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A DUAL BAND NOTCHED PATCH ANTENNA WITH CIRCULAR SLOTS FOR ULTRAWIDEBAND

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ABSTRACT- ***A compact planar monopole antenna with flat ground plane for ultra wideband antenna to introduce dual band-notched structures is presented. The proposed an antenna which consists of a radiating patch and the ground plane. To avoid the problem of interference in the ultra wideband a dual band notch function is generated in the proposed antenna. It can also provide wider fractional bandwidth of more than 130%. By using rectangular slot and circular slot on the radiating patch, it covers the dual band notched function at 5.5 GHz and 3.1 GHz .The proposed antenna can be designed with the dimensions of 25 x 25mm^2. The simulated antenna design can operate a wide range of frequency from 2 -12 GHz with the band rejection frequency around 4.2-7.2 GHz. The centre band rejection frequency approximately is 5.5 GHz. It has been seen that the measured results shows a better parameters of gain throughout the frequency, return loss below -10dB, Omni directional radiation pattern, VSWR < 2, constant group delay and radiation efficiency.***

Keywords- Dual-Band, Patch antenna, slot, UWB

I INTRODUCTION

Ultra wideband communication system became a very attractive application in a wireless communication system. This happens because it has good features like high speed data rate, low complexity, short duration pulse, narrow band, low spectral power density, high precision ranging, and, low cost [1]. The Federal Communications Commission (FCC) released the commercial operations for an ultra wideband range from 3.1-10.6 GHz, which is used to avoid the interference between the existing a wireless communications and Ultra wideband (UWB) communication system. The Federal Communications Commission power requirement of –41.3dBm/MHz, 5 equal to 75 nano watts/MHz for Ultra wideband system [2].

There are many benefits that Ultra wideband brings in a wireless communication. One is power spectral density (PSD) which increased interference and vulnerability to the other system. Another one is larger channel capacity which increased bandwidth .The larger channel capacity is defined that maximum data can be transmitted per second over Ultra wideband. The Hartley-Shannon's capacity gives the formula where C represents the maximum channel capacity, B is the bandwidth, and SNR is the signal-to-noise power ratio [3]. The Ultra wideband signal is available in gigahertz while data rate signal is available in gigabits. The higher data rate is available only for short pulse up to 10m. The trade-off between the range and the data rate makes Ultra wideband technology ideal for a wide array of applications in military, civil, and commercial sectors. The Ultra wideband communications systems have low average transmission power for detection and intercept an inherent immunity [4]. Due to this, the eavesdropper has very close to the transmitted power to detect the transmitted information. The time modulation of extremely narrow pulses adds more security to Ultra wideband transmission, because it detecting pulses in picoseconds without knowing when they will arrive is next to impossible.

It is well known that in narrow band, the Ultra wideband spectrum covers a vast range of frequencies from near DC to several gigahertz and provides high processing gain for the Ultra wideband signals. The high multipath channel is unavoidable in a wireless communications system [5]. This happens because of multiple reflections is transmitted signal from various surfaces such as buildings, trees, as well as people Hence it is well know that an ultra wideband is a radio technology that can be used at very low energy levels for short-range and for high bandwidth communications. This is due to by using a large portion of the radio spectrum in the ultra wideband communication. In the ultra wideband communication system can be used many applications for that are device-to-device transfer, digital video cameras and printers.

The antenna design can face various problems in an Ultra wideband communication system. The main problem in the ultra wideband communication system is interference [6]. To avoid the interference between existing wireless communications system and ultra wideband communication system, one method is defined a dual band notch function in the system such as IEEE 802.11a in the USA, 5.15–5.35 GHz, 5.725–5.825 GHz, 2.4-2.48 GHz, which cover the frequency of Bluetooth, WLAN, WIMAX, WIFI and C bands [7]. Another method to avoid the interference from the Ultra wideband antenna is embedded slots, slits, different types of shaped that are used in the ground plane. The fractals, planar inverted F shaped access (PIFA) and frequency selective surface (FSS) are used on the radiating patch to overcome the interference [8].

Recently, many antennas are design to overcome the interference problem by using band stop functions To generate a single band notch function different types of slots are used in the ground plane that is U shaped, Pi shaped, square ring shaped, C- shaped, T-shaped [9]. To use a single band notch function a large space antenna can be obtained for an ultra wideband. The main motive of the proposed antenna is to reduce the antenna size, increased bandwidth and overcome interference problem [10]. The main challenge comes to obtain high efficiency for a dual band notch function. The main problem occurs with the frequency rejected function design is controlling the width of the band-notch in a limited space [11]. In this paper, the proposed antenna describe about dual band notch function. Also, an efficient frequency band rejected frequency for lower the WLAN band and upper the WLAN band is difficult to implement for Ultra wideband applications because of dual band notch functions

In this paper, a compact dual band notched characteristics is proposed for a wireless communication system. By cutting an circular shaped slot on the radiating patch a dual band notch characteristics can be achieved. Also by inserting a six circular shaped on the radiating patch a wider impedance bandwidth as well as wider fractional bandwidth of more than 130% can be .achieved. By properly selecting the dimensions of circular and rectangular shaped slots, a dual band notch with sharp shape can be obtained.

II. ANTENNA CONFIGURATION

The proposed antenna shows geometry and configuration in fig.1, which is printed on the substrate with the dimensions of, 25mm x 25 mm, thickness 1.6mm, and relative permittivity of dielectric constant 4.4. The microstrip feeding is used in the proposed antenna. The width of feed line is 3.4mm to achieve 50 ohm characteristic impedance. By using a combination of a circular shaped and rectangular shaped pair on the radiating patch a better impedance bandwidth can be easily achieved.

The electromagnetic software Ansoft HFSS 12.0 version is employed to perform the design. To achieve a dual band notch characteristics, a pair of an circular shaped slots are used on the radiating patch as well as a parallel strip with the square rectangular slots are used on the radiating patch to generate a band stop function with center frequency of 5.2, and 5.8 GHz_respectively. The main advantage of using circular slot on the radiating patch is the flexibility of the band-notch design, due to which it can easily control the width of the band-notches as well as the rejected frequency. The proposed antenna provides narrow band notch characteristics because of using a circular slot on the radiating patch. The two different strips can act as two stop filters at different adjacent frequencies. The dual band notches cover the frequency from 5.05–5.4 and 5.75–5.87 GHz for an ultra wideband antenna.

It is seen that one circular slot is used in the radiating patch, it does not have a maximum effect in the surface current distribution, but two circular slots have enough surface current distribution and has stronger coupling effect. Hence, we can say that by using a circular slot on the radiating patch an exact dual band notched characteristics can be achieved. If the width of the slots increased, capacitor is small hence no notches are created. It is seen that firstly by applying a single a circular shaped on the radiating patch better impedance bandwidth can be achieved but poor return loss. Secondly, when a pair of circular shaped slot is used in the radiating patch bandwidth is same as same above but slightly improved in the return loss parameters. Thirdly, by using circular shaped slightly improved in the impedance bandwidth as well as return loss below -10dB. Fourthly by combination of a pair of an circular shaped on the radiating patch impedance bandwidth with better return loss can be achieved Finally the proposed an antenna contain a six circular shaped slots and rectangular slots on the patch due to which WiMax band can be achieved. The circular slots acts as an electromagnetic coupling effect to achieve dual band-notch characteristics. Here the proposed antennas achieve good dual band-notch for Ultra wideband (UWB) antenna with band rejection-frequencies.

It is observed that if the length of the slots increased then the inductor, capacitor value increased, as well as it also reducing the center band rejection frequency and bandwidth. It is seen that width of the slot parameter and capacitor value is inversely proportional to each other. If the slot width increases, capacitor value decreases with large center band rejection frequency and bandwidth. Different shape slots are being used in order to increase the bandwidth. From the survey it is noted that, the bandwidth of antenna can be varied by varying the dimension and geometry of antenna. As by changing the geometry of patch, it is noted that the bandwidth increases by introducing the different shape patch in the antenna.

The design value of the antenna parameters are L_1=25mm, L_2=15mm, L_4=13mm, W_1=25mm, W_2=15mm, W3=8.3mm, G_2=1mm, L_{G2}=1.5mm ,W_{G2}=1.5 mm, L_{G3}=1.5mm, W_{G3}=1.5mm, L_{G4}=1.5mm, W_{G4}=1.5mm, L_{G5}=1.5mm, W_{G5}=1.5mm, L_{G6}=1.5mm, W_{G6}=1.5mm, L_{G1}=1.5mm, W_{G1}=1.5mm

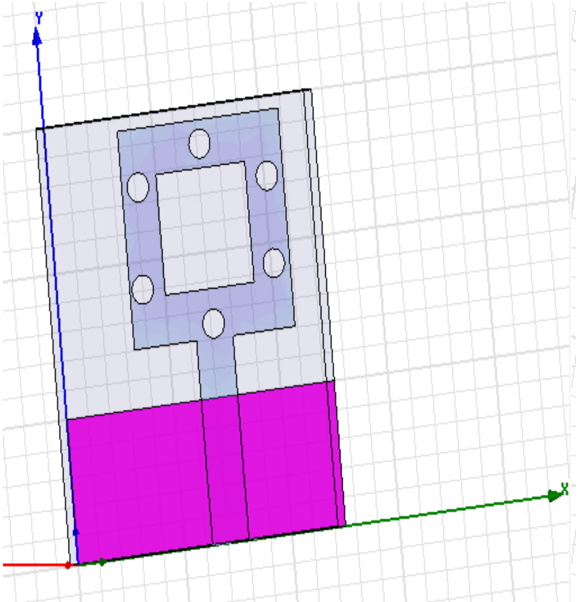

Fig.1 Proposed Antenna Design

III. RESULTS AND DISCUSSIONS

In this portion, proposed antenna with various design parameters is described. The experimental results of return loss, VSWR, gain, Radtion efficiency, radiation pattern and group delay are discussed here. The simulated results are produced by using HFSS version 12 [12].

The proposed antenna show results of return loss or S_{11} parameters. It is clearly shown that firstly, the proposed antenna used the single an E shaped in the ground plane, but it observed that return loss have poor bandwidth. Secondly, when the proposed antenna is used a pair of circular shaped on the patch then, it is seen that resonance frequency are 3.1, 5.9 GHz. with return loss of -10dB and -13dB respectively.

Thirdly, when the proposed antenna is employed single circular shaped on the radiating patch then, it is seen that resonance frequency are 3.1, 5.9 GHz with return loss of -10dB and -10dB respectively. Fourthly, when the circular shaped slots are used n the patch of proposed antenna then it is seen that resonance frequencies are 3.1, 5.9 GHz with return loss of. -12dB and -15dB.Finally by using a six circular shaped slot on the radiating patch then, it is seen that resonance frequency are3.1, 5.9 GHz with return loss of -10.48dB and -23dB.respectivley.

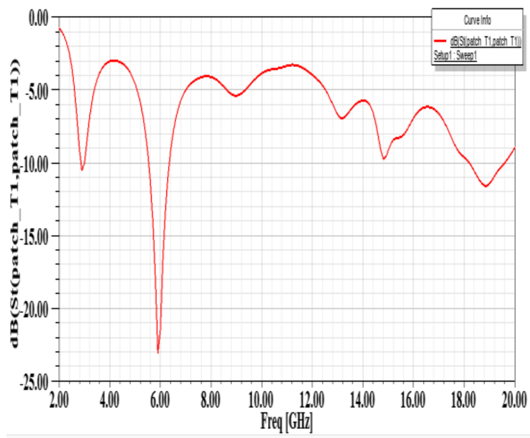

Fig. 2 Return loss

The proposed antenna shows the simulated results of far field radiation pattern in terms of xy, xz and yz plane at different frequencies. The proposed antenna has E plane and H plane. The H plane radiation pattern is Omni-directional. The E plane is bidirectional and number of lobes rises with increase of frequency. It is seen that both E plane and H plane shows radiation pattern at low frequencies.

The proposed antenna measured radiation pattern in terms of xy plane. This happens because y plane is polarized monopole antenna. The co polarization and cross polarization are far field component. To measure co polarization theta is varying from 0 to 180 degree and phi is constant but to measure cross polarization theta is constant and phi is varying from -180 to 180 degree.

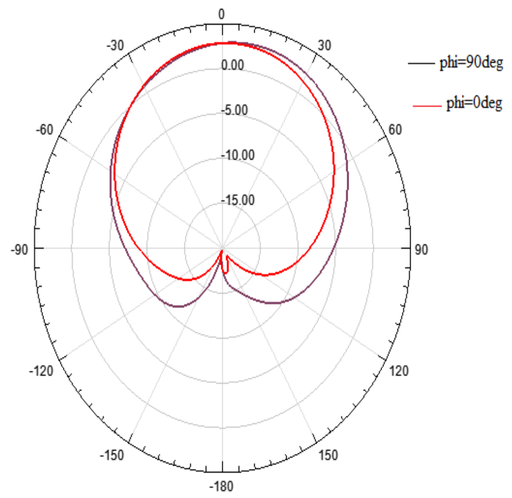

Fig. 3 Radiation patterns

After simulates radiation pattern, the proposed antenna in Fig.3 shows results of gain and radiation efficiency versus frequency .The peak gain is measured of the antenna design. The peak gain is 5.8 dBi from 2-20 GHz. The figure shows a two sharp gains decrease at two frequencies. The gain is also measured of the proposed antenna. In Fig.3 the gain is 2.5 – 5.6dBi from 2 -20 GHz frequency. As it is observed that the gain remains same with an E shaped slot in the ground plane and without E shaped. This happens because gain depends on the substrate height and patch width. The radiation efficiency of the proposed antenna is 70% at 2.4GHz.

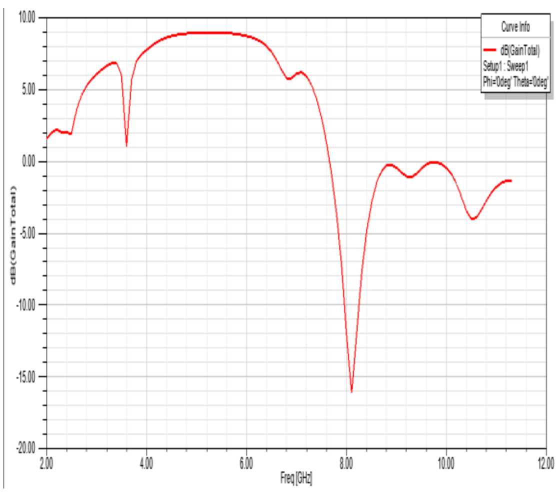

Fig.4 Gain of proposed antenna

Group delay is also important parameters for an ultra wideband system. Group delay is constant entire bandwidth of an ultra wideband excepted notches.

Group delay is a degree of distortion of pulse signal. It is observed that group delay variation is less than 0.35 s from the frequency range 3–13 GHz and less than 0.05 s from the frequency range from 6–13 GHz. Group delay causes distortions to the transmitted pulses except notches.

The proposed antenna measured radiation efficiency for ultra wideband applications. The radiation efficiency has a maximum value of 72% and a minimum value of 27% within the frequency range from 3–11 GHz.

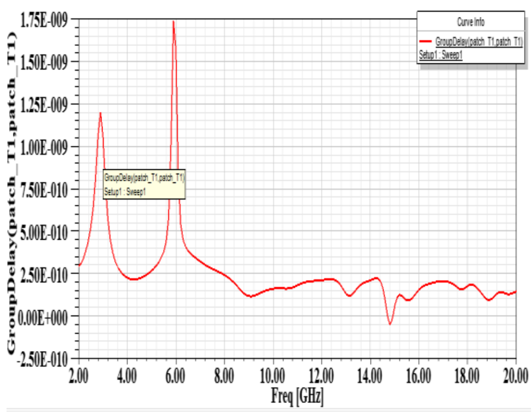

Fig.5 Group delay of proposed antenna

The proposed antenna measure voltage standing wave ratio (VSWR) is less than 2. The voltage standing wave ratio is depending on return loss. If the VSWR is reduced then it is well known that return loss is below-10dB. The VSWR is used for better impedance matching. The impedance matching is one that means 100% accurate results occurs. The impedance matching can also avoid the interference exiting between wireless system and ultra wideband system. It is seen that when the proposed antenna used combination of an E- shaped and L-shaped in the ground plane, VSWR is less than 2 at overall operating band. It is clearly shown at 5.5 GHz, VSWR is 1.99.

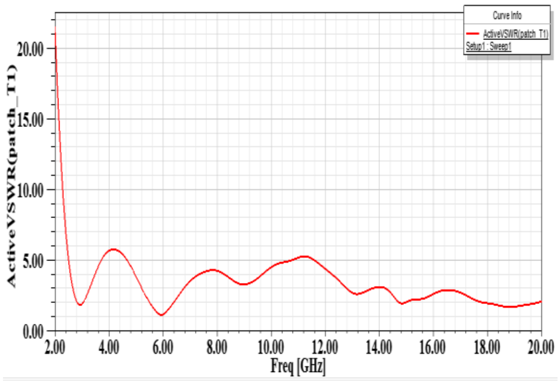

Fig.6 VSWR of proposed antenna

IV CONCLUSION

A dual band notch characteristic with defected ground plane structure has been presented. By properly adjusting the length and width of the proposed antenna a band rejection frequency as well as dual band notch functions can be controlled. The antenna size reduces to 10 x 25 mm^2. The proposed antenna is designed to reduce antenna size, to create a dual band notch function, and to provide wider impedance bandwidth. By cutting a pair of circular shaped slots on the patch, an additional are excited, better impedance bandwidth can be achieved .It can also provide a fractional bandwidth of more than 130%. The antenna design can operate from 2 -19 GHz with band rejection frequency around 3.5, 5.5, 5.8 GHz. By adding a parallel strips on the radiating patch a dual band notch function can be obtained for an ultra wideband antenna. The dual band notch function can be obtained band rejection frequency from 5.09-5.84 GHz To achieve a single, dual or multi band-notch characteristics for an Ultra wideband antennas is difficult for WLAN applications. The simulated results shows good Omni directional radiation pattern, gain throughout the frequency , return loss below -10dB ,constant group delay, radiation efficiency, peak gain, and VSWR < 2 can be achieved.

V FUTURE SCOPE

The future scope of ultrawideband is to increase the fractional bandwidth by more than 20%. The next steps in USB technology is wireless USB.WUSB will be high speed wireless interconnect technology to take advantage of ultrawideband.With WUSB user can be hard disk of proximity to a personal computer , laptop and authentication and authorization can be complete files can be transfered to personal computer. Depending on which technology is implemented, short range wireless can also be used to create a personal area network (PAN) with a range of zero to ten meters (Bluetooth), or a local area network with a range of 0 to 100 meters (802.11b). Bluetooth's current main use is to create a personal area network between devices like cell phones and personal computer (PC) combining many small range systems in one building, such as a mall, airport, or hotel can provide either Internet access or access to a proprietary system.

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