A SIMPLE MINIATURE U-SHAPED SLOT ANTENNA FOR WIMAX APPLICATIONS

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ABSTRACT
The design of a simple small-size antenna for worldwide interoperability for microwave access (WiMAX) application is presented in this paper. The antenna covers the 3-5 GHz WiMAX band. The proposed printed-type antenna is based on a 1.6 mm-thick FR4 epoxy substrate with dimensions W=25 mm and L=40.5 mm. It has a rectangular split-ring slot enclosed inside a rectangular patch. The inclusion of the split-ring slot and the U-shaped slot in the partial ground plane gives resonance at two additional frequencies. The dimensions of the patch, the ground, and the two slots are optimized to obtain these desired functional frequency ranges.

I. INTRODUCTION

Due to the rapid and wide development of wireless communications, the design goal is heading towards the desired features of compact, lightweight and low cost antennas. UWB antennas have the advantage of covering a very wide frequency range. In a UWB antenna operational over the 2-11 GHz range is presented. However, UWB antennas are prone to noise from unwanted frequencies, which could degrade the original message. On the other hand, reconfigurable antennas are designed to be able to control the resonance of the antenna and limit the disadvantage of UWB antennas. A frequency reconfigurable antenna is proposed. Though very robust, reconfigurable antennas are complex as they require the use of switching elements and their biasing lines, or other complicated reconfiguration mechanisms. Antenna can be thought of as an intermediate solution combining simplicity and single-frequency operation.

In several printed antenna designs for WiMAX applications have been presented. In the single-band characteristic is designed by etching two narrow slots with given length on a wideband monopole antenna. In the design uses a trapezoidal ground to achieve the single-band frequency of WiMAX applications. In single-band unidirectional coplanar antenna is presented, but with a large size of 100 and 60 mm. usually, to meet the requirements of single-band frequency range, a various types of configurations could be used. In a meander T-shape with a long and a short arm are used to achieve single-band frequency. However these antennas have a large size comparing to the limited space of mobile wireless terminals. Through the development of antenna design, slot structures have been proposed to reduce the size of the single-band antennas. In the use of U-slots with a combination with an L-probe feed is used to produce dual and single-band characteristics. A triangular-slot loaded single-band antenna excited by the strip monopole is presented. The adjustment of the size of the slots on the radiating patch improves the performance of the coplanar waveguide-fed monopole antenna, but with a low antenna gain. Meandering slot antennas could also be used as well with different slots to generate two resonant modes. However, the complex structures of these antennas make them unsuitable for the practical applications. In a miniaturized single-frequency antenna is proposed using circular ring, a Y-shape-like strip, and a defected ground plane.

In this paper, using a split-ring slot enclosed inside a rectangular patch and etching a U-shaped slot in the partial ground plane are the two techniques used to achieve not only single-band operation performance, but also smaller size and simpler structure. By using the resonant frequency, the proposed antenna can generate a resonant mode to cover the desired band for WiMAX applications. The geometry and the design guidelines of the proposed antenna structures are presented in Section 2. Experimental results are presented in Section 3. In Section 4 a brief conclusion is given.

II. ANTENNA STRUCTURE AND DESIGN

The configuration of the proposed single-band antenna is shown in Figures 1(a){(b). The rectangular patch is the main radiating element of the antenna combined with split-ring slot enclosed inside of it. The proposed printed-type antenna is based on a 1.6 mm-thick FR4 epoxy substrate with dimensions 25 mm and 40.5 mm, fed by a 50 - microstrip feed line with a width of 3.1 mm and a length of 12 mm. The partial ground plane is located on the backside of the dielectric substrate, shown in Figure 1(b), where a U-shaped slot is illustrated.

Figure 3 represent the design evolution of the proposed antenna and its corresponding simulated reflection coefficient. Initially, the antenna consists of a rectangular patch in addition to a partial rectangular ground. As shown in Figure, there is one operating band from 3 to 5 GHz. The inclusion of the split-ring slot leads to the excitation of an additional coverage of the 3.5 GHz band, shown in Figure 3, without increasing the size, where the current will be divided between the rectangular patch and the split ring slot giving a resonance frequency.

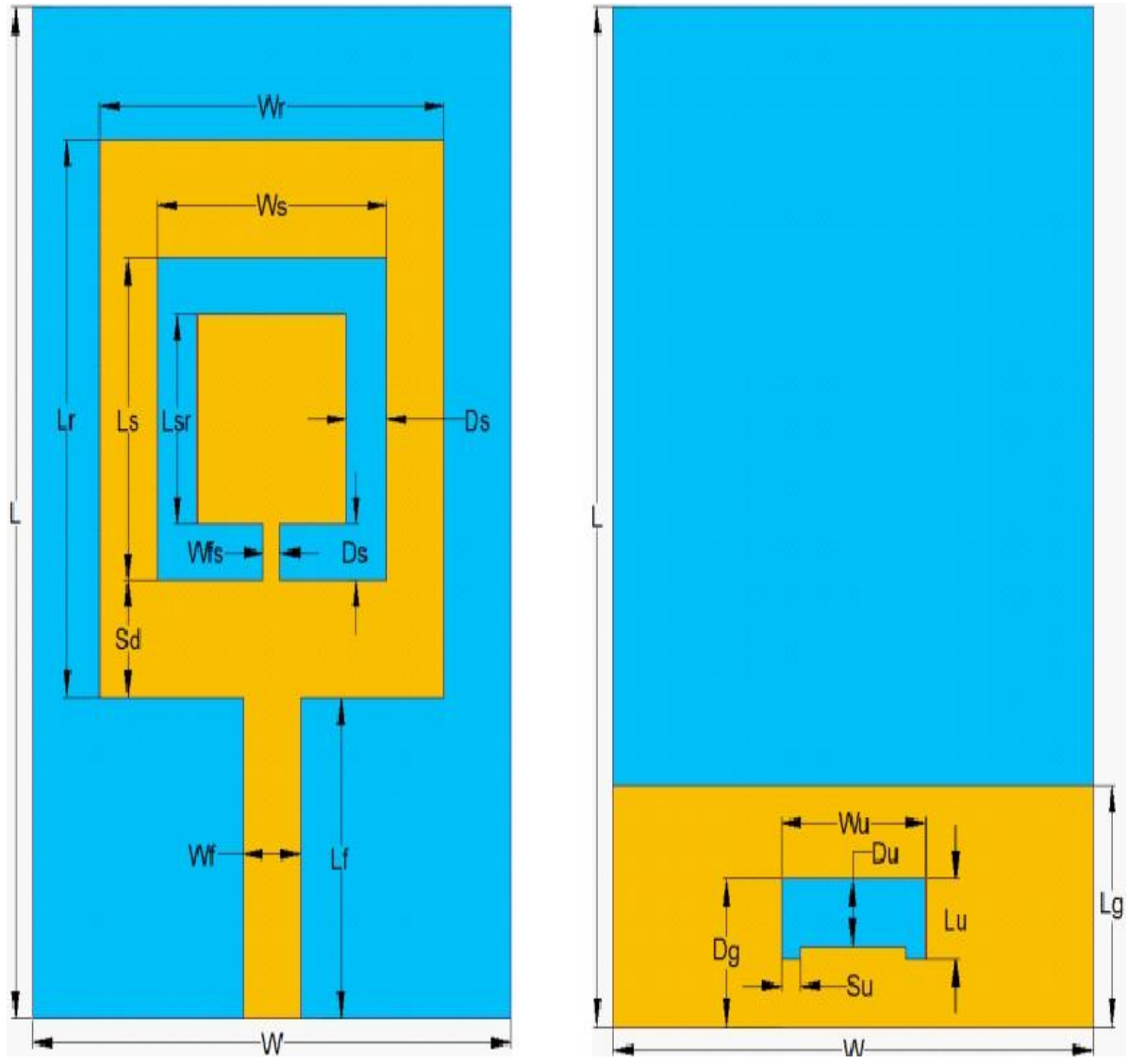
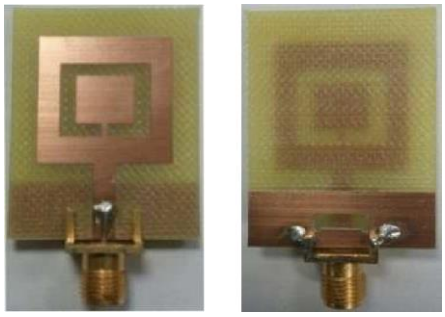


Figure 1: Geometry of the proposed antenna. (a) Front view, (b) back view



(a) (b)

Figure 2: fabricated antenna (a) Front View (b) Back View

In Figure 3 the microstrip feed line, the ground plane is defected by etching a U-shaped slot without adding a split-ring slot in the rectangular patch. The U-shaped slot, as shown in Figure 3, gives resonance in the 3-5 GHz bands. Finally, the two slots were added to the design to achieve resonance in the three frequency bands, The dimensions of the patch, the ground, and the two slots are optimized to obtain these desired functional frequency ranges using Advanced Design System. Figure 4 represents the creation of mesh during simulation time

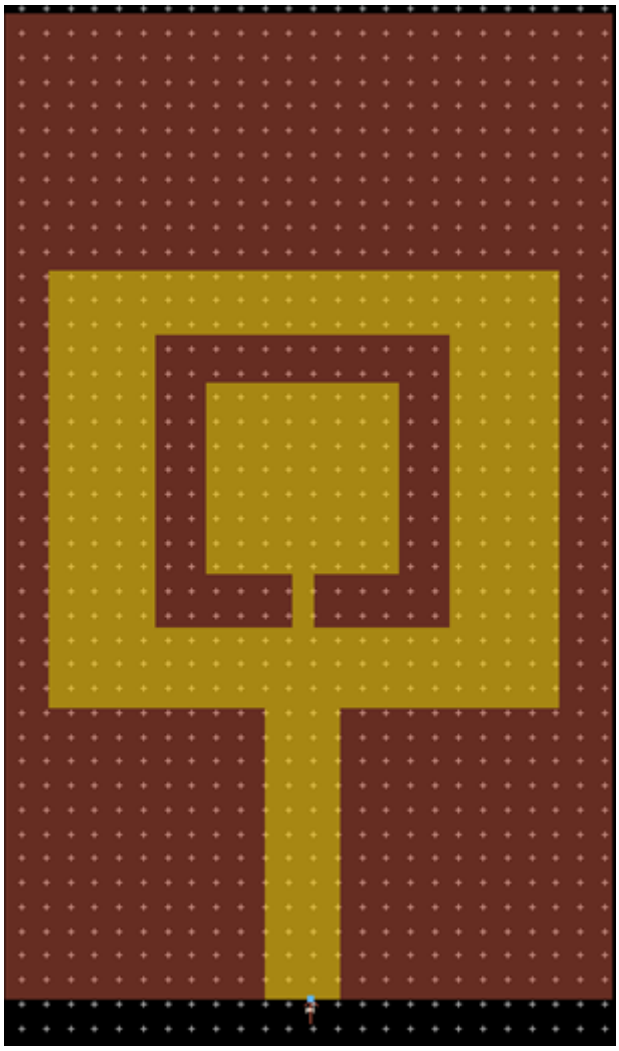


Figure 3: The Antenna design

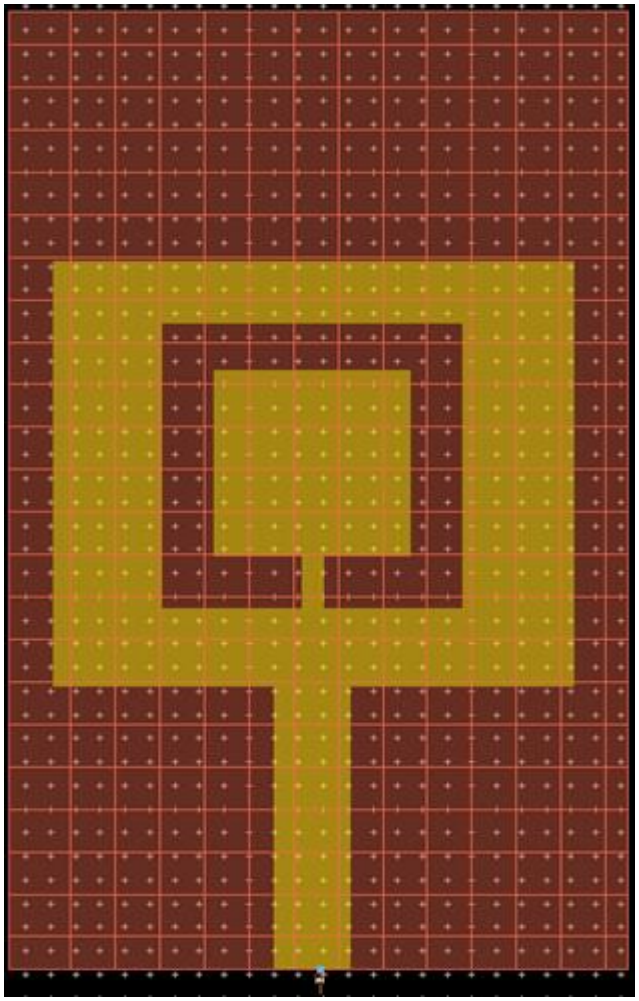


Figure 4: creating mesh

Figures 3 show the designed antenna, with the dimensions shown in Table 1.

Table 1: The antenna dimensions (in mm).

Parameter	Size (mm)	Parameter	Size (mm)	Parameter	Size (mm)
W	25	*Ws*	12	*Lg*	9
L	40.5	*Ls*	12	*Wu*	7.5
Wf	3.1	*Ds*	2.1	*Lu*	3
Lf	12	*Lsr*	7.7	*Du*	2.5
Wr	18	*Wfs*	0.9	*Dg*	5.5
Lr	21	*Sd*	3.3	*Su*	1

III. RESULTS AND DISCUSSION

The computed and measured plots are given in Figure 5, where good analogy is revealed. From the measured results it is seen that the antenna covers the frequency band of WiMAX networks operating in the 3.5GHz band.

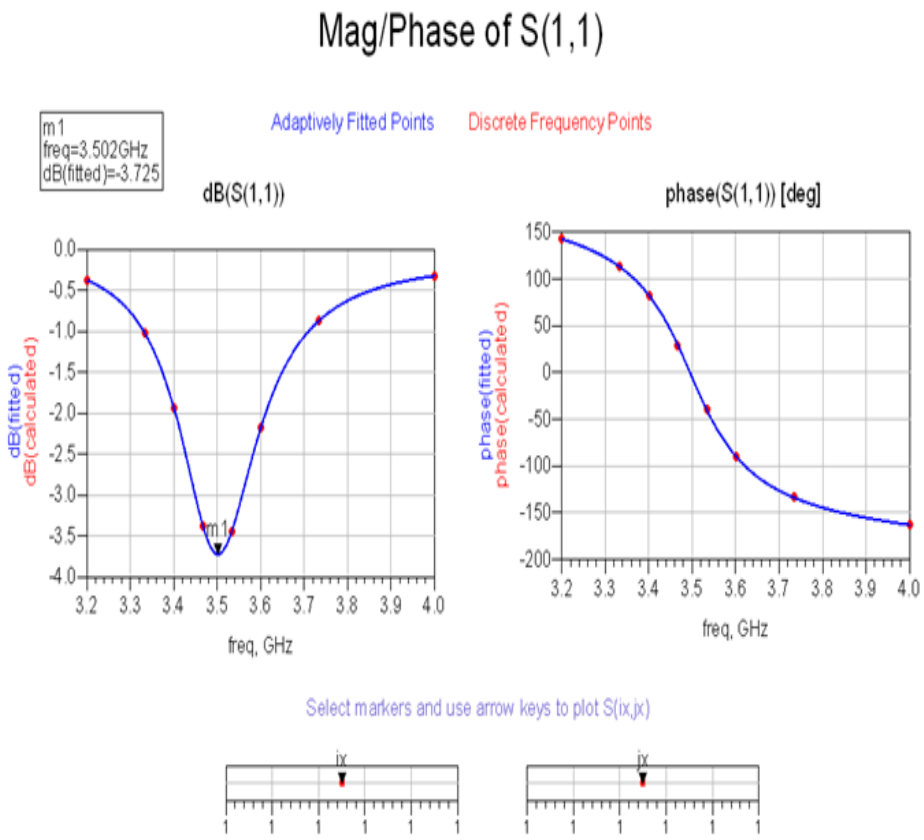


Figure 5: output waveform

Figure 6, 6(a), 6(b) shows the radiation patterns of the designed antenna in different views.

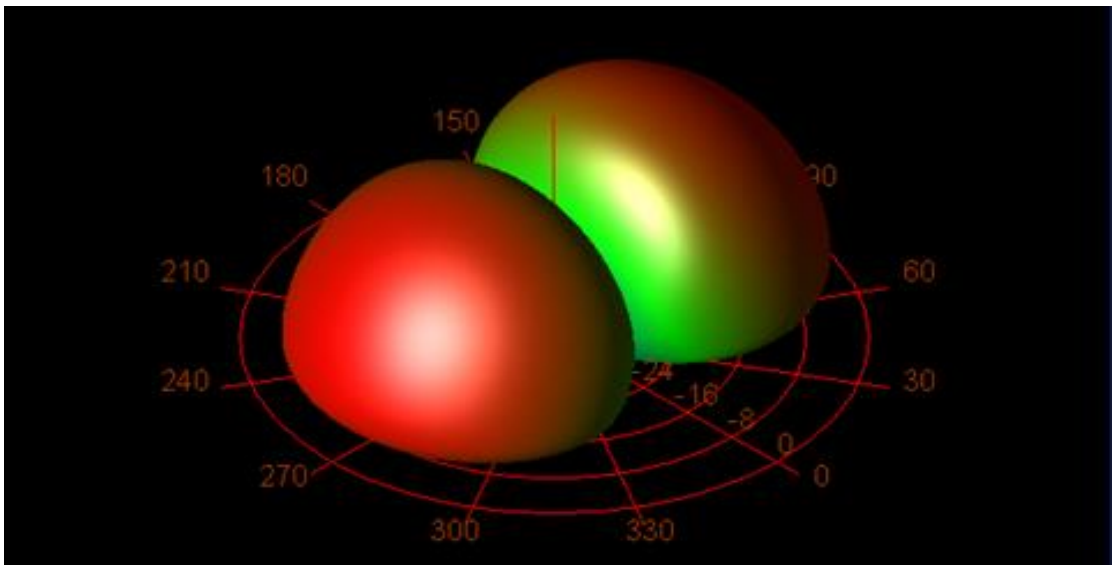


Figure 6: Side view of the radiation pattern

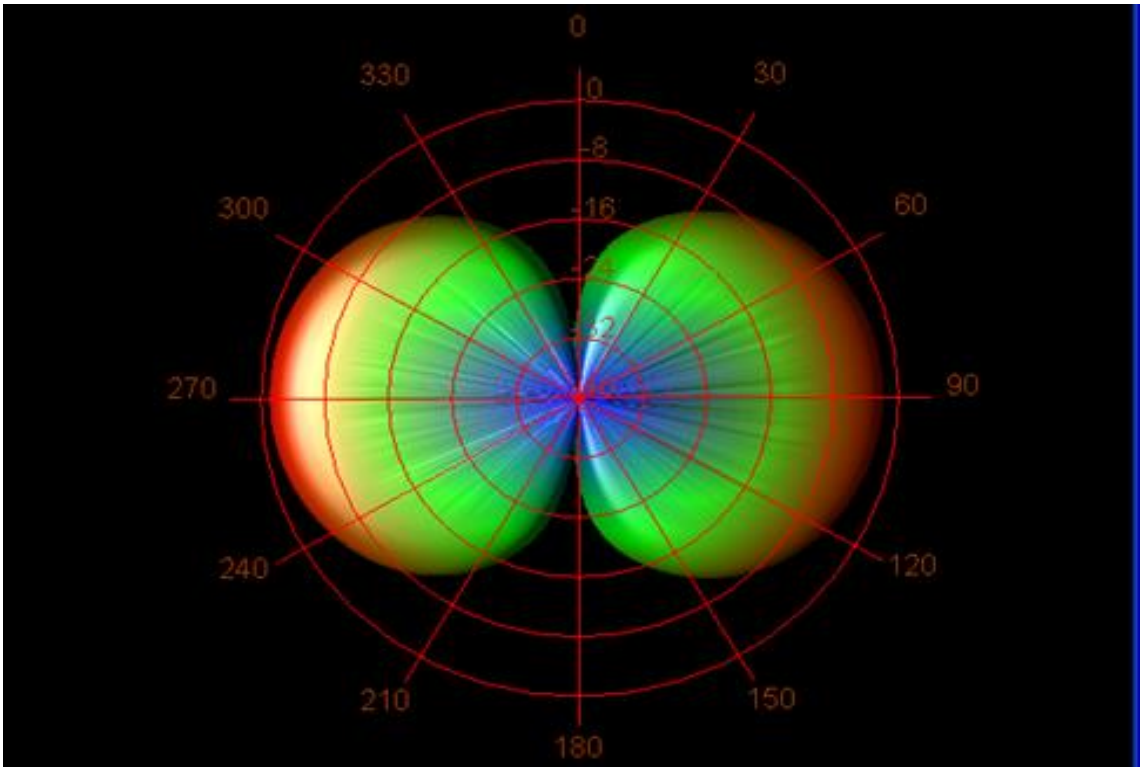


Figure 6(a): Bottom view of the radiation pattern

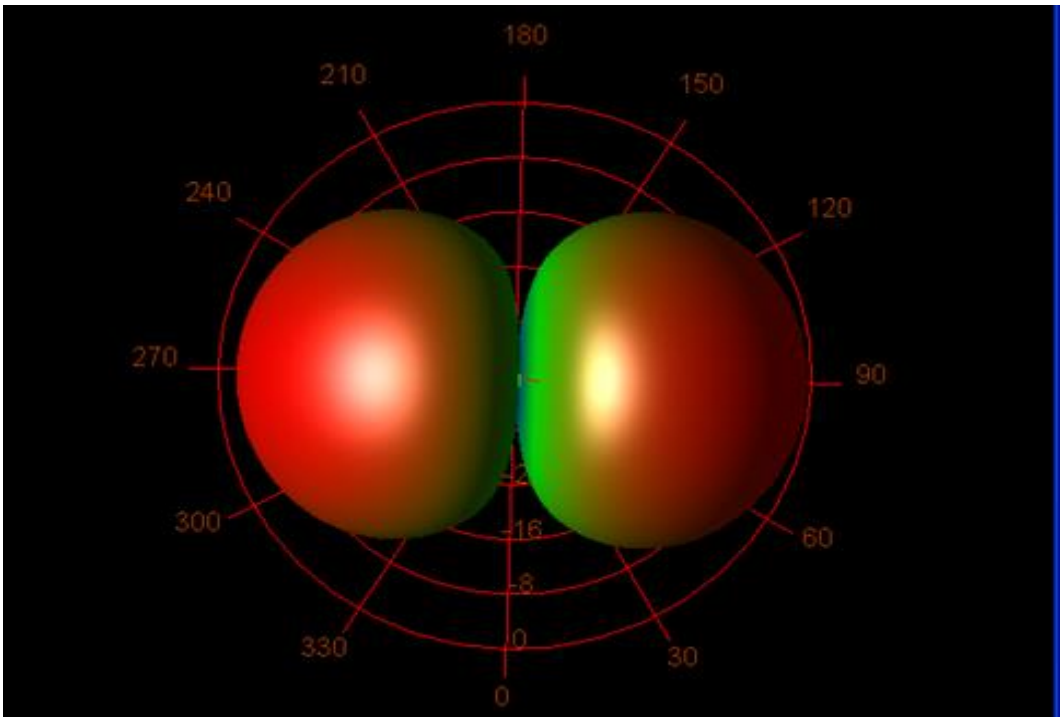


Figure 6(b): Top view of the radiation pattern

IV. CONCLUSION

A single-band antenna suitable for WiMAX applications is proposed in this paper. Using a split-ring slot implanted in the rectangular patch and a U-shaped slot etched partial ground plane, resonant mode with excellent impedance performance are achieved.
The compact size, single-band frequency, excellent radiation patterns, good gain and a simple structure makes this antenna suitable for practical wireless communication systems, working on WiMAX networks, in the frequency band of 3.5GHz.

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