

Circular slot antenna for triband application

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ABSTRACT

We recommend a circular monopole antenna (CMPA) with a central feed to operate in three bands. The antenna is circular and has an 8 cm diameter. The suggested antennas' resonance frequency ranges are 2.43 GHz, 5.24 GHz, and 9.61 GHz. The planned CMPA is made up of two circle-shaped slots cut into the radiating patch. The whole structure is supplied via a microstrip feed line and analysed using CST Studio's electromagnetic simulator, which is based on finite integral technique (FIT). To check the structure, the return loss, radiation pattern, voltage standing wave ratio (VSWR), and gain are all examined. The structure's ideal dimensions are determined using a parametric study of three factors: feed position, feed breadth, and ground size. The proposed CMPA is capable of operating in several bands and has good matching impedance in all of them.

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1. INTRODUCTION

Wireless transmission to single-band antennas in the field is the most rapidly evolving communication technology. It's a method of transmitting data from one point to another without using wires, cables, or any other physical medium. In a communication system, data is transferred across a short distance to a receiver. Wireless communication transmitters and receivers may be anywhere from a few metres (like a television remote control) to thousands of kilometres away (satellite communication). A multiband antenna may operate across many frequency bands [1]–[5]. Multiband antennas consist of two components, one of which is active for one band and the other for another. The antennas may have lower-than-average gains or be physically bigger to accommodate the various bands [6]–[10].

Metamaterials are artificial materials with properties that aren't found in nature. These qualities come from the insertion of small inhomogeneities to assure successful macroscopic behaviour. Metamaterials are now part of the primary electromagnetic stream [11]–[15]. Metamaterials with a one-of-a-kind design and structure are very valuable. Electromagnetic waves interact with inclusions in composite media, generating electric and magnetic moments that affect the bulk composite medium's macroscopic effective permittivity and permeability. This provides criteria such as host material quality, size, form, and inclusion combinations to the designer. All of these design aspects combine to form the final result. The shape of the inclusions in these materials brings up new metamaterial processing opportunities [16]–[20].

A split-ring resonator (SRR) is a negative index metamaterial (NIM) component, sometimes known as double negative metamaterials (DNG). Other metamaterial kinds, such as single negative metamaterial, may also include them (SNG). Metamaterial research, such as terahertz metamaterials and acoustic metamaterials, also uses SRRs. Split ring resonators have two concentric annular rings with splits at either end. The rings are made of a nonmagnetic metal like copper, and there is a little gap between them. It creates the proper magnetic susceptibility up to 200 terahertz [21]–[25].

2. PROPOSED CIRCULAR MONOPOLE ANTENNA CONFIGURATION

In backview, just the earth and substrate are visible. The parameters of the circular slot are shown in Table 1. The brown colour symbolises the substrate, which is FR4, and the grey colour depicts the ground, which is copper is shown in Figure 1. Antenna A is a simple circular monopole antenna affixed to the feed with a length of 36 mm and a radiating element width of 32 mm is shown in Figure 2.

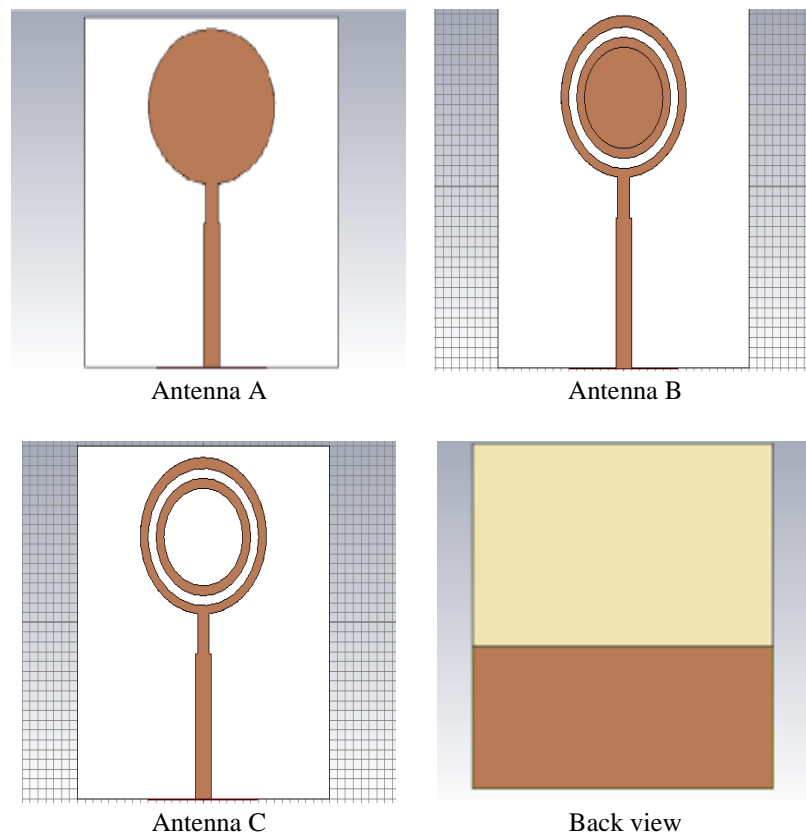


Figure 1. Evolution of proposed circular monopole antenna (CMPA)

The port is activated after the simulation, and its frequency ranges from 2.5 GHz to 2.5 GHz with a voltage standing wave ratio (VSWR) of 1.069. Antenna B is a circular antenna with a 7 mm inner circle radius. After modelling, its radiating frequencies were 2.4 GHz, 5.43 GHz, and 9.78 GHz, which we were able to attain for multiband applications. The VSWR for each radiating frequency must be more than two, according to the specifications. The applications include ISM band, WIFI, and X band. The next phase is Antenna C, which entails cutting a 5 mm diameter slit from the backview in order to increase frequency response. As a multiband antenna, it can operate at frequencies of 2.4 GHz, 5.23 GHz, and 9.60 GHz. For use in the ISM, WIMAX, and X bands. Each radiated frequency satisfies the VSWR criteria. The surface current radiates greater at a frequency of 9.6 GHz. In the ISM band, the gain of antenna d is determined to be 2.6 dbi after modelling. Because the radiation pattern in the shape of an eight is thought to radiate effectively, we have a radiation pattern that radiates successfully.

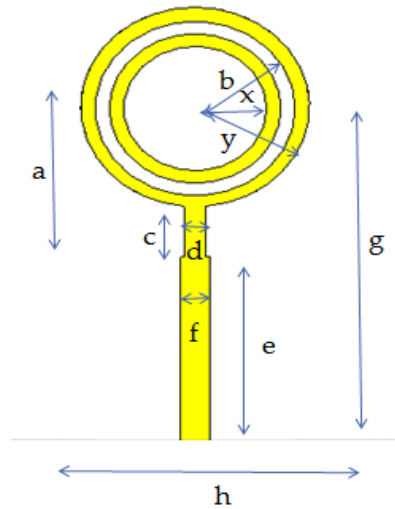


Figure 2. Circular patch antenna

Table 1. Parameters values of circular slot

a	b	c	d	e	f	g	h	z
17.1	8	2.4	1.5	18.9	2	36	32	5

3. RESULT AND DISCUSSION

The S parameter of the circular slot is shown in Figure 3. The blue color wave is the gain wave obtained after simulating antenna A. The green color wave is obtained after simulating antenna B. The red color wave is obtained after simulating antenna C. Figure 4 as a graph indicates the gain of the antennas. The gain of the circular slot is shown in Figure 4(a).

As illustrated in the image, the circular monopole antenna connected to the feed resonates at a single frequency of 2.56 GHz, giving it a gain of 1.53 GHz is shown in Figure 4(b). The gain is shown in Figure 4(c) at 9.7 GHz and the gain is shown in Figure 4(d) at 9.6 GHz. After etching a slot in the antenna's centre, it starts to transmit triband frequencies of 2.43 GHz, 5.43 GHz, and 9.76 GHz, resulting in a well-structured loop. The etching of another slot with a radius of 5 mm from the CMPA's centre causes the antenna to resonate at 2.4 GHz, 5.2 GHz, and 9.6 GHz. In all operating bands, the gain generated is greater than 1 dBi, as seen in the simulated gain plot vs. frequency. The radiation pattern of the circular slot is shown in Figure 5. The results value is shown in the Table 2.

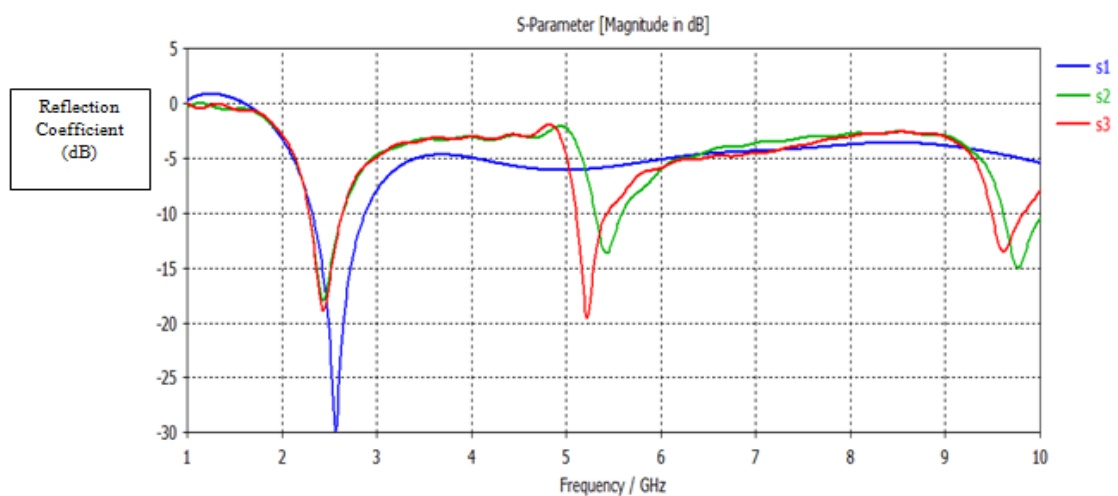
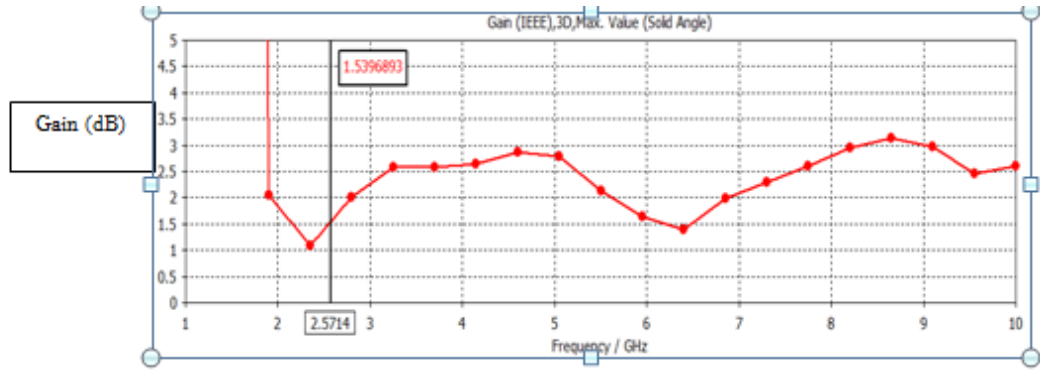
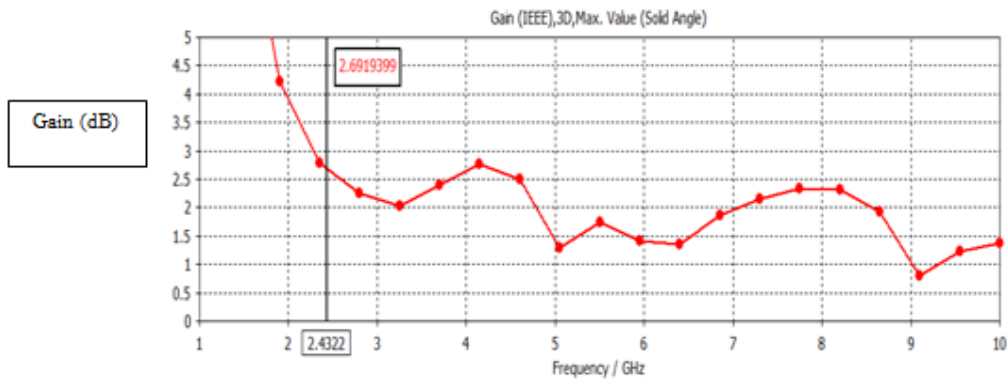


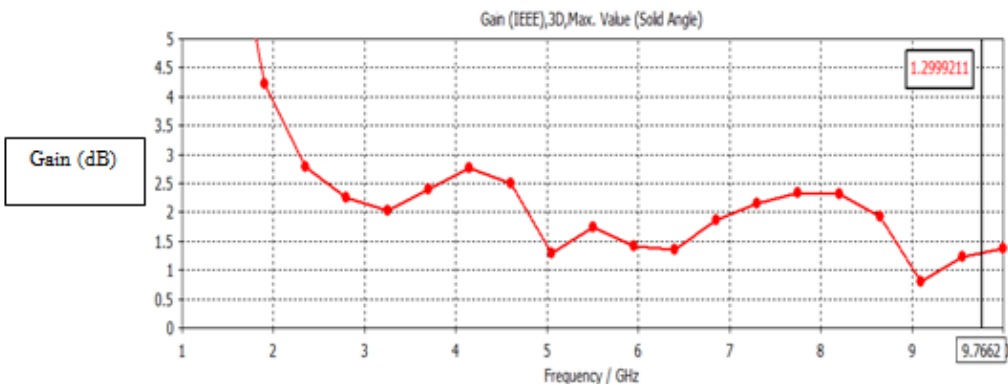
Figure 3. S-parameters of circular slot



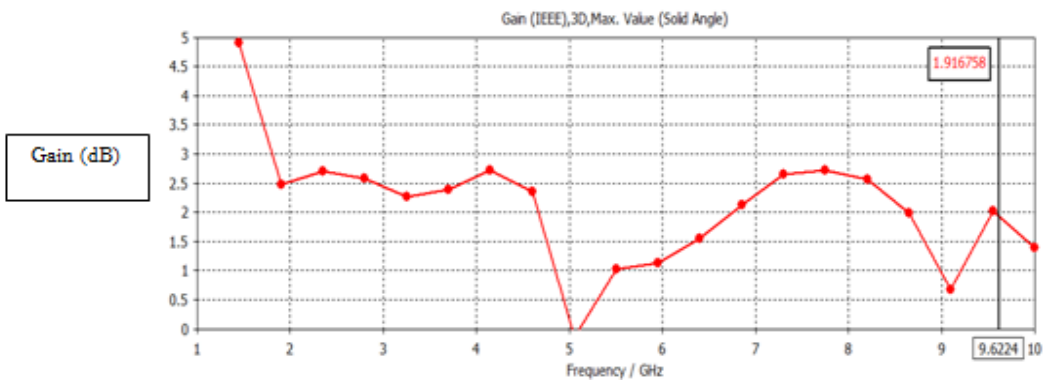
(a)



(b)



(c)



(d)

Figure 4. Gain of the circular slot (a) gain for 1.5 GHz, (b) gain for 1.4 GHz, (c) gain for various frequencies, and (d) gain for 9.6 GHz

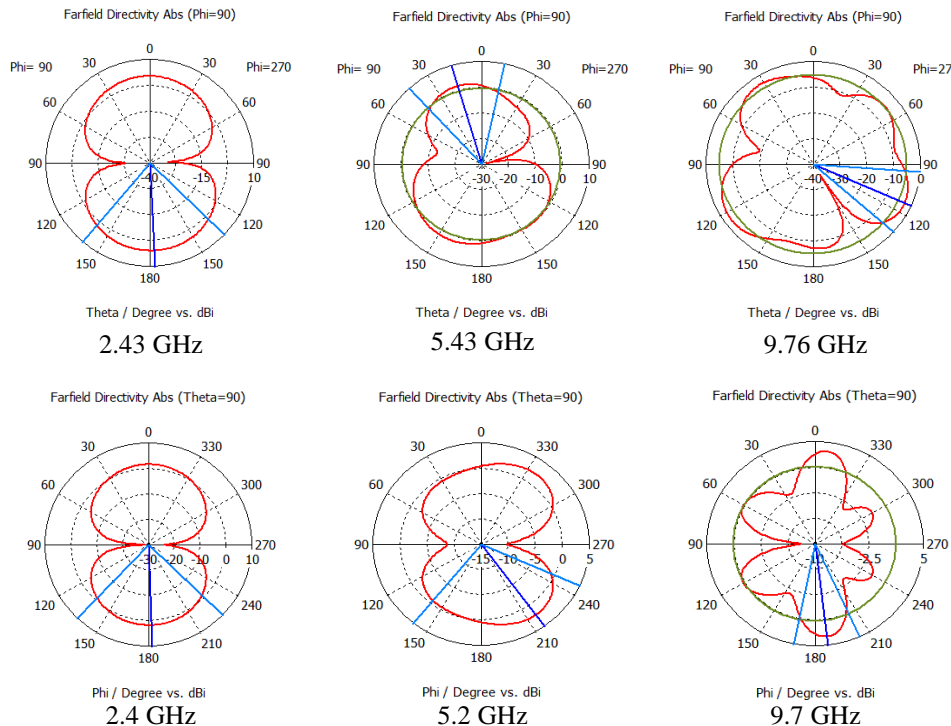


Figure 5. Radiation pattern of the circular slot

Table 2. Results of the circular slot antenna

Antenna	A	B	C
Frequency of resonance (GHz)	2.56	2.4	5.4
Gain (dBi)	2.57	1.7	2.7
S11 (dB)	-30	-18	-13

4. CONCLUSION

The performance of a multiband compact low-profile circular patch antenna with minimal cost and latency is investigated. The antenna can operate at 2.43 GHz, 5.22 GHz, and 9.67 GHz with a VSWR of 2. Parametric evaluations of the antenna are carried out in considerable detail. The antenna is simple to build and integrate. In the ISM, WIMAX, and X bands, this circular patch antenna may be utilised. The operating frequency's bandwidth has been suggested to be altered or shifted using a bandwidth augmentation strategy. The return loss, bandwidth, and signal power transmitting percentage of the designed antenna were used to assess its performance in terms of radiation parameters. Additionally, their straightforward designs, compact size, and simplicity in integration with microwave circuits make them very useful in usage. But the second antenna's omnidirectional radiation characteristic was impacted by the ground's opening slot, which needs further research.





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