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DESIGN OF A MONOPOLE ANTENNA IN TWO OPERATING STATES

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Abstract:

A switchable monopole radio wire is utilized for working in all inclusive band mode (UWB). The switching is triggered with a photoconductive semiconductor switch activated by Light Emitting Diode (LED). In the switched-off state, the antenna operates in the UWB/Dual band mode in the switch-on state the configuration converts to a dual band antenna due to the extended ground plane. The radiated results show that the dual-band/UWB mode entirely covers the UWB frequency band. Ultra-wide band (UWB) antennas and the multiband antennas serve to overcome the bandwidth limitations of the strip antenna design. Large bandwidth of UWB antennas can be employed to support high data rate indoor applications, while dual band antennas serve outdoor and/or indoor wireless applications whose specified spectrums are entirely separated.

Key Terms: Monopole Antenna, UWB, Dual band, LED, CdS & PCSS

1. Introduction:

For wireless communication systems, antenna is one of the most essential components. An antenna is a radiating element which radiates electromagnetic energy into free space, from the transmitting antenna. A good antenna design can relax system requirements to improve the overall system performance. An antenna can be used in many fields, such as broadcasting and wireless communication networks due to their Omni-directive property. Research in this area is therefore by the need for larger capacity networks and smaller mobile terminals which provide better mobility. The monopole antenna can be used for such of these applications because of their relative low cost and faster installation makes them an obvious choice for research in this area. This project focuses on simulating a monopole antenna operating in two modes.

The single pole antenna can function as an open - resonator with standing waves are voltage and current with respect to its length. Therefore length of the antenna is determined by the wavelength of radio waves. An antenna operating in the full UWB spectrum(3.7-10.6GHz), however, it can interfere with some already existing applications, so antennas are designed with band notches to minimize the interference.

This is achieved either by designing permanent band notches or by controllable notches, UWB antennas have also been designed with additional band or bands (multiband/ UWB mode) to support wireless local area network (WLAN), global system for mobile communications (GSM) and global positioning system (GPS) and body area network. Multiband antennas have also been proposed to support two, three and sometimes even four applications simultaneously. In this paper, we proposed a monopole antenna that can switch between UWB/Dual bands by controlling the ground plane with a Photo Conductive Semiconductor Switch (PCSS) material which is used to control the bandwidth of a microwave filter without biasing lines. Illuminating Cadmium Sulphide (CdS) which leads to improved conductivity and extensive in ground plane, so the antenna operates as a dual band antenna. By turning off illumination, the Cadmium sulphide conductivity is decreased, and the antenna operates in the UWB mode due to reduction in ground plane size. The radiated results of the dual- band/UWB mode in light on and off mode are in very good agreements and show enhanced antenna performance.

2. Antenna Design:

Figure 1 (a) shows that the antenna front view is designed with a half elliptical ring instead of circular base and two stubs. The antenna is fed by microstrip line and etched on FR4 dielectric substrate with a dielectric constant of 4.3, loss tangent of 0.025, and height of 1.6mm .The back view (Fig. 1(b)) shows a modified ground plane and a rectangular rod separated from the ground plane by distance (d). The rectangular rod can be connected and disconnected from the ground plane by illuminating and darkening the CdS patchs. Turning off the LED disconnect the ground plane from the rectangular rod, and this modification makes the antenna operates the UWB mode. Improving contact between the conductor and operates in multi narrow band modes instead of UWB mode. It is necessary in this case, and would add large cost to the overall shown in Fig. 1(c). Connecting and disconnecting the rectangular rod of Fig. 1(b) switches the operating mode to dual band mode and dual-band/UWB mode, respectively. For dual-band/UWB mode, the rectangular rod is kept away from the ground plane so that there is no Electro Magnetic (EM) coupling between them.

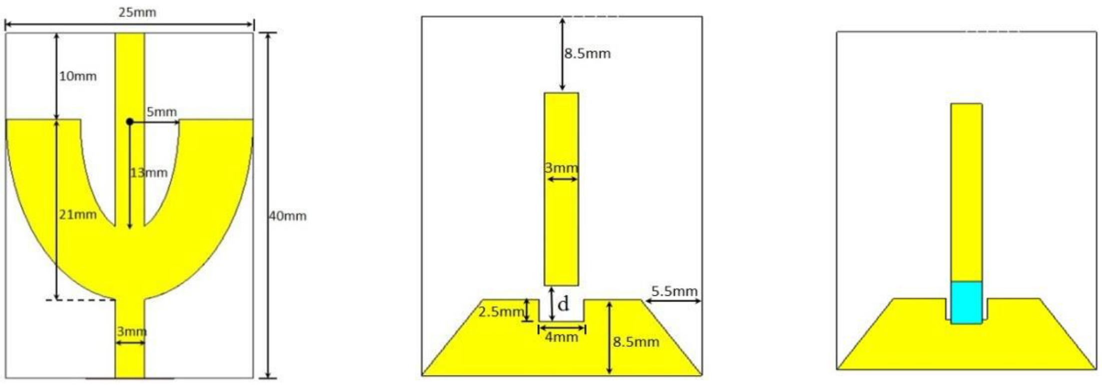

Figure 1(a) Figure 1(b) Figure 1(c)

Parameter	Unit (mm)
Dielectric Constant	4.3
Loss tangent	0.025
Height	1.6mm
Wi-max frequency	3.3-3.7GHz
WLAN frequency	2.4GHz

Table 1: Dimensions of the proposed Antenna

3. Operation Concepts:

Figure 2 shows the reflection coefficient of the antenna without the rectangular rod and for different separation distances *d* to minimize electromagnetic coupling between the rectangular rod and the ground plane. The optimal value is found to be 4mm at which the reflection coefficient is almost similar to the removal of rectangular rod since the ground plane is separated from rectangular rod. Photoconductive materials, which act both as conductors and insulators at the same time were used as switch. Conventional switches reflect EM wave, causing EM coupling between the rectangular rod and the ground plane through their metallic parts even if they are turned off. Illumination of the Cadmium Sulphide (CdS) wafer l connects the ground plane with the rectangular rod because the illumination leads to enhance the CdS conductivity significantly. This connection extends the antenna ground plane and the antenna operates in multi narrow band modes instead of UWB mode. The antenna semiconductor requires high doping between the two but it is not design. Therefore, CdS photo resistor has been used as advancement to CdS wafer and PIN diodes, which require biasing circuits to switch them between two modes.

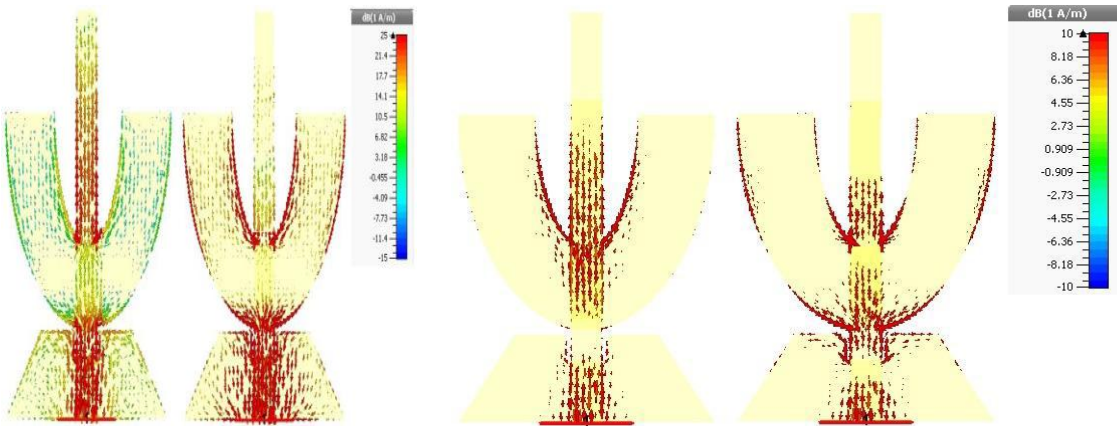

Figure 2

It is worthwhile to highlight the antenna operation mechanism of the proposed antenna. When the light is switched off, the rectangular rod has negligible effect on the antenna, as shown in Fig. 2. Therefore, the antenna operates as an UWB antenna. The central patch shown in Fig. 1(a) operates as a narrow band quarter wavelength monopole antenna radiating at 2.4GHz. The half elliptical ring resonates at three resonant frequencies centred at 4.2, 7.8, and 8.6GHz, and the resulted antenna bandwidth covers the UWB frequency band entirely. It is clear that the current is concentrated at the central patch at 2.4GHz, while it is concentrated at the half ring at 3.4GHz. On the other hand, turning the light on leads to eliminate the effect of the central patch since it is almost covered by the ground plane. The sides of the elliptical ring that are not covered by the rectangular rod operate as an antenna resonating at 2.4GHz and 6.4GHz, respectively. Since the resonant frequencies are far from each other and unoverlapped, the antenna operates as a multiband antenna

As seen above there are two operational modes.

They are,

- ✓ UWB mode (light is off).
- ✓ Dual band mode (light is on).

UWB mode (light is off): The central rectangular patch, shown in Fig. 1(a), operates as a quarter wavelength narrow band monopole antenna radiating at 2.4GHz. The half elliptical ring covers the frequency band specified for UWB applications. The central patch shown in Fig. 1(a) operates as a narrow band quarter wavelength monopole antenna radiating at 2.4GHz. The half elliptical ring resonates at three resonant frequencies centred at 4.2, 7.8, and 8.6GHz, and the resulted antenna bandwidth covers the UWB frequency band entirely. In fact, the antenna in this configuration covers the entire indoor applications. The radiation pattern is almost stable along the operating band with bidirectional E-plane and Omni-directional H-plane patterns. The gain has an almost stable value over the UWB coverage as well as accepted value at the 2.4GHz WLAN. Between these two bands and outside them the gain has reduced value. This is expected since the antenna shows high losses for the undesired frequencies.

Dual band mode (light is on): When applying light on the CdS photo resistor, the antenna ground plane is completed and the antenna is not UWB monopole antenna, but operates as a dual band antenna radiating at 2.4GHz for Wi-Max (3.3–3.7GHz) applications and at 6.4GHz, in a network that wirelessly connects the main reflector antenna of X-band satellite communications (7.25- 7.745 GHz) with receivers. The minimum resistance value is ~ 50 ohms at turn-on, so the contact between the rectangular rod and the ground plane is not perfect. However, attaching the CdS photo resistor reduces antenna cost effectively. In addition, it does not need biasing circuit for operational control.

4. Radiation Pattern Results:

The radiation pattern of the UWB mode and dual band mode antenna is shown in fig 3(a) and fig 3(b) respectively. It has noticeably reduced value due to the finite conductivity of the photo resistor which accumulates additional loss to the antenna. Different resistors affect the antenna gain differently depending on the conductivity of the resistor after illumination.

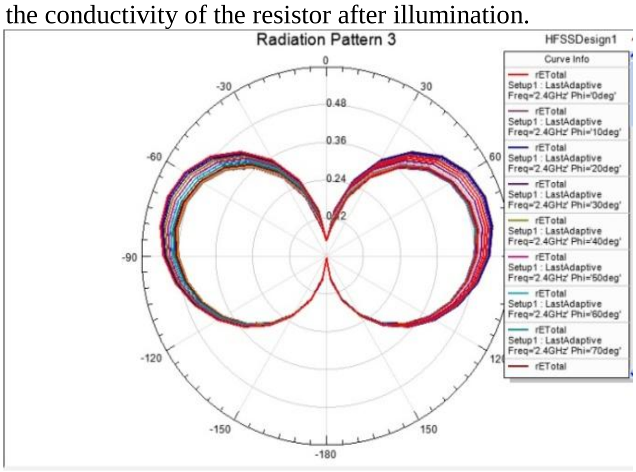

Figure 3(a): Radiation pattern of the antenna for light off state

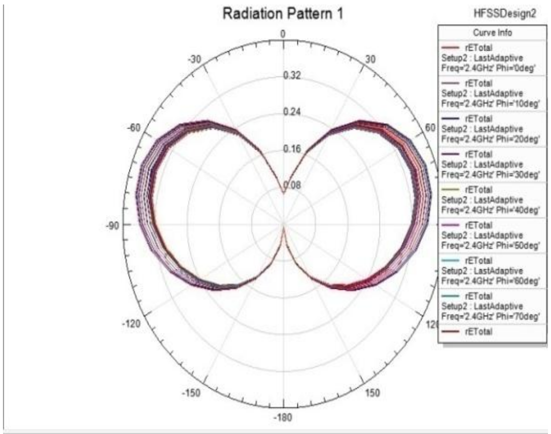

Figure 3(b): Radiation pattern of the antenna in light on state

5. Conclusion:

A switchable antenna has been simulated and analyzed to demonstrate a monopole antenna operating in dual mode. The switching between the two modes is achieved by enlightening a cadmium sulfide (CdS) photo conductive semiconductor switch (PCSS) which is attached to the antenna ground plane. The PCSS switches are illuminated from dual-band/UWB mode to dual band mode. Radiated results show that at dual-band/UWB mode the antenna covers the 2.4GHz WLAN and the UWB applications, while at the dual band mode it covers the WiMax and the X-band satellite communications. For multiband mode and low cost operation, the toleration in the measured reflection coefficient due to the use of CdS photo resistor rather than CdS wafer is deemed acceptable.

6. References:

1. C. A. Balanis, “Antenna Theory, Analysis and Design,” John Wiley & Sons, New York, 1997.
2. K. Lee, K. Luk, K. Mak, and S. Yang, “On the Use of U-Slots in the Design of Dual- and Triple-Band Patch antennas,” IEEE Antennas and Propagation Magazine, vol. 53, no. 3, pp. 60-74, June 2011.
3. Z. Wang, L. Lee, D. Psychoudakis, and J. Volakis, “Embroidered Multiband Body-Worn Antenna for GSM/PCS/WLAN Communications,” IEEE Transactions on Antennas and Propagation, vol. 62, no. 6, pp. 3321-3329, June 2014.
4. Siddiqui Naushad Ather, P.K. Singhal, “Wideband CPW-fed Monopole Antenna with Half U Slot Cut in Rectangular Patch”,5th International Conference on Computational Intelligence and Communication Networks, IEEE 2013 conference.

5. E. Antonino-Daviu., M. Cabedo-Fabres, M. Ferrando-Bataller, and A. Vila-Jimenez, “Active UWB antenna with tunable band-notched behavior,” Electronics Letters, vol. 43, no. 18, pp. 959-960, 2007.
6. M. Alam and S. Moury, “Conversion of an Ultra-Wide-Band (UWB) Antenna to Dual-Band Antenna for Wireless Body Area Network (WBAN) Applications,” IEEE 3rd International Conference on Informatics, Electronics, and Vision, pp. 1-4, 2014.
7. Dai Yang, Liu Wen-Chung and Wu Chao-Ming , “Design of Triple Frequency Microstrip Fed Monopole Antenna Using Defected Ground Structure”, IEEE Transactions on Antennas and Propagation, Vol. 59, No. 7, pp 2457-2463, 2011.
8. Mahdi Moosazadeh and Sergey Kharkovsky,” Compact and Small Monopole Antenna with Symmetrical L-and U-Shaped Slots for WLAN/WiMAX Applications”, IEEE Antennas And Wireless Propagation Letters, Vol. 13, IEEE conference 2014.