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Design of Ku Band Cylindrical Dielectric Resonator Antenna

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Abstract
In this paper a cylindrical dielectric resonator antenna for Ku band is proposed. By using cylindrical DR, metallic cylinder and intermediate layer we obtain large bandwidth and high gain. The cavity formed by the metallic cylinder gives the high gain. The intermediate layer suppresses the surface wave propagation to improve the gain. The measured result for the proposed antenna achieves a bandwidth from 15.2 GHz to 16.7 GHz with a voltage standing wave ratio of less than 2 and a high gain of nearly 11.5 dB.

Keywords: *Cylindrical dielectric Resonator antenna; Intermediate layer; Metallic cylinder; Slot feeding*

INTRODUCTION
Now a day the dielectric resonator antennas are used for many wireless applications because of their design flexibility. The structure of DRA consists of mainly three parts. They are first one substrate, secondly ground etched on substrate material and dielectric resonator material placed on ground. DRAs provide the high radiation efficiency, minimal conductor losses and low surface wave losses. The demand for wideband antennas is more for wireless communications because of low profile and small in size. The gain of antennas can be enhanced by using several methods, they are stacking DRAs on top of each other, arraying of elements together, using shallow pyramidal horn antenna. Mushroom-like electromagnetic band gap structures, placing circularly polarized DRA with in a circular cavity increases the gain of DRA.

Higher-mode methods are also used to improve the gain. However, all these methods are for narrow impedance bandwidth. Slot feeding technique is used. The main advantage of this method is that it avoids a direct electromagnetic interaction between the feed line and the DRA.

In this paper to improve the bandwidth and gain an intermediate layer, metallic cylinder which forms a cavity are used.

ANTENNA DESIGN AND CONFIGURATION

The proposed DRA configuration is as shown in the fig. 1 Rogers RO4350 substrate of 45 X 45 mm with a dielectric permittivity of 3.66 and thickness of 0.762 mm. A copper metallic ground with a size of 45 X 45mm. A narrow slot with the size of 3.8 X 0.3 mm is centrally etched on ground.

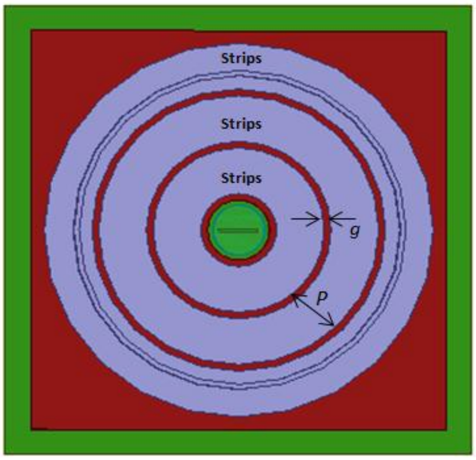

Fig. 1 Topview of proposed antenna

A microstrip line feeding with 50Ω is etched on the slot (0.6 X 25 mm) and terminates with open stub length of 2 mm. The dielectric resonator material of RT/Duroid 6010 with a dielectric permittivity of 10.2 with a height of h1 = 8.4 mm, and a radius of 2.5 mm. The intermediate layer of Rogers RT/Duroid 6002 with a dielectric permittivity of 2.94, thickness of 3.048 mm and with a hole of radius 3 mm in its center. A metallic cylinder with radius of 16 mm and height of 8 mm is placed concentric with the dielectric resonator. On the upper surface of the intermediate layer the concentric rings of the metallic strips are printed with the parameters of g = 0.65 mm, P = 5.25 mm. where g represents the distance from one strip to another strip and P represents the radial period. The first strip on the intermediate layer starts at the radius of (3 mm + g). Next strip with the radius of (3 mm + P).

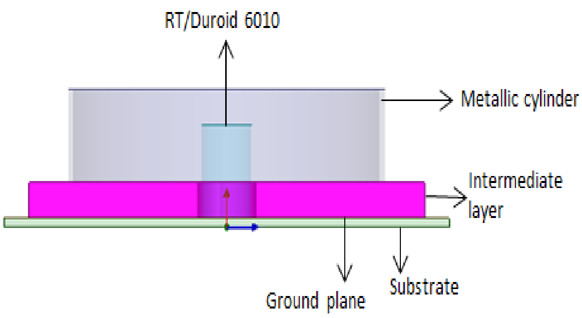

Fig. 2 side view of proposed antenna

Fig.2 represents the side view of the proposed antenna; it shows the alignment of the materials used in proposed antenna.

SOFTWARE

HFSS (high-frequency structure simulator) version 13.0 is used to design the proposed antenna. HFSS is one of commercial tool used for antenna gain, radiation pattern, design of complex RF electronic circuit elements including filters, transmission lines, and packaging. We may use other software CST (Computer Simulation Technology) to design the antenna.

SIMULATION RESULTS

The proposed dielectric resonator antenna was optimised by using the HFSS software.

Fig.3 represents the return loss; Return loss is defined as power returned back by reflections due to discontinuity or mismatch in the optical cable. Return loss is the ratio of incident power to the reflected power. Less in the value of return loss results in better performance. The measured bandwidth covers the range from 15.2 to 16.7 GHz with less than -10dB.

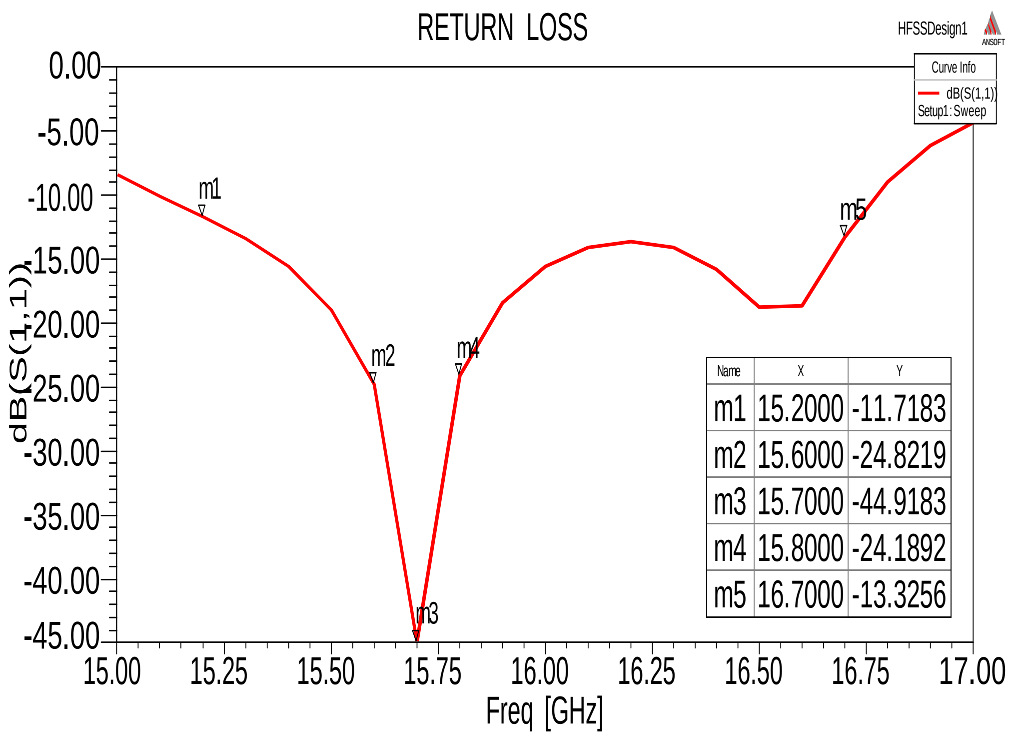

Fig.3 Simulated return loss

Voltage standing wave ratio measures power reflected from antenna which describes about impedance matching of antenna. The VSWR with value less than 2dB gives best result. **Fig. 4** represents the voltage standing wave ratio(VSWR) less than 2 which produces a bandwidth 1.5 GHz from the frequency range of 15.2 GHz to 16.7 GHz

Fig. 5 illustrates the simulated peak gain of the proposed antenna. It is seen that the gain is stable in between the frequency range of 15.4 to 16.1 GHz.

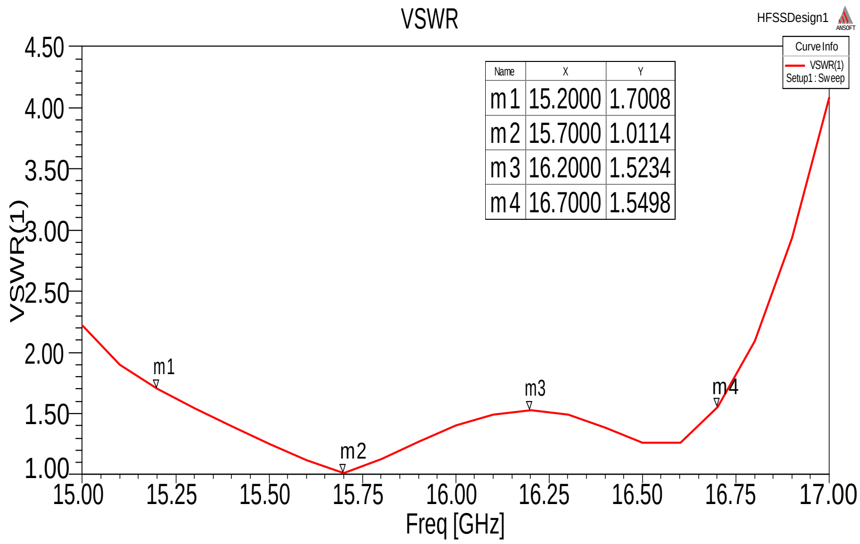

Fig.4 simulated voltage standing wave ratio

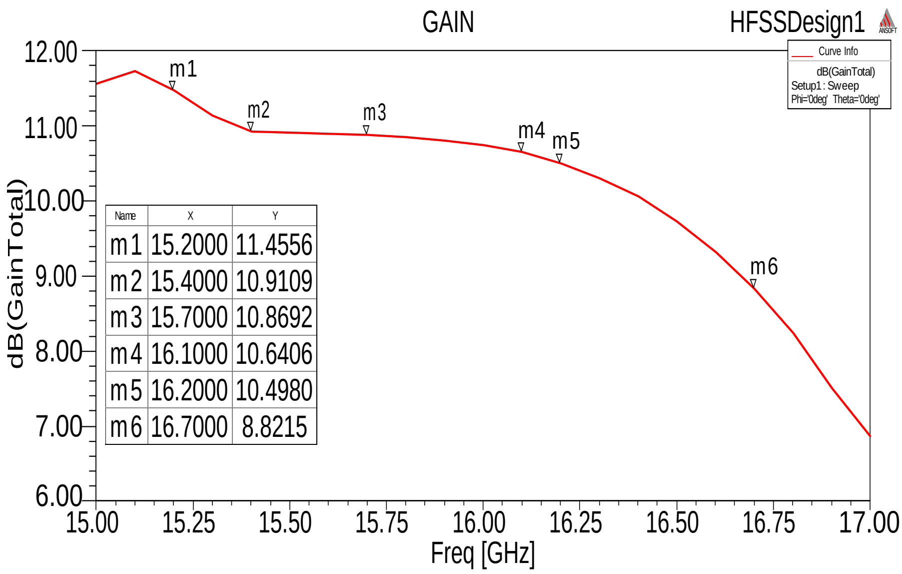

Fig. 5 peak gains of the proposed antenna

Radiation pattern represents the variation of power radiated by an antenna as a function of the direction away from the antenna. The radiation plots at 15.2 GHz and 15.7GHz are as shown in fig. 6(a) and fig. 6(b).

The gain patterns for the frequencies of GHz and 16.7 GHz are as shown in the fig. 7(a) and fig. 7(b). Gain obtained at the 15.2 GHz is 11.456 dB and at the 15.7 GHz is 10.869 dB.

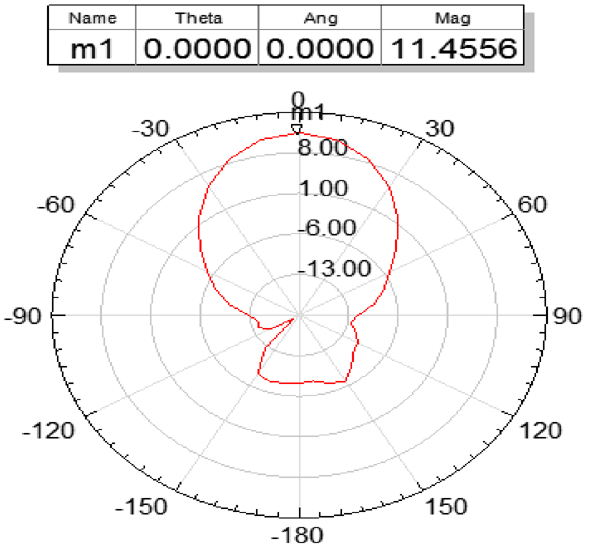

Fig. 6(a) radiation pattern at 15.2 GHz

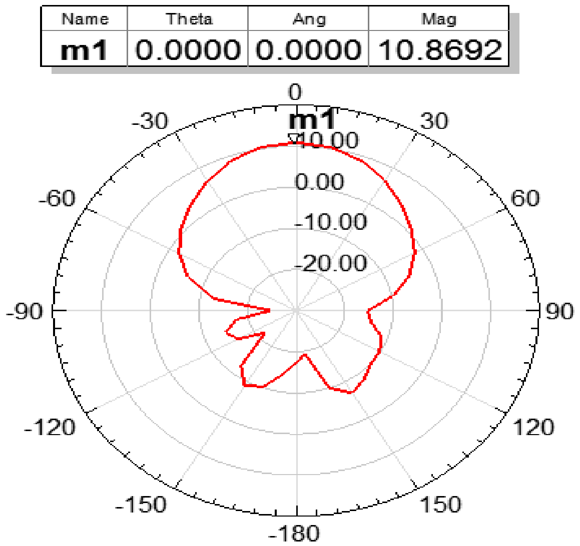

Fig. 6(b) radiation pattern at 15.7 GHz

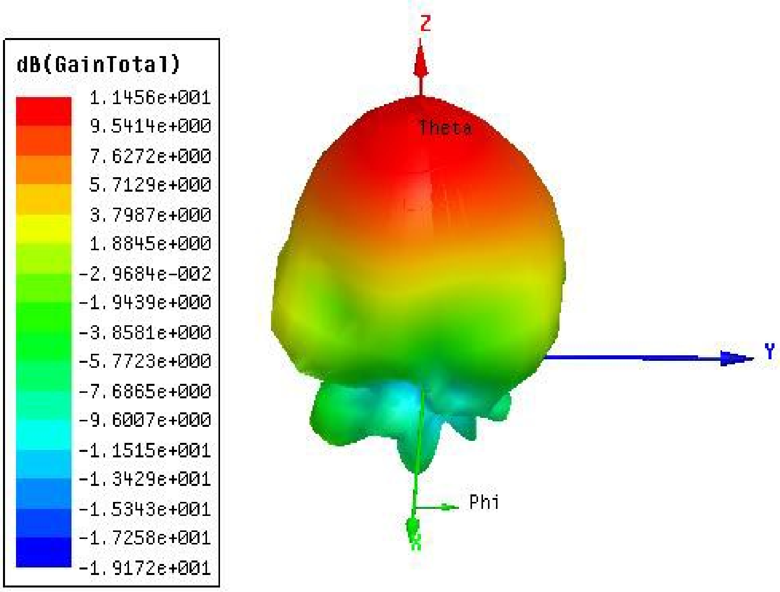

Fig. 7(a) Gain at 15.2 GHz

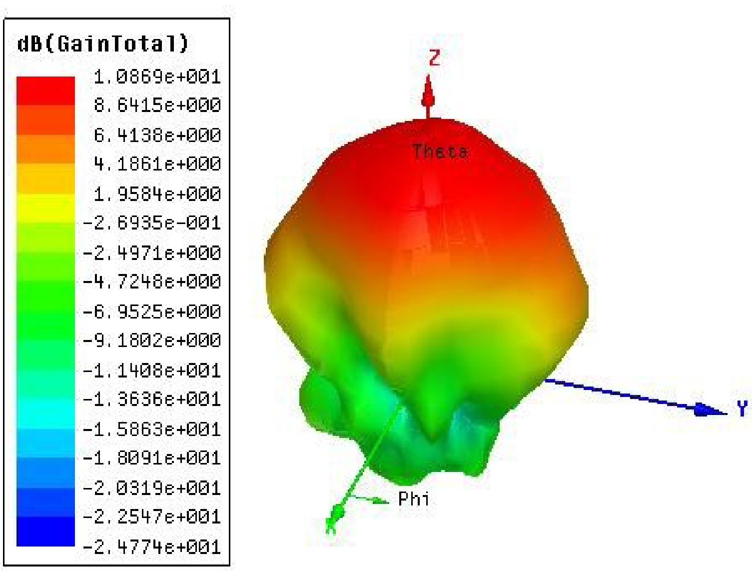

Fig. 7(b) Gain at 15.7 GHz

The gain of the proposed antenna antenna at the frequency of 15.2 GHz and 15.7 GHz are shown in fig. 7(a) and fig. 7(b).

The radiation efficiency obtained for the antenna is 97.4098%.

CONCLUSION

A new broad band cylindrical DRA design has been proposed for Ku band. By using intermediate layer and a metallic cylinder cavity, the proposed design achieves a high gain of 11.45 dB, a wide bandwidth range from 15.2 to 16.7 GHz. The proposed antenna can be used for fixed satellite broadcast services and international space shuttle communications.

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