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Research Paper

COPLANAR WAVEGUIDE-FED MICROSTRIP ANTENNA WITH HEXAGONAL AND RECTANGULAR SHAPE SLOT FOR WLAN/WIMAX APPLICATIONS

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In this research work, a CPW-fed octagonal shaped patch embedded with various hexagonal and rectangular shaped slots are cut on it which produces dual-band operation which is suitable for WLAN/WiMAX applications. The proposed antenna has a simple structure the overall size of the proposed antenna is 38 mm x 30 mm x 1.6 mm and patch size of 24 mm x 30 mm x 1.6 mm. The parametric study is performed to understand the characteristics of the proposed antenna. The proposed antenna is capable of generating two distinct operating bands 3.4-4.3 GHz and 4.8-6.3 GHz, covering 5.2/5.8 GHz WLAN bands and 3.5/5.5 GHz WiMAX bands. The various antenna parameters like S-parameters, current distribution and radiation pattern are studied.

Keywords: Microstrip Antenna, WLAN, WiMAX, CPW feed, BW

INTRODUCTION

The growth of ULSI/VLSI and modern wireless communication system has caused wide interests in designing multiband antennas; especially for Wireless Local Area Network (WLAN) and worldwide interoperability for microwave access (WiMAX) (Constantine, 1972). There is a need to design such antennas which are compact in size and meet the demands of today's compact trends (Supriya and Devender). Also to satisfy the IEEE 802.11 WLAN standards in the 2.4/5.2/5.8 GHz operating bands or WiMAX 2.5/3.5/5.5 GHz bands, multiple-bands antenna with low cost, compact size, easy fabrication, and higher performance are required (Girish and Ray,

2010). The demand for compact and low profile antennas has brought the Microstrip Antenna (MSA) to a great demand (Choi *et al.*, 2001). These are one of the most useful antenna at microwave frequency ($f > 1$ GHz). In this investigation, Octagonal shape microstrip antenna with hexagonal and rectangular slots is presented for wireless communication application. In this design, the main patch is fed by CPW (Coplanar Waveguide) feed. Further, modifications are done in the patch to improve the bandwidth. The details of antenna design are discussed in section 2. The parameters of antenna are studied in section 3. Simulated results and discussions are provided in section

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4, and conclusions are presented in section 5.

ANTENNA GEOMETRY

The geometry of the proposed monopole antenna is shown in Figure 1. The total size of the proposed antenna is 24 mm x 30 mm x 1.6 mm. The geometry of proposed antenna is shown in Figure 1. The antenna is designed on FR4 substrate with dielectric constant of 4.4 with thickness of 1.6 mm. As shown in figure, the ground size of the proposed antenna is 14 mm x 11.5 mm. The ground plane is symmetrical at the base line of the feeding strip line. Thus, the proposed antenna design can provide a wide bandwidth while retaining stable performance via the optimized geometrical parameters. The parameters of proposed antenna are shown in Table 1. The distance between patch and ground is 9.6 mm and between feed and ground is 1.12 mm. The rectangular strip feed line has dimensions of 14.5 mm x 4.5 mm. Initially, an octagonal shape like patch is taken then modifications are done in patch like, addition of hexagonal slots in its upper

part and rectangular slots in its lower left part step by step are cut in the proposed antenna. The parametric study is done in next section like variation in distance between patch and ground and distance between feed and ground has been varied.

PARAMETRIC STUDY

Figure 2 shows the evolution of proposed antenna design and its corresponding simulated frequency response of return losses. The following analysis is based on basic antenna structure as shown in Figure 2 (a) named as Antenna 1, which consists of an octagonal shape patch. Then modifications are done in the patch step by step as shown in Figure 2 (b) and 2 (c).

Figure 3 shows the comparison of return losses of different antenna configuration. Only lower bands of WLAN/WiMAX are obtained by antenna1. When a triangular slot is cut in the lower left part of patch, it has been noted that higher bands are not obtained. Thus, in order to

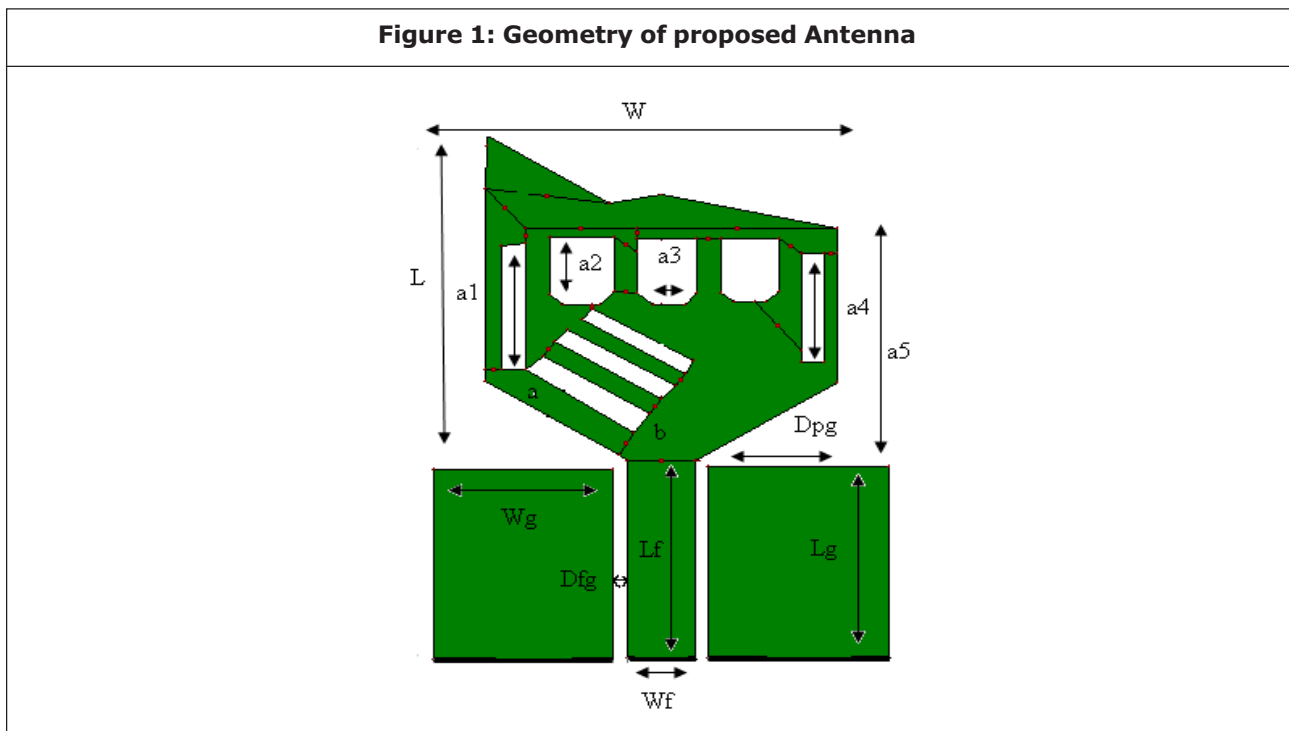


Table 1: Dimensions of Antenna					
Parameter	Size (mm)	Parameter	Size (mm)	Parameter	Size (mm)
L	24	L_f	14.55	a_1	9.2
W	30	D_{pg}	9.6	a_2	4
W_g	11.5	D_{ig}	1.12	a_3	2
L_g	14	A	7	a_4	8
W_f	4.5	B	0.52	a_5	17.25

Figure 2(a) Antenna 1

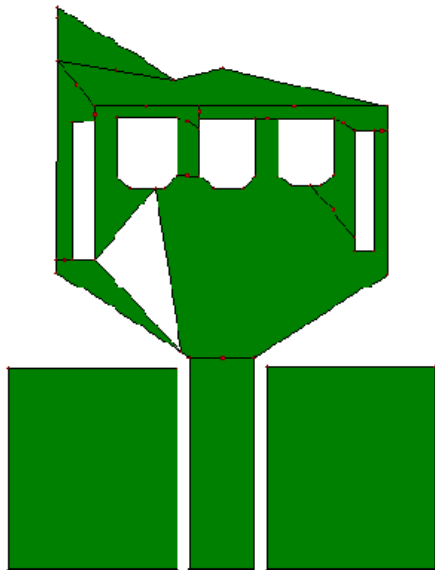


Figure 2(b) Antenna 2

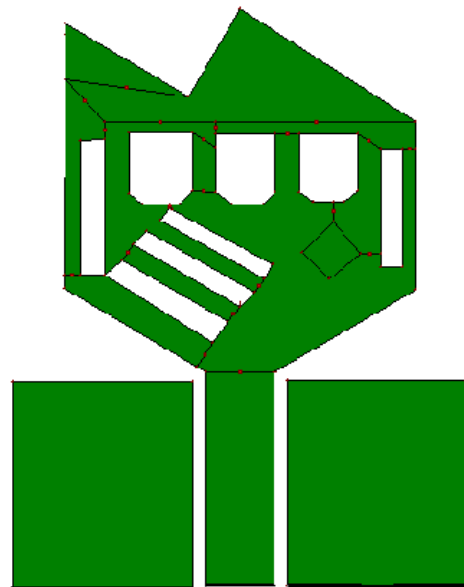


Figure 2(c) Antenna 3

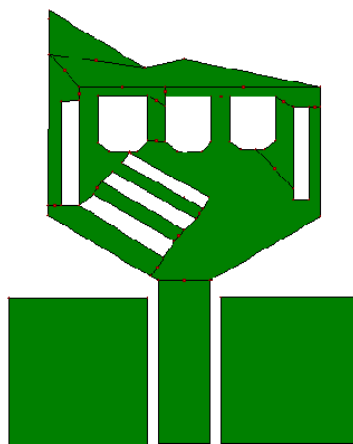


Figure 3: Comparison of Return Losses of different antenna configuration

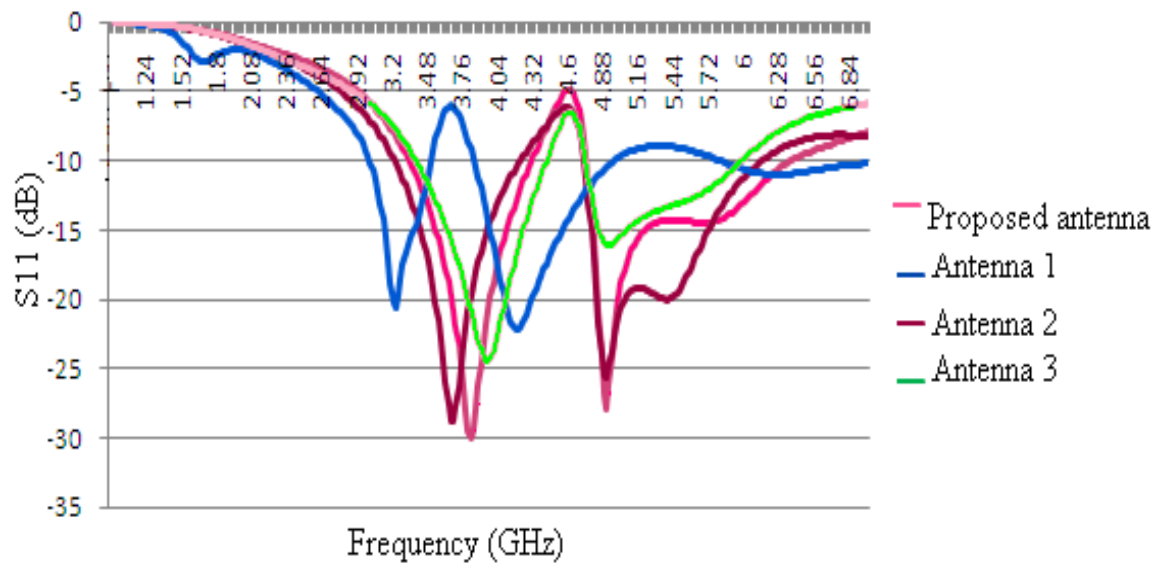
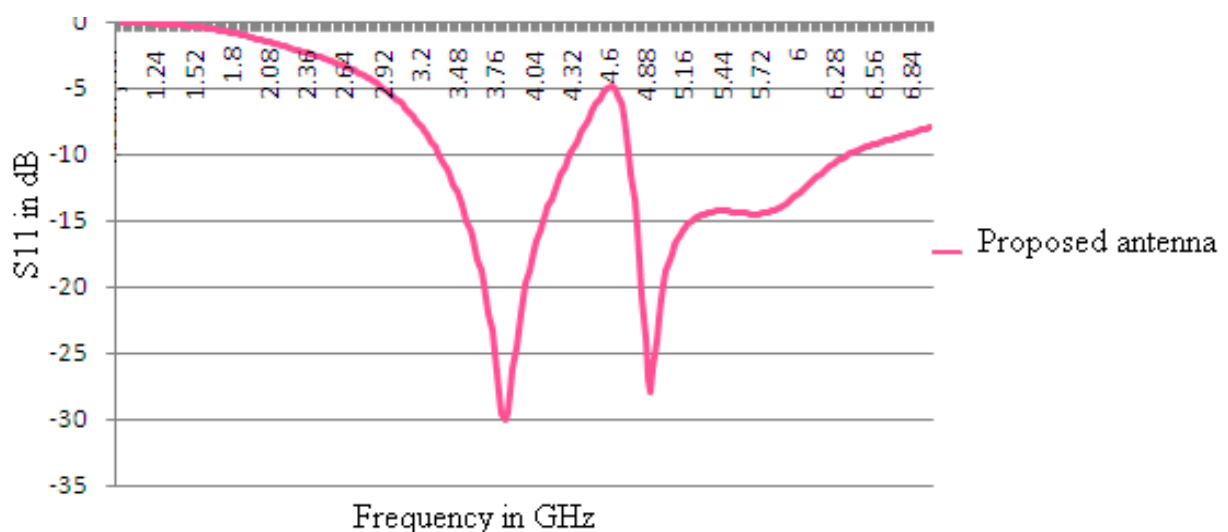


Figure 4: Return losses for proposed antenna



obtain the upper bands changes have been made in design of antenna 1. It has been observed that when rectangular slots are cut instead of triangular slot and length of patch along y-axis is increased, there is a significant change in the covered bands. Now a band of frequency 3.4 GHz to 4.3 GHz is getting covered. Also the upper

bands of WLAN/WiMAX are also getting covered in the range of 4.8 GHz to 6.2 GHz. Further changes are made in the design of antenna 2. Length of ports is decreased by 1 mm, but this variation leads to decrease in the peak of return losses. Such results are undesirable, so length of port is again increased.

SIMULATED RESULTS AND DISCUSSION

Figure 4 shows the corresponding return loss of proposed designs. The above graph in Figure 4 shows that the proposed antenna has an impedance bandwidth of 1.1 GHz at lower band ranging from 3.2 GHz to 4.32 GHz and other impedance bandwidth of 1.8 GHz at higher band ranging from 4.7 GHz to 6.5 GHz. The graph is having 2 resonance frequencies at 3.72 GHz and 5 GHz. The peak of return losses reaches -30 dB and -28 dB losses. The 2D radiation pattern and current distribution has been observed on 2

resonance frequencies. The resonance frequency is controlled by patch length and substrate permittivity (Girish and Ray, 2010). Radiation efficiency is ratio of power radiated in space to the total input power. Antenna radiation patterns usually take two forms, the elevation pattern and the azimuth pattern (Anshul, 2012). The elevation pattern is a graph of the energy radiated from the antenna looking at it from the side. The azimuth pattern is a graph of the energy radiated from the antenna as if you were looking at it from directly above the antenna (Girish and Ray, 2010). Simulated 2D Radiation Pattern for different frequencies like 3.76 GHz, 5 GHz has

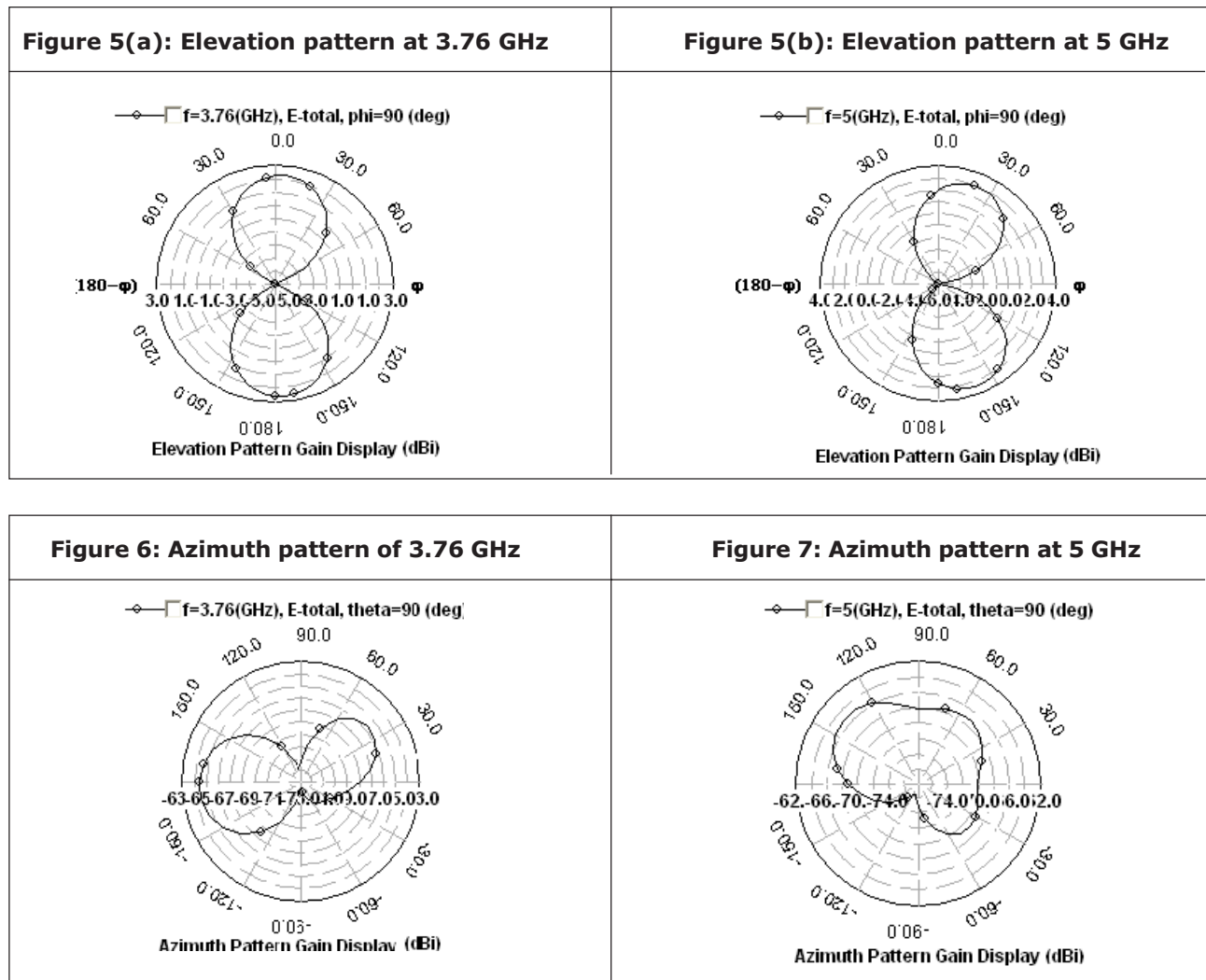


Figure (8) 3-D Pattern of Proposed Antenna at 5GHz and 3.76GHz

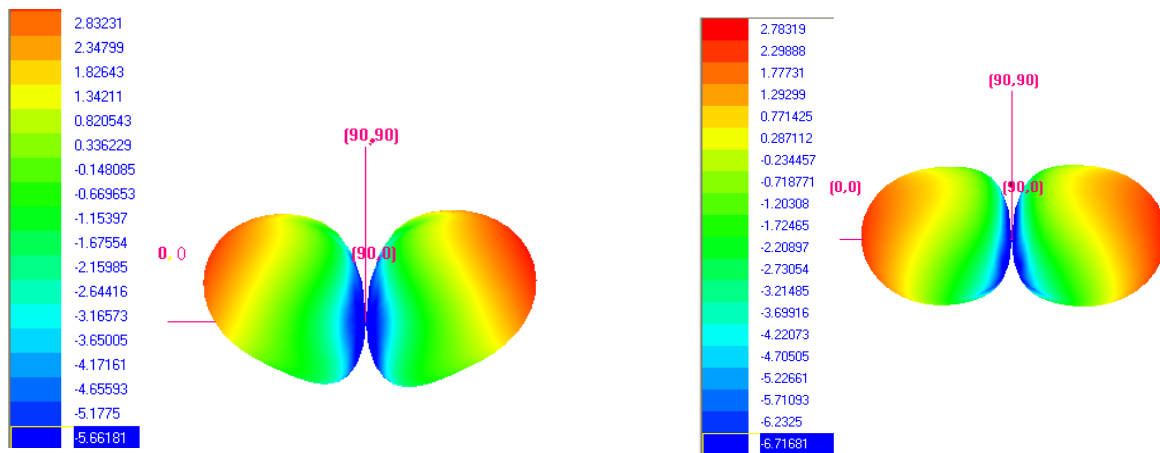


Figure 9(a) Current Distribution of Proposed Antenna at 3.76 GHz

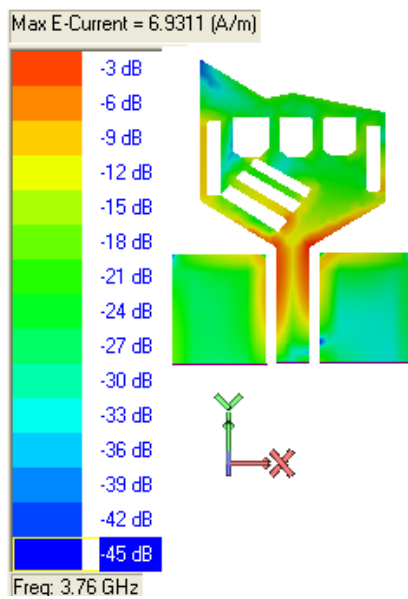
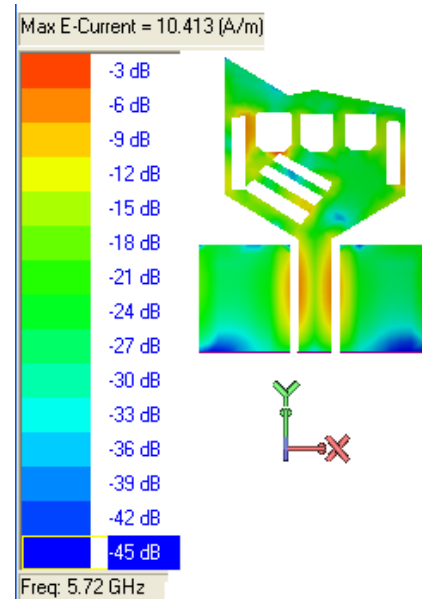


Figure 9(b) Current Distribution of Proposed Antenna at 5.72 GHz



been observed in Figures 5 and 6. In Figure 7 azimuthal pattern of proposed antenna at 5GHz is shown. Figure 8 shows the three- dimensional pattern of antenna at the two resonant frequencies.

The formation of the frequency resonances can be explained by observing the surface currents on

the conductors of the antenna at 3.76 GHz, 5.72 GHz as shown in Figure 9(a) and Figure 9(b). Current distribution is changed by changing the length and dimensions of patch. The maximum E-current at 3.76 GHz is 6.9311 A/m and at 5.72 GHz is 10.413 A/m.

CONCLUSION

In this investigation, a microstrip antenna fed by Coplanar Waveguide (CPW) feed is proposed. The proposed antenna has compact size of 24 mm x 30 mm x 1.6 mm and covers Wireless Local Area Network (WLAN) and worldwide interoperability for microwave access (WiMAX) bands also. The various antenna parameters like S-parameters, current distribution and radiation pattern are studied. It can be concluded from the results that the antenna has satisfactory performance and hence can be used for broadband wireless communication systems.

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