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Fractal microstrip patch antenna with application to GPS

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Abstract
These days, our life become easier and comfortable with bless of new domain of Technology. Invention increases with the pursue of innovative people. WiMAX is one of the great inventions by those scientists. WiMAX is an acronym meaning "Worldwide Interoperability for Microwave Access" and it is a new in terms of a standard initiative. WiMAX is designed to extend local Wi-Fi network across greater distance. In this paper, our aim is to analyze the performance of an antenna by using dielectric material for using in WiMAX communication application system.

Keywords: Fractal microstrip patch antenna and GPS

Introduction
Microstrip antenna was proposed in early 1970 [1] and provides a great revolution in the field of antenna design and Research. Nowadays, microstrip patch antenna has become very popular and is widely used in many areas like in mobile communication, Wi-Fi and WiMAX applications. It is a popular printed resonant antenna for narrow-band microwave wireless links that require semihemispherical coverage. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been heavily studied and is often used as elements for an array [2–3]. For designing and manufacturing, Microstrip antenna has low cost because of the simple two dimensional Physical geometry [4].

Structure and design specifications
A microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Fig 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate [5].

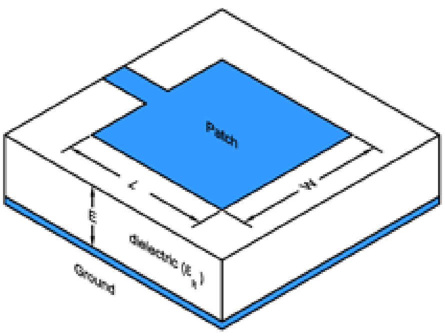

Fig 1: Structure of Patch antenna

In these different layers different materials are used. Copper is used in ground plane, patch and microstrip line. In substrate layer different dielectric substrate materials are used. In this research different dielectric materials were used for specific cut-off frequency to analyze the performance of the antenna for WiMAX application. Table 1. shows the name of the layers and materials used in the microstrip patch antenna.

In simulation software materials with loss effect were selected to get practical simulated results.
Table 2 shows the list of the dielectric materials used in this research purpose to analyze the performance of the antenna for 5.8 GHz.

Table 1: Name of the layers and materials used

Layer Name	Material Name
Microstrip Line	Copper
Patch	Copper
Substrate	Dielectric substrate materials
Ground plane	Copper

Table 2: list of different dielectric materials used in this research and their dielectric constants

Name of the dielectric materials	Dielectric constants (ε_r)
FR4	4.3
RTDuroid 5880	2.2
Arlon Di 522	2.5
Taconic RF 35P	3.5
Bakelite	4.8
Dupont-951	7.8

The essential parameters require designing Microstrip Patch Antenna are:
Frequency of operation (f_0): The resonant or cut-off frequency of the antenna must be selected appropriately. WiMAX communication system uses 5.8 GHz frequency. Thus the designed antenna must be able to operate at this frequency.
Dielectric constant of the substrate (ε_r): 6 different dielectric materials were used in this research. Name of the dielectric materials and their dielectric constants are mentioned in table. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna [6].
Height of dielectric substrate (h): For the microstrip patch antenna used in WiMAX communication system should not be bulky. Hence, the height of the dielectric substrate used to design the antenna is 1.5 mm [7].
Calculation of effective dielectric constant, ε_{reff}: Effective dielectric constant, ε_{reff} can be calculated from the below equation.

$$\varepsilon_{reff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}[1 + 12\frac{h}{w}]^{1/2} \quad (1)$$

Calculation of the width of the patch, W: The width of the patch can be calculated from the below equation.

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

Calculation of the length of the patch, L: The effective length of the patch can be calculated from the below equation.

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}} \quad (3)$$

The length extension can be calculated from the below equation.

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{w}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{w}{h}+0.8)} \quad (4)$$

The actual length of the patch can be calculated from the below equation.

$$L = L_{eff} - 2\Delta L \quad (5)$$

Calculation of the length of the ground plane, L_g: The length of the ground plane can be calculated from the below equation.

$$Lg = 6h + L \quad (6)$$

Calculation of the width of the ground plane, W_g: The width of the ground plane can be calculated from the below equation.

$$Wg = 6h + W \quad (7)$$

Calculation of the length of the feed line, L_f: The length of the feed line can be calculated from the below equation.

$$L_f = \frac{\lambda_0}{4\sqrt{\varepsilon_r}} \quad (8)$$

Where, $$\lambda_0 = \frac{C}{f_0} \quad (9)$$

Calculation of the width of the feed line, W_f: IfZ_c= 50 Ω, the width of the feed line can be calculated from the below equation.

$$Z_c = \frac{120\pi}{\sqrt{\varepsilon_{reff}}[\frac{W_f}{h}+1.393+0.667\ ln(\frac{W_f}{h}+1.444)} \quad (10)$$

Calculation of the gap of the feed line, G_{pf}: The gap of the feed line can be calculated from the below equation.

$$G_{pf} = \frac{4.65x10^{-9}xC}{fo\sqrt{2\varepsilon_{reff}}} \quad (11)$$

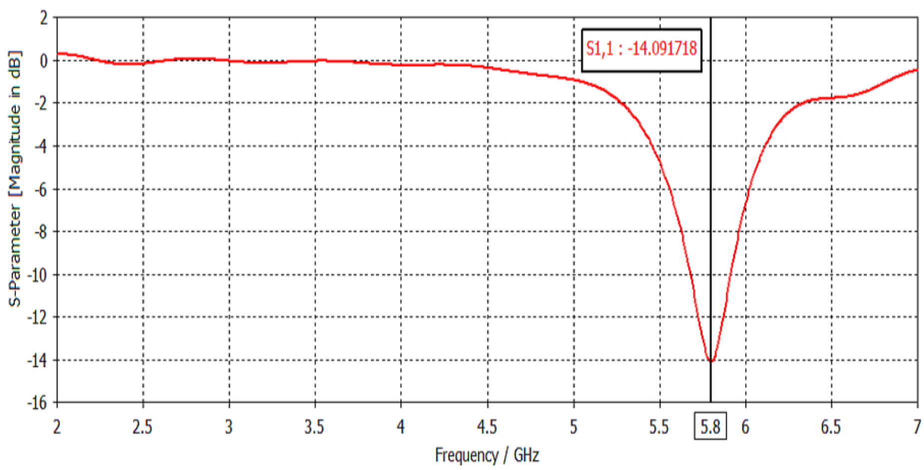

Fig 2: shows the return loss graph for Bakelite. According to the below figure the value of S11 parameter at 5.8 GHz is -14.091718 dB.

Conclusion

This paper discusses the wireless communications system. Using WiMAX communication system which is widely used around the world.

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