiating elements. On the other hand, this is done using strips beneath the radiating patches in [5] and protrude grounded patch in [6]. It is also obtained in MIMO antenna having common radiating element [7] using grounded stub and slot in the radiator. In [8], a different method is used by using antenna elements having different patterns and polarizations to get good isolation. Polarization diversity in addition to good isolation are obtained by placing antenna elements orthogonally in [9–13]. To improve isolation further, decoupling structures are also used in [11–13]. Coplanar waveguide (CPW) feeding is preferred to microstrip line feeding in body proximity scenarios of UWB-WBAN antennas as they detune less near the human body [14].

In this paper, a compact CPW-fed UWB-MIMO antenna with overall size of 45 × 25 mm^2 operating in the UWB between 3 and 12 GHz is presented which fulfils the requirements of FCC for the portable devices. The antenna consists of two identical anti-parallel monopole elements, and each element has a hexagonal ring radiator. Two connected circular arc shaped grounded stubs are used to provide isolation whereas slots in ground plane are created to achieve ultra-wide band with enhance isolation. The size of the antenna is almost equal to UWB MIMO antenna proposed in [12] and is compact in size in comparison to [3–5,7,9–11], and [13,14], a detailed comparison is presented in Table 2.

2. Antenna design

Fig. 1 shows the geometry of the proposed UWB MIMO antenna. FR4 substrate with dielectric constant of 4.4, loss tangent of 0.02, and substrate thickness of 0.8 mm is used for designing the antenna. The size of the antenna is 45 × 25 mm^2. The MIMO antenna has two identical antiparallel UWB monopoles. Each monopole consists of a hexagonal ring radiator. To achieve broad band impedance response best choice for designer is circular radiator. Because of their curved structure they provide broad band impedance matching. Hexagonal structure is chosen because it occupies less area for the same radius as compared to circular radiator. Since antenna is placed in anti-parallel manner so both the antenna covers maximum range within the same plane. Proposed structure is suitable for USB Dongles as it occupies very small area. For getting resonance, total ring length is taken about half of the guided wavelength at 3.1 GHz. Slots between feedline and ground

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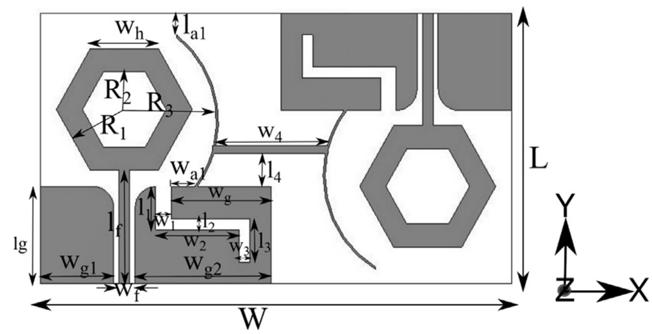

Fig. 1. Geometry of the proposed UWB MIMO antenna-I.

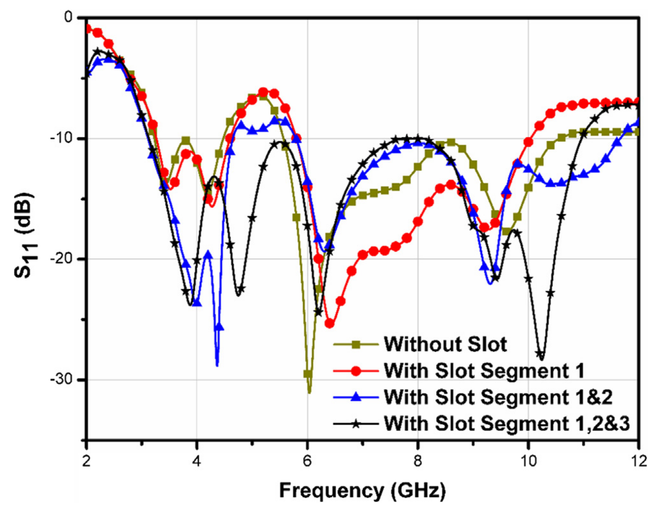

Fig. 2. Effect of ground slots on antenna performance.

planes of CPW are tapered to get good impedance matching over a broad bandwidth. Two grounded slots also are placed between two monopoles for the same purpose. Two circular arc shaped grounded stubs are used to get low mutual coupling. Ground planes of two monopoles are connected using stub over circular arc. To get a design guideline, effect of different portions of the antenna on the performance is discussed. CST Microwave Studio is used for simulation purpose.

Each ground plane is defected with slots having three segments. Fig. 2 depicts the effect of introduction of the parts of the slots step by step on impedance matching. It shows that S_{11} is above -10 dB in the frequency range of 4–6 GHz specially and overall S_{11} response is not

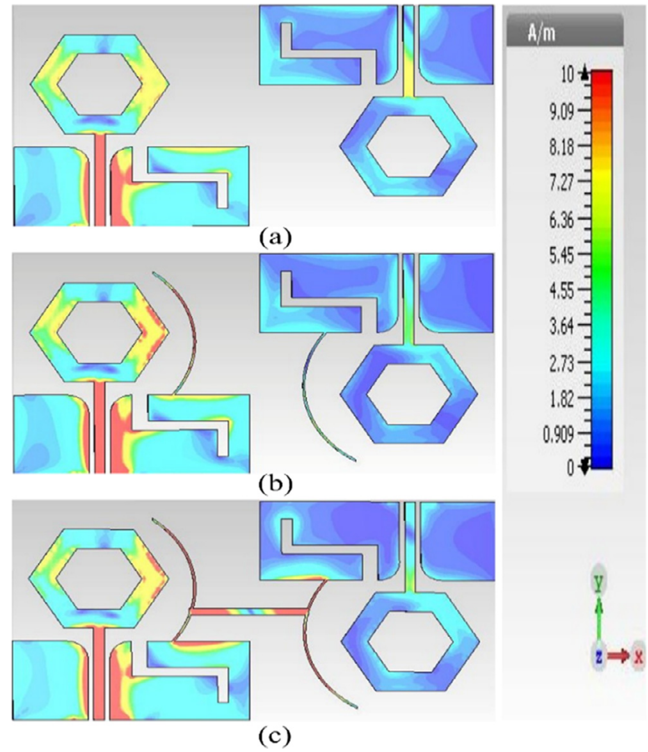

Fig. 4. Simulated surface current distribution at 7 GHz when port 1 is excited (a) without circular arc stub and (b) with isolated circular arc stub (c) with connected circular arc stub.

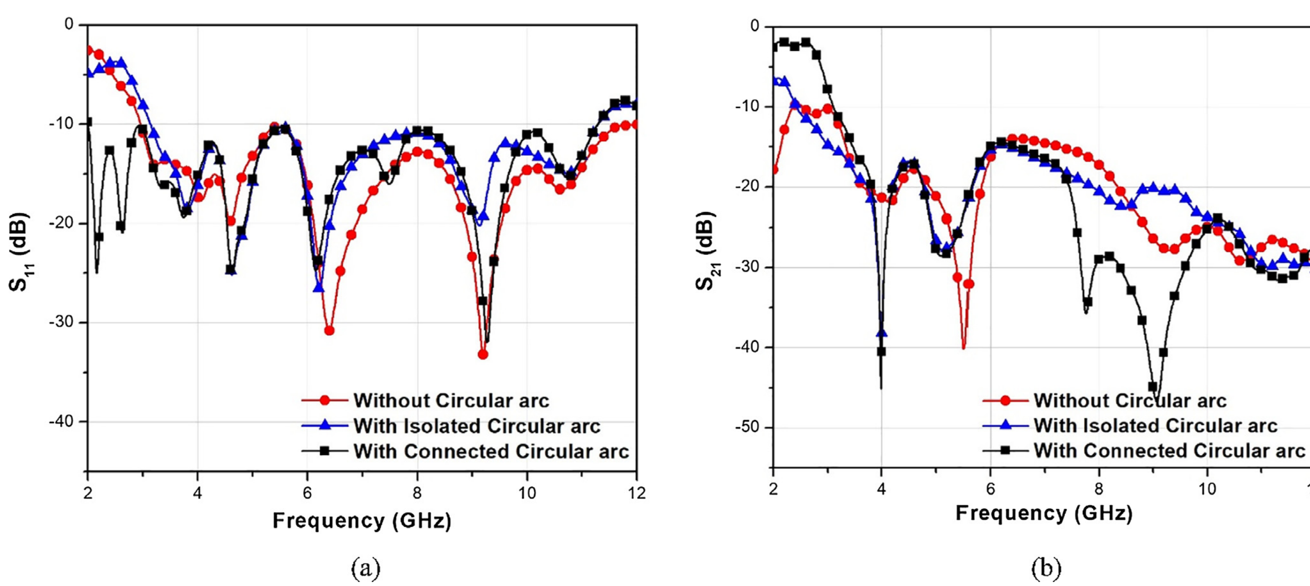

Fig. 3. Effect of circular arcs on s-parameter of the proposed antenna.

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