Abstract—In this paper, an electrically small reconfigurable antenna fed by a co-planar waveguide (CPW) is proposed. The resonance is achieved by providing an extra path for current through additional meander lines which are attached with the main feed line. Two PIN diodes are used to reconfigure the antenna from 4.27 GHz to 3.56 GHz. The proposed antenna measures only $14.5 \times 12.8 \text{ mm}^2$ and is printed on a low loss 1.524 mm thick Rogers TMM4 laminate with a dielectric constant of 4.5 and a loss tangent of 0.002. The antenna has an omnidirectional radiation pattern at both switching frequencies with a peak gain of 1.3 dBi at 4.27 GHz and 0.2 dBi at 3.56 GHz. The proposed antenna is suitable for WiMAX and indoor wireless applications.

I. INTRODUCTION

Due to congestion in the electromagnetic frequency spectrum, frequency reconfigurable antennas have received much attention due to their prominent feature of using the spectrum efficiently. Cognitive radio utilizes frequency reconfigurable narrow band antennas to operate at some unoccupied spectrum. Besides, compact size, easy fabrication and low profile structures, other features are also required, such as good frequency selectivity and stable radiation patterns at all frequencies. Antenna reconfigurability can be achieved by employing microelectromechanical systems (MEMS) switches, varactor diodes or PIN diodes as tunable components. Various methods have been introduced to achieve the reconfigurability while maintaining the compactness of the antenna. In [1], a PIN diode is used to reconfigure the dual band patch antenna (2.4 GHz and 3.5 GHz) to a single band (2.4 GHz) but overall dimensions of the antenna are $50 \times 52 \text{ mm}^2$. A circular monopolar patch antenna, fed from center and surrounded by four sector-shaped patches, is presented in [2]. Eight varactor diodes are used to bridge the gaps between the circular patch and the sector-shaped patches to operate the antenna between 1.64 GHz to 2.12 GHz. A single (2.4 GHz) or dual band operation (2.4 GHz and 5.2 GHz) is achieved in [3] by integrating a PIN diode between one of the splitting radiators and the microstrip feed line. In [4], a printed antenna for WLAN/WiMAX applications is proposed which can be switched to three different frequencies by controlling the states of the switches.

In this paper a CPW-fed antenna with switching capabilities is presented and is shown in Fig. 1. The resonance at 4.27 GHz is achieved by providing an extra path for travel on the patch using additional meander lines. Later on PIN diodes are activated to switch the resonance frequency to 3.56 GHz. The proposed antenna is much more compact than the designs presented in [1]-[4].
While, for the reverse bias state, the inductance is in series with the parallel combination of the reverse bias resistance $R_R = 1.5k\ \Omega$ and the capacitance $C_R = 0.02\ \mu F$, which generates high isolation. The lumped elements have negligible effects on the antenna performance because the impedance of the antenna is much smaller (lower) than the impedance of the RLC circuit, allowing little currents to flow through.

III. EXPERIMENTAL VALIDATION
A low loss 1.524 mm thick Rogers TMM4 laminate with a dielectric constant of 4.5 and a loss tangent of 0.002 was used to fabricate the prototype as shown in Fig. 1(b). The extra patches were connected via surface-mount voltage controlled PIN diodes and RF chokes were used to place the control voltage (+V = 0.7V) on the conducting surface. The PIN diodes were manufactured by Skyworks [7] (part number: SMP 1322) and the RF chokes were manufactured by Mini-circuits (part number: ADCH-80A) [8]. The reflection coefficients were measured using the Agilent N5242A PNA-X network analyzer in a full anechoic chamber. It can be seen in Fig. 3 that the measured results are in good agreement with the simulated results. The small deviations in the results are due to the non-ideal response of the chokes and diodes. It can be seen in Fig 1(b) that the SMA connector has large dimensions which could affect the properties of the proposed antenna but the simulations were carried out with the SMA connector model to avoid its affects in the measurements.

The radiation patterns of the proposed antenna design were also measured in a fully calibrated anechoic chamber and plotted in Fig. 4. The radiation patterns show a null in the E-plane and is omnidirectional for the H-plane at both switching frequencies. The peak gain was measured in the direction of maximum radiation and found to be 1.3 dBi at 4.27 GHz but it is reduced to 0.2 dBi at 3.56 GHz due to the losses introduced by the PIN diodes.

IV. CONCLUSION
A compact size antenna with a co-planar waveguide feed is presented. An extra path for the current was generated from the feed line to radiator to increase the electrical path and resonate the antenna at a lower frequency. Two PIN diodes were used to reconfigure the antenna from 4.27 GHz to 3.56 GHz. Along with the compactness, the proposed design has a stable radiation pattern and good matching bandwidth on both switching frequencies which makes it suitable for cognitive radio, WIMAX and indoor wireless applications.

REFERENCES