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DESIGN AND SIMULATION OF RHOMBUS SHAPED FRACTAL DESIGNED MICROSTRIP PATCH ANTENNA USING IE3D SOFTWARE

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ABSTRACT
The objective of this paper is to enhance the bandwidth of Rhombus Shaped Fractal Microstrip Patch Antenna. To achive this, we cut a rhombus shaped slot in the microstrip antenna geometry. Glass epoxy is used as a dielectric substrate material of the antenna. The dielectric constant of substrate is 4.4 and the loss tangent is taken 0.006. In this paper different iterations are compared to get a better result in the form of improved efficiency, bandwidth and directivity. The performance of the final modified antenna is compared with conventional Rhombus Shaped Microstrip Patch Antenna. The designed antenna has two resonant frequencies 1.75 GHz and 2.48 GHz.

KEYWORDS: *Microstrip Antenna , Fractal Antenna, IE3D*

I. INTRODUCTION

Antenna is a device which can receive as well as transmit the electromagnetic signals. Now-a-days, wireless communication, mobile communication, satellite communication, military, medical field, etc all these requires antennas of wider bandwidth, higher gain, multiband support, low cost and requires smaller size. Microstrip Antenna are profound applications in all such fields. Its light weight and small size has diverse its utilizations. They are having a narrow bandwidth as well as low efficiency. The performance of microstrip antenna is depends upon the substrate parameters that are using for its fabrication such as: uniformity, loss tangent, di-electric constant. To improve the radiation pattern, gain and to minimize the return losses the fractal geometry is adding to the antenna design. The concept of fractal antenna is comes from the fractals existing in nature. Fractals geometry used in the antenna design helps to achieving the multiband behaviour of the antenna. Self similarity and space filling are two properties contained by fractals geometry. As antenna is radiates through its edges, these edges are increases by the fractal design so the radiation are increased by this geometry and it helps to increase the gain of antenna.
In this paper, IE3D software is used to simulate the radiation pattern and results. Basically, Ie3d is a full wave magnetic simulator which uses the tactics of moment. By the utilization of green's function it solves the Maxwell's equation in integral form.

II. FRACTAL ANTENNA

The term 'FRACTAL' means 'BROKEN' or some irregular fragments. The use of fractal geometry is a new solution to the design of multiband antenna and array.
According to the Mandelbrot "A fractal is a set for which the Hausdorff dimension strictly exceeds the topological dimension". The fractals are "self similar" as they repeat their geometric design or their statistical properties on many scales. Some of the advantages using fractal geometries are:

1. Supports multiband: it can be used in dual and triple frequency operations.
2. Increased bandwidth and gain: as the number of edges are increased so it will help to increase the gain of antenna.

3. The antennas may be easily mounted on missiles, rockets and satellites without major alterations.
4. Fractals antennas are having better input impedance matching.
5. Fractal antenna are having low cost as well as more reliable than the traditional ones.
6. By altering the relationship between gain, bandwidth and size, permit antennas to be more powerful and compact.

III. ANTENNA PARAMETERS

The basics parameter that discussed in this paper are as follows:

1. **Gain:** The term of antenna gain describe how much power is transmitted in direction of peak radiation to that of an isotropic source.
2. **Directivity:** It is the fundamental parameter of an antenna. It is a measure of how 'directional' an antenna's radiation pattern is. It is the ratio of maximum radiation intensity to the average radiation intensity. It is denoted by D.
3. **Radiation pattern:** These are the geometric pattern of the relative field strength of the field emitted by the antenna.
4. **VSWR:** It stands for voltage standing wave ratio. It is the ratio of maximum voltage to the minimum voltage in a standing wave pattern.
5. **Bandwidth:** Bandwidth specifies the range of frequencies over which the designed antenna can operate correctly.
6. **Return loss:** Return loss is the loss of power in the signal returned/reflected by the discontinuity in the transmission channel.

RL(dB)=10log10pi/pr
Pi= incident power
Pr= reflected power
RL(dB)= return loss

All these antenna parameter are used to specify the electrical and physical characteristics of an antenna.

IV. ANTENNA DESIGN ON IE3D

IE3D stands for Integral Equation Three-Dimensional . IE3D is a microwave circuit simulator from Zeland. In this paper, Microstrip patch antenna consisting a conducting ground plane of copper , a di-electric substrate(FR-4 epioxy) having permitivity of Ɛr = 4.4
The geometry for the antenna is calculated by the following formulaes:

1. Width , $W = \frac{c_o}{2f_o}\sqrt{\frac{2}{(1+\varepsilon_r)}}$
2. Effective Dielectric Constant , $\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1 + 12\frac{h}{W}]^{-1/2}$
3. Effective Length , $L_{eff} = \frac{c_o}{2f_o\sqrt{\varepsilon_{reff}}} - 2dL$
4. Length extension due to fringing field , $dL = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.624)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$

Where,
c_o = Velocity of light in free space
f_o= Resonant frequency
ε_r= Dielectric constant of the dielectric
ε_{reff}=Effective Dielectric Constant of the Dielectric

On applying these respective values we obtained the figure 1.

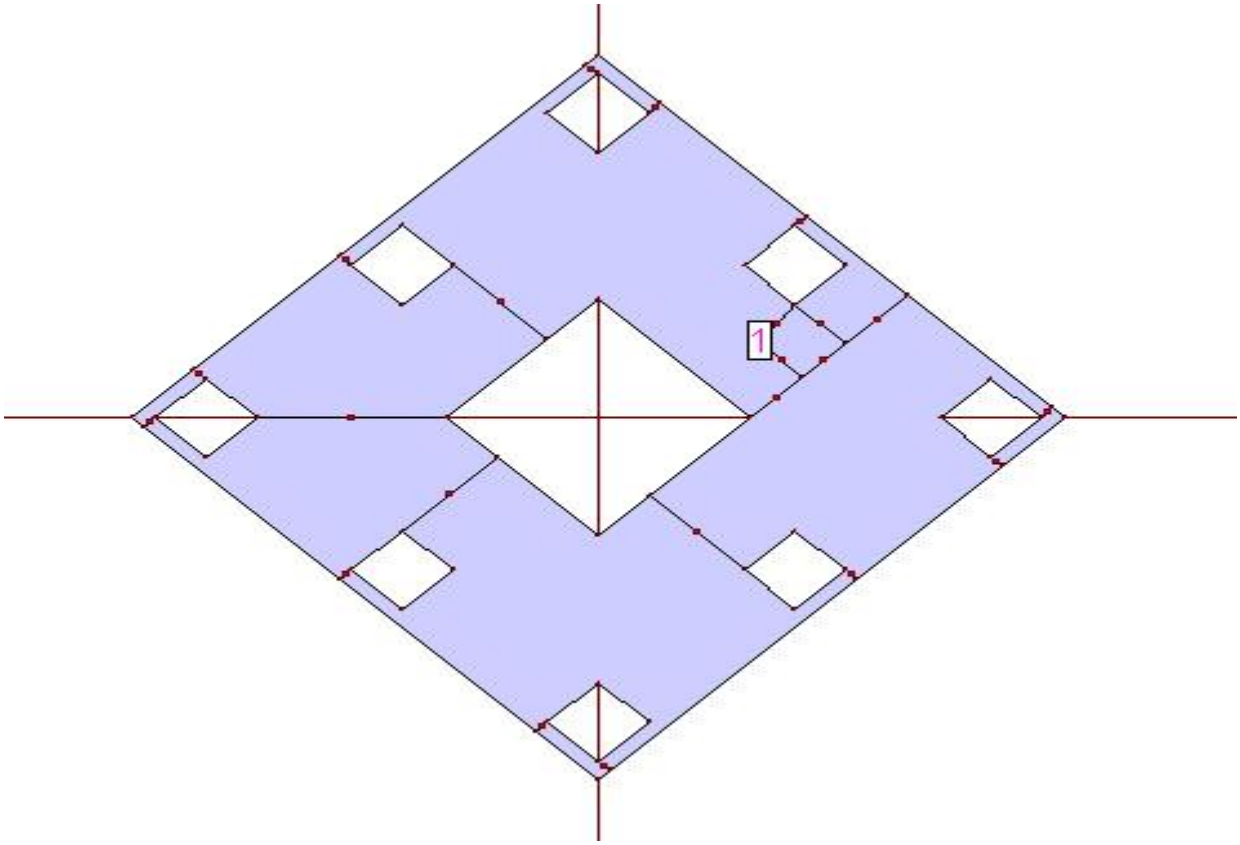

Figure 1 Rhombus Shaped Fractal Antenna

Figure 1 shows the designed antenna after the simulation by IE3D. As to meet the necessary dimension the co-ordinates of the patch are choosen as:
The coordinates (in mm) are (-26,0); (26,0); 0,26); 0,-26).

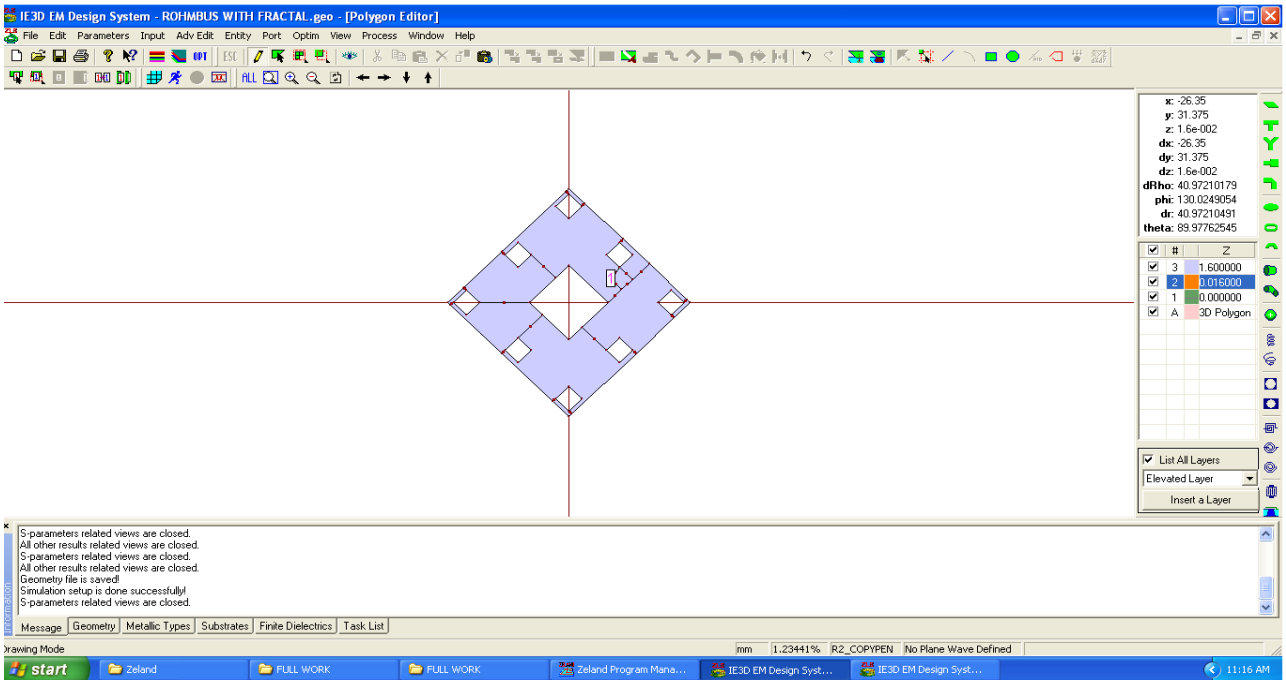

Figure 2 Simulation on IE3D

This designed is set for the freq. But it can be sweep over frequency 2.482 . The feeding technique is used at the co-ordinates of (9.5,5.5).

V. RESULT AND ANALYSIS

5.1 RADIATION PATTERN

It is the geometric pattern of relative field strength of the field emitted by the antenna. The results for the radiation pattern are shown in figure 3

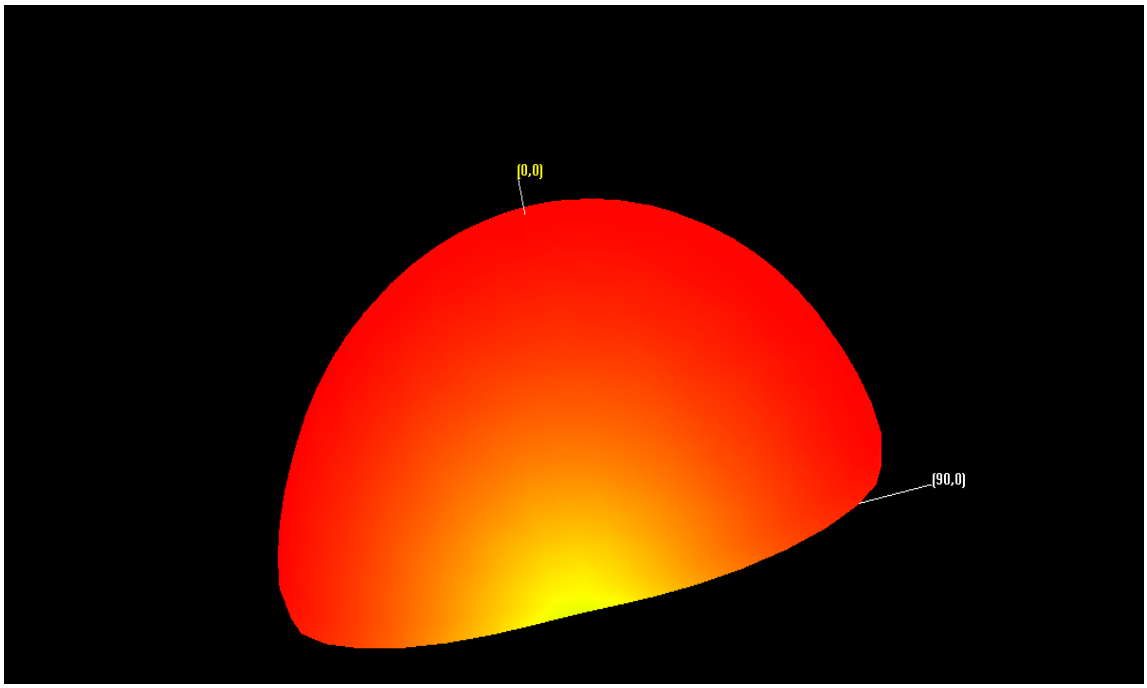

Figure 3 Radiation Pattern

5.2 GAIN

Gain is a measure of an output power for an isotropic source. It is defined as ratio of output power to the input power. In this paper, the gain observed of the antenna is 1.95356. For this antenna, we observe a graph between the frequency & the gain as shown in figure 4

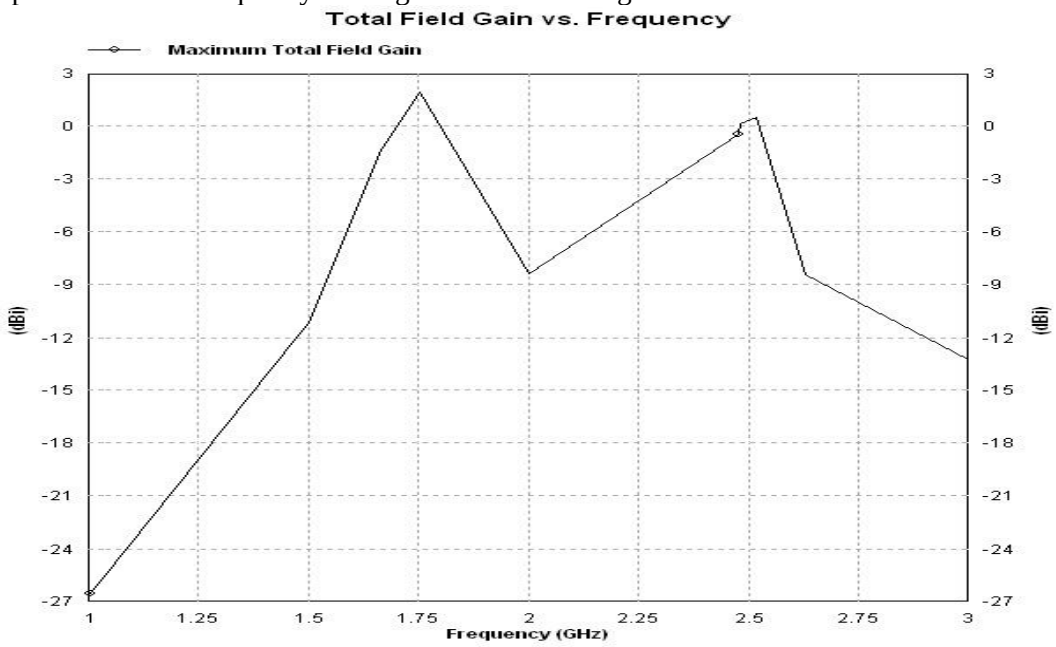

Figure 4 Gain

5.3 VSWR

It is ratio of maximum voltage to the minimum voltage in a standing wave pattern. The VSWR observed for the antenna is 0.14500. Graph shows the relationship between frequency & VSWR as shown in figure 5.

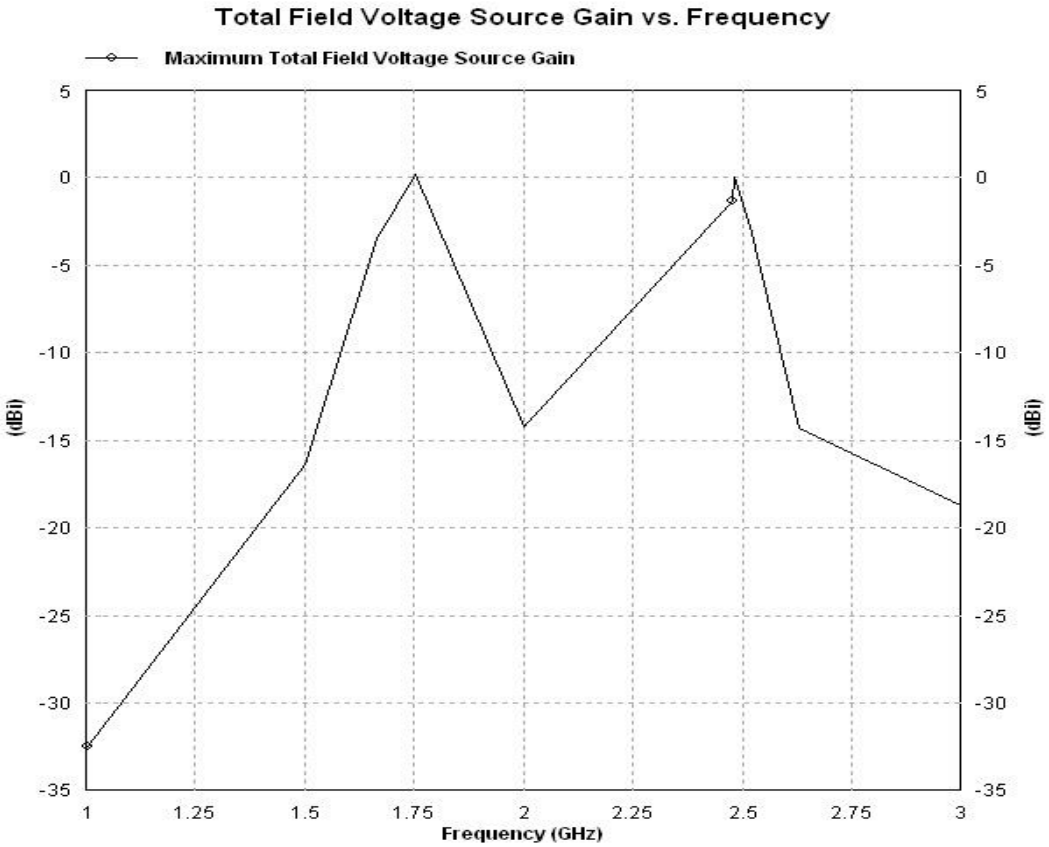

Figure 5 VSWR

5.4 DIRECTIVITY

The directivity observed for the antenna is 6.3400 dbi. The graph between the frequencies and the directivity is shown in figure 6.

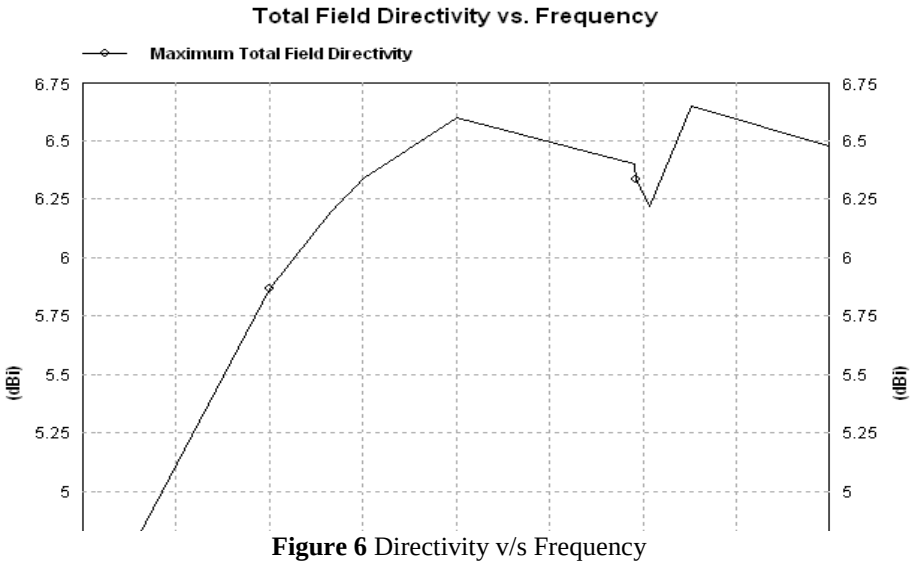

Figure 6 Directivity v/s Frequency

5.5 RETURN LOSS

The return loss observed for the antenna is -26.535 dB. The graph shows the relationship between return loss & the frequency in figure 7.

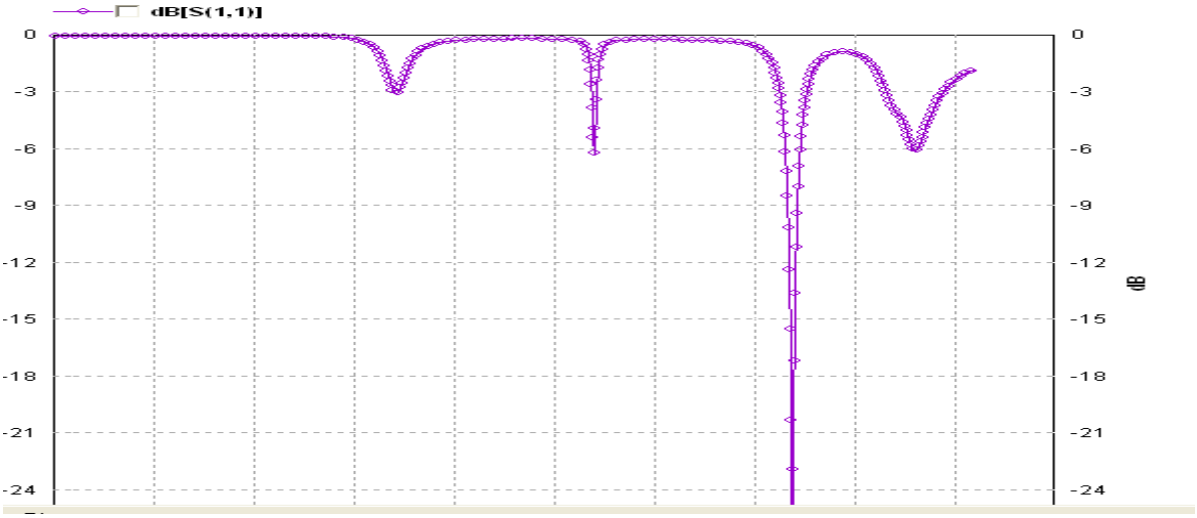

Figure 7 Return loss v/s Frequency

VI. CONCLUSION

This paper presents a rhombus shaped fractal designed microstrip patch antenna simulated by IE3D software. The results are analysed. Rhombus shaped gives better result than the square having same number of edges in less area. Fractal geometry is used to increases the gain of antenna and reduces losses create by the side lobes. IE3D simulator plays a vital role in such design procedure and researches. The main aim for this research is to maximize the gain of antenna, obtain better radiation pattern , at the same time to reduces the return losses.

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