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# Wrist Watch Shaped Slotted Rectangular Microstrip Patch Antenna for 3.5 GHz Operations Like Wi-Max

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***Abstract* – In this research paper we have presented a design of rectangular microstrip patch antenna by making a slot of wrist watch shape at its centre. Antenna parameters like Return loss, VSWR, Antenna efficiency and Radiation pattern etc for the proposed design is being calculated using electromagnetic simulation tool IE3D. IE3D software works on principle of Method of Moment. Microstrip antennas are getting popular these days because of their low cost, small volume, excellent integration and high performance. All of these are the prime requirement in field of communication such as Wi-Max, Wi-Fi, microwave application, Ethernet etc.**

***Keywords* – Wrist Watch Slot Shaped, Return Loss, Antenna Efficiency, VSWR, Radiation Efficiency.**

## I. Introduction

With the advancement of technology devices are getting miniaturized day by day. Even if it is antenna technology small and low profile antennas are in great demand e.g. in wireless communication like cell phones the communicating device should be small enough to be carried out easily, so small size antennas are required in such devices but the performance of the antenna should not be degraded. Microstrip antennas are simple and can be easily fabricated that's why they are widely used in microwave frequency spectrum. This antenna could be used in a wide range of applications such as in the communications industry for cell phones or satellite communication our objective is to design antenna with the best possible results. Significant amount of research and study is being carried out to determine the augment in gain and bandwidth of the micro strip patch antenna by using different feed techniques. These antennas generally have the narrow bandwidth. This limitation can be addressed by using thick substrates, using aperture coupled stacked patch antenna and cutting slots in the metallic patch. Wireless communication needs high antenna gain and if the bandwidth is also increased along with the gain it will be an additional advantage, though enhancing both gain as well as bandwidth at a same time is a challenging task.

## II. Antenna Design

The proposed antenna is designed by cutting a slot that looks like wrist watch. Cutting of this slot in antenna increases the current path which increases current intensity as a result efficiency is increased and desired return loss is obtained. Start off by calculating basic equation of typical rectangular patch and then convert its equivalent area to a Rectangular form. The Essential parameters of this Rectangular microstrip patch antenna are W= 33.88mm, L= 27.90mm, Length of ground plane=38.70, Width of ground plane=44.68155. The rectangular microstrip patch antenna designed on one side of glass/epoxy structure with εr = 2.2, height from the ground plane d= 1.8mm and loss tangent=0.0009. Design is being calculated taking frequency 3.5GHz and it is shown in figure (1).

Steps for calculating the dimension of patch[10]

*Step 1: Calculation of the Width (W):*

The width of the Microstrip patch antenna is given as:

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r+1)}{2}}}$$

Substituting $c$ = 3.00e+008 m/s, $\varepsilon r$ = 2.2 and $fo$ = 3.5 GHz, we get:

$W$ **= 0.03388 m = 33.88 mm**

*Step 2: Calculation of Effective dielectric constant (εreff):*

The effective dielectric constant is:

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Substituting εr = 2.2, $W$ = 33.88 mm and $h$ = 1.8 mm we get:

ε*reff* = **2.0688**

*Step 3: Calculation of the Effective length ( Leff):*

The effective length is:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Substituting ε*reff* = 2.0688, $c$ = 3.00e+008 m/s and $fo$ = 3.5 GHz we get:

*Leff* **= 0.02979 m = 29.79 mm**

*Step 4: Calculation of the length extension (ΔL):*

The length extension is:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

Substituting ε*reff* = 2.0688, $W$ = 33.88 mm and $h$ = 1.8 mm we get:

Δ$L$ **= 0.94 mm**

*Step 5: Calculation of actual length of patch (L):*

The actual length is obtained by:

$$L = L_{eff} - 2\Delta L$$

Substituting *Leff* = 29.79 mm and $\Delta L$ = 0.94 mm we get:
*L* **= 27.90 mm**

*Step 6: Calculation of the ground plane dimensions (Lg and Wg):*

The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. It has been shown by [9] that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design, the ground plane dimensions would be given as:

*Lg* = 6*h* + L = 6(1.8) + 27.90 = 38.70 mm
*Wg* = 6*h* + W = 6(1.8) + 33.88 = 44.68 mm

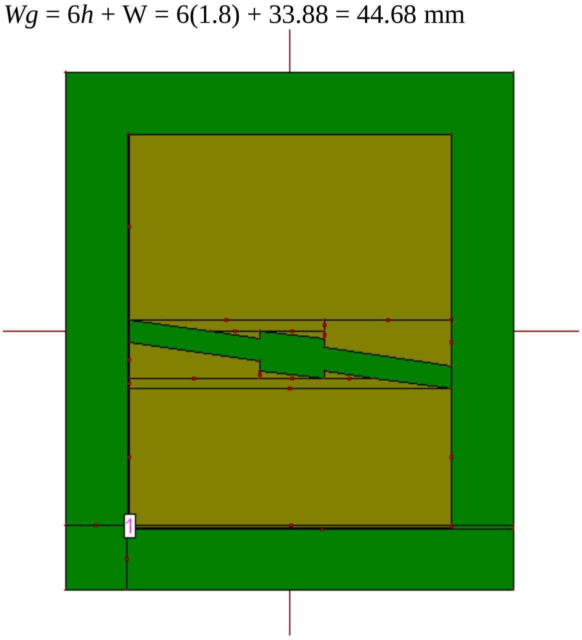

Fig.1. Proposed Rectangular Micro-strip Patch Antenna with wrist watch shaped slot.

## III. Antenna Result

The simulation of micro-strip patch antenna is done by using IE3D simulation software. The VSWR graph for a declined rectangular shaped slotted patch antenna is shown in figure (2). The VSWR indicates the mismatch between the antenna and the transmission line. For perfect matching the VSWR value should be close to unity. The VSWR for this slotted antenna is 1.03. The simulated radiation pattern in 3D are shown in figure (3), the return loss graph is shown in figure (4) and it is -36.69 dB, the total field gain & frequency is shown in figure (5), the antenna efficiency & frequency is shown in figure (6),

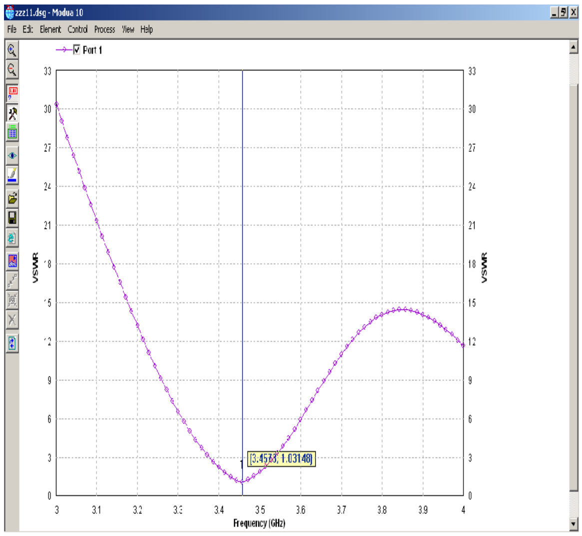

Fig.2. VSWR of the Proposed Antenna = 1.03.

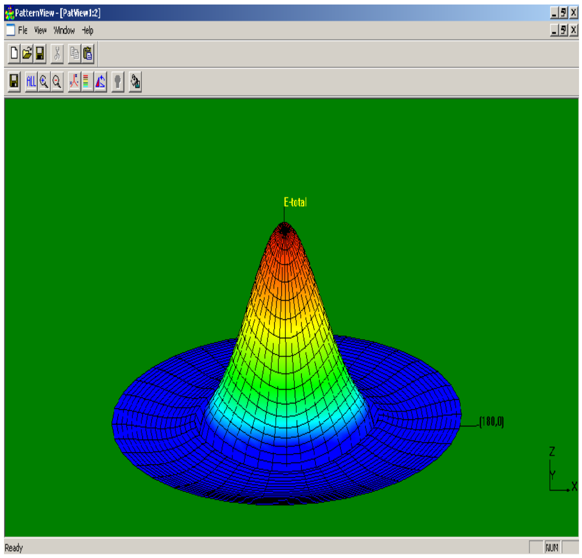

Fig.3. Radiation pattern in 3D of the Proposed Antenna

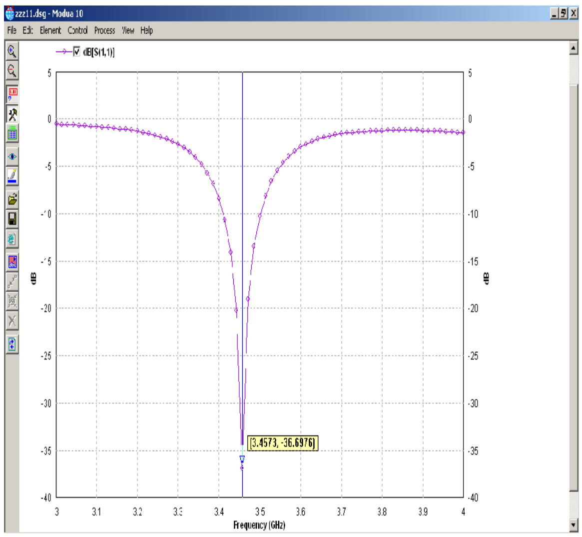

Fig.4. Return Loss of the Proposed Antenna = -36.6976 db

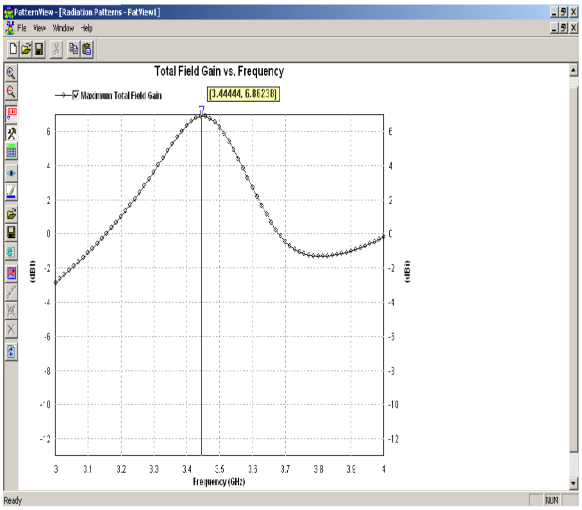


Fig.5. Total field gain & frequency of proposed antenna=6.862

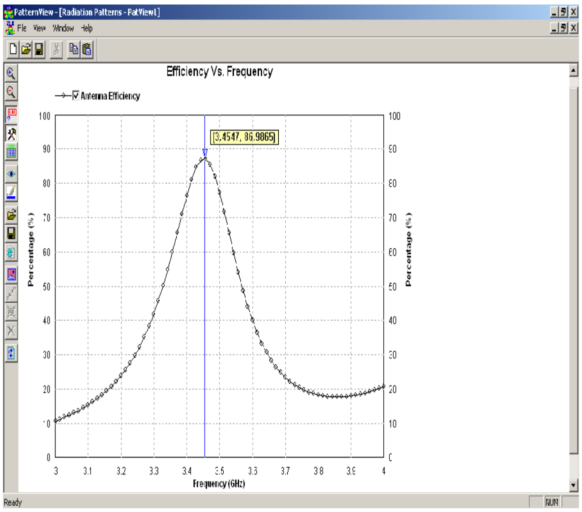


Fig.6. Antenna efficiency vs frequency of proposed antenna=87

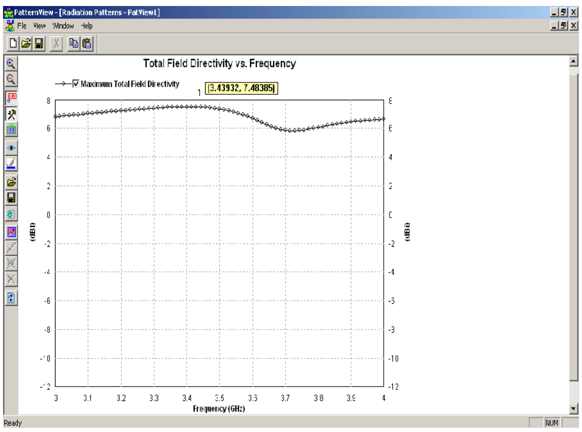


Fig.7. Antenna Field directivity vs frequency.

## IV. Conclusion

It is observed that a probe feed, wrist watch shaped slotted rectangular micro-strip patch antenna designed covers all standards of a good antenna. The proposed antenna has a compact size of (27.9 x 33.88 x1.8) and it can effectively cover the Wireless operations like Wi-Max.

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