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Designing Of Ultra Wideband Monopole Antenna with Triple Band-Rejected Characteristics Using An soft HFSS

Vineet Sharma [1], Mr. Amit Kumar [2] , Bhupendra Kumar [3]
Subharti Institute of Technology& Engineering , Meerut, UP, India

Abstract— A compact microstrip-fed ultra wideband (UWB) monopole antenna with triple band rejected characteristics is presented in this paper. This antenna is printed on a dielectric substrate and it is fed by a microstrip line. By etching two square slots of different dimensions, in the microstrip feedline, triple band rejections in the WiMAX, WLAN and ITU bands are achieved. The dimensions of these slots in the micristrip feedline can be used to tune the band-notch and bandwidth characteristics. The proposed antenna with the size of 27X30.5 has been constructed and tested. The measured results show that the antenna can operate over the frequency band between 1.1 to 10.4 GHz with a VSWR lower than 2 and provide sufficient rejection band notches for Wimax (3.1-4.3 GHz), WLAN (5-6.3 GHz) and ITU (8-8.8 GHz) and by inserting slots in the microstrip feedline, a better gain pattern is realized.

Index Terms-Band-notch characteristics, gain patterns, ultrawideband antenna.

1. INTRODUCTION

The recent allocation of frequency band from 3.1 to 10.6 GHz by the Federal Communication Commission (FCC) for ultra wideband radio applications has presented an opportunity and challenge for antenna designers. Since then, the feasible design and implementation of UWB antenna has become a highly competitive topic in both academy and industries of telecommunications. However the frequency range for UWB systems will cause interference to the existing communication systems such as the worldwide interoperability for microwave access (WiMAX 3.5 GHz), the wireless local area network (WLAN 5.4 GHz), and ITU 8.3 GHz bands. Therefore, the ultra wideband antenna with rejected characteristics is required. In the present literatures, the square slots etched into the microstrip feedline constitutes a (2n+1)/2 wavelength of the resonant structure to produce the band notched characteristics of Wimax, WLAN, and ITU in UWB band.

In this paper, a simple and compact planar monopole antenna with triple band notches for WiMAX 3.5 GHz, WLAN 5.4 GHz, and ITU 8.3 GHz is proposed. The antenna consists of a microstrip feedline, a ground plane, and a rectangular shaped radiation patch with two square slots etched in the microstrip feedline. The dimension of these square slots realize the triple stop-band fuction.

2. ANTENNA DESIGN

The geometry of the designed antenna is shown in Fig. 2.1. This antenna is printed on a substrate with size of 27 X 30.5, thickness of 1.6 mm and relative permittivity of 4.6. It has rectangular patch with two steps on the front side and a ground plane of 14.8 X 27 on the back side. A 50-Ω micro strip feed line is designed with a width of 3.2 mm. This structure has a feeding configuration that consists of a splitting network connected to two symmetrical ports on its base, which prevents the excitation of horizontal currents and assures that only the dominant vertical current mode is present in this structure.

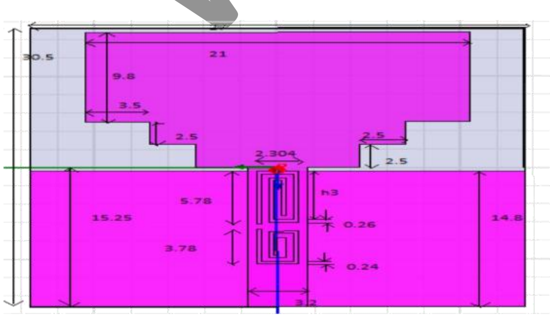

Fig. 2.1 Geometry of the Proposed Antenna

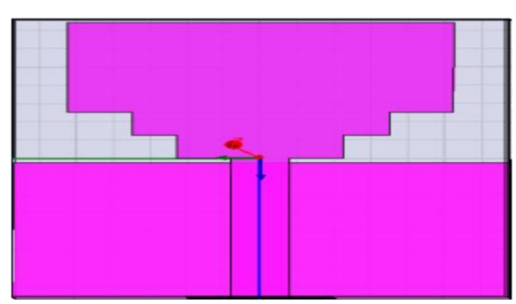

Fig.2.2 Geometry of the Reference Antenna

By inserting different slots on the antenna, the band-notched characteristic in the specific band is realized. Band-notched characteristics of 3.1–4.3, 5.0–6.3, and 8.0–8.8 GHz can be controlled by properly adjusting the parameters of slots.

3. Impact of the Different Number of the Same Slot

As shown in Fig. 3.1, the one and mirror two slots are etched into the micro strip feed line. The band notched characteristic can be controlled by properly adjusting the total length, width, the numbers, and longitudinal length of slots. The parameters of this proposed antenna are studied by changing one parameter at a time and fixing the others.

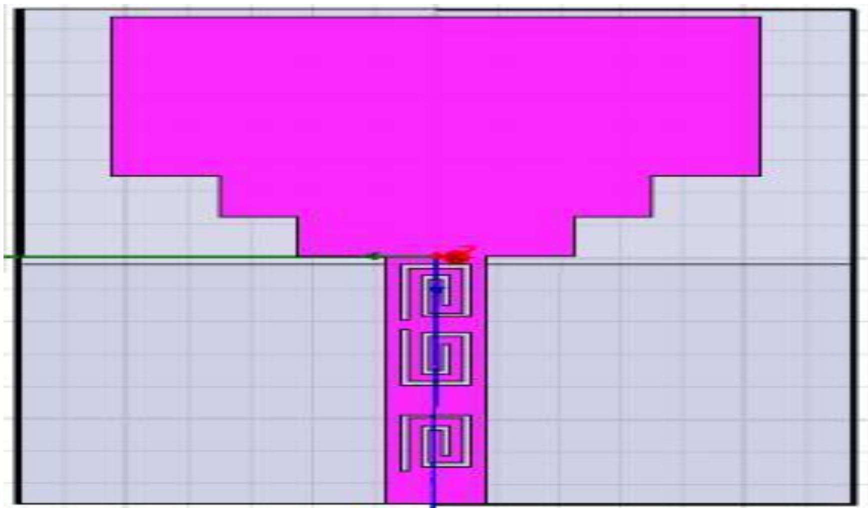

Fig. 3.1 Three Slots on the Feed Line

The length of slots appears to be a quarter-wavelength at resonance, which plays a dominant role in determining the rejection band notches for Wi-MAX, WLAN, and ITU, respectively. The notch frequency given the dimensions of the band-notched feature can be assumed as

=

Where C, ϵ_r and L are the speed of light in free space, the effective dielectric constant, and the total length of the strip, respectively. We can take into account in obtaining the total length of the slot at the beginning of the design, and then adjust the geometry for the final design. The frequency varies with the length of the slot, which shifts from around the lower frequency to the higher, corresponding to the length of the slot from long to short. The width of the slot has a slight effect on the rejected frequency
and the bandwidth: As the width decreases, the notched band shifts toward the higher frequency, and the bandwidth also increases. The VSWR obtained for the one slot is compared to that of two slots and three slots, respectively, by inserting on the microstrip feedline in Fig. 3.1, Fig. 3.2 and Fig. 3.3.

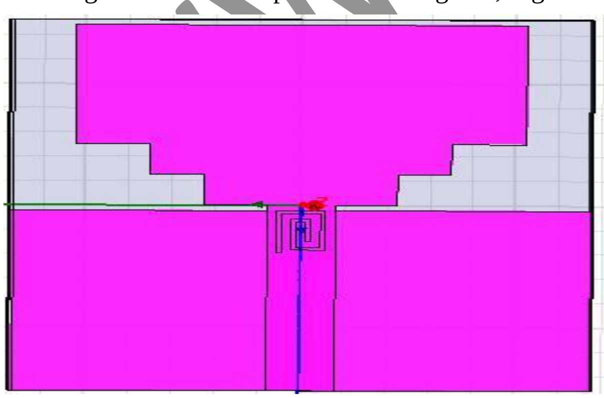

Fig. 3.1 One Slot on The Feed line

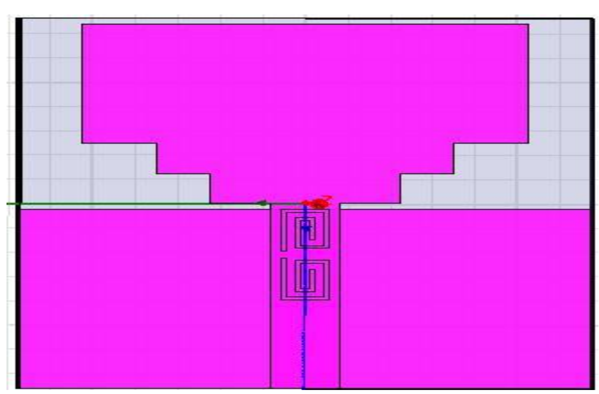

Fig.3.2 Two Slots on The Feed line

According to the results, it is found that the VSWR is increased significantly with increasing the number of the mirror slots.

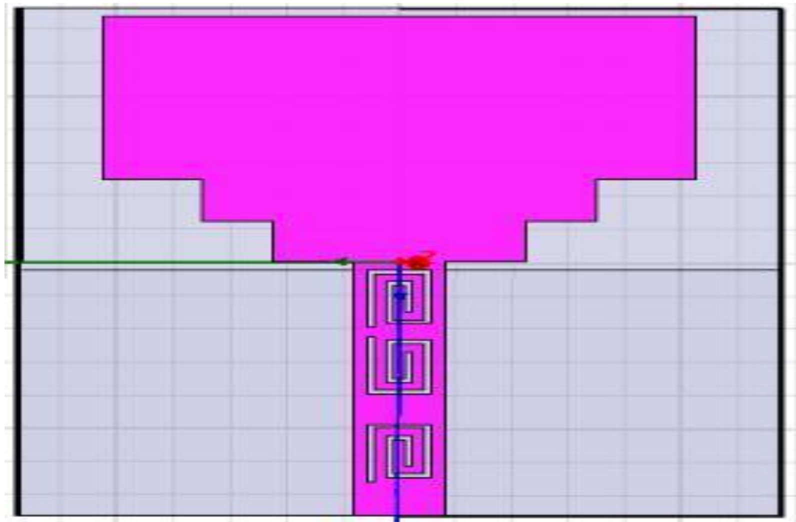

Fig. 3.3 Three Slots on The Feed line

This is due to the LC resonance circuit of the slot gap being changed, and the quality factor Q of the slot is varied too. Also, it has a certain impact on the bandwidth of the rejected band. This is due to a plurality of slots between certain mutual couplings.

4. IMPACT OF THE LONGITUDINAL LENGTH OF THE SLOT

No matter what the shape of the slot, the result as the same. However, it is found that the longitudinal length of the slot has a significant effect on the bandwidth of the rejected band. That is changing the electrical length of the slot significantly.

The slot is similar to a resonator, whose equivalent circuit is transformed by $(2n+1)\gamma/4$ from a short-circuited state to an open-circuited state, or an open-circuited state is converted by $(2n+1)\ \gamma/4$ to a short-circuited state. The slot produces different current distribution. The first notched band is generated from its first-order mode; the second notched band is generated from its third-order mode, and so on. The notched band is generated from the higher-order mode submerged in the outside of the UWB band. The longitudinal length parameter of the slot inserting on the micro strip feed line is changed at a time and produces a plurality of notched band. As the longitudinal length of the slot is short, and the electrical length is also short, the second- and higher-order notched band is submerged in outside of the UWB band. The band-notched frequency shift from around the higher frequency to the lower corresponds to the longitudinal length of the slot decreased. Therefore, it can be seen that the antenna can produce two rejected bands just as we need bands by properly adjusting other parameters of the slot.

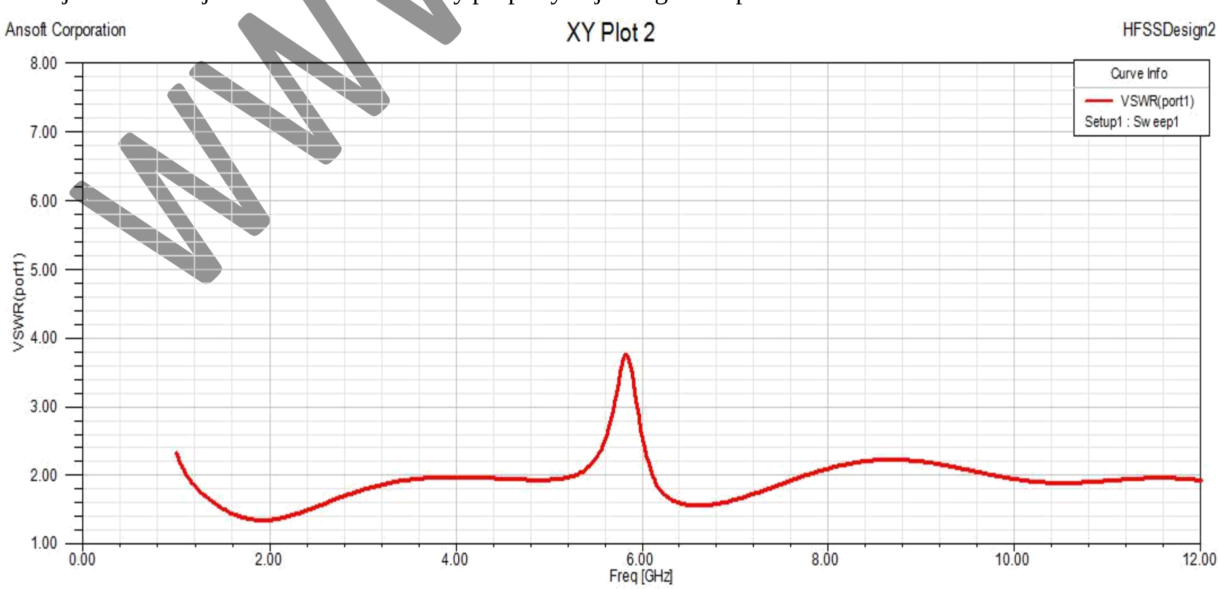

Fig.4.1 VSWR of one Slot

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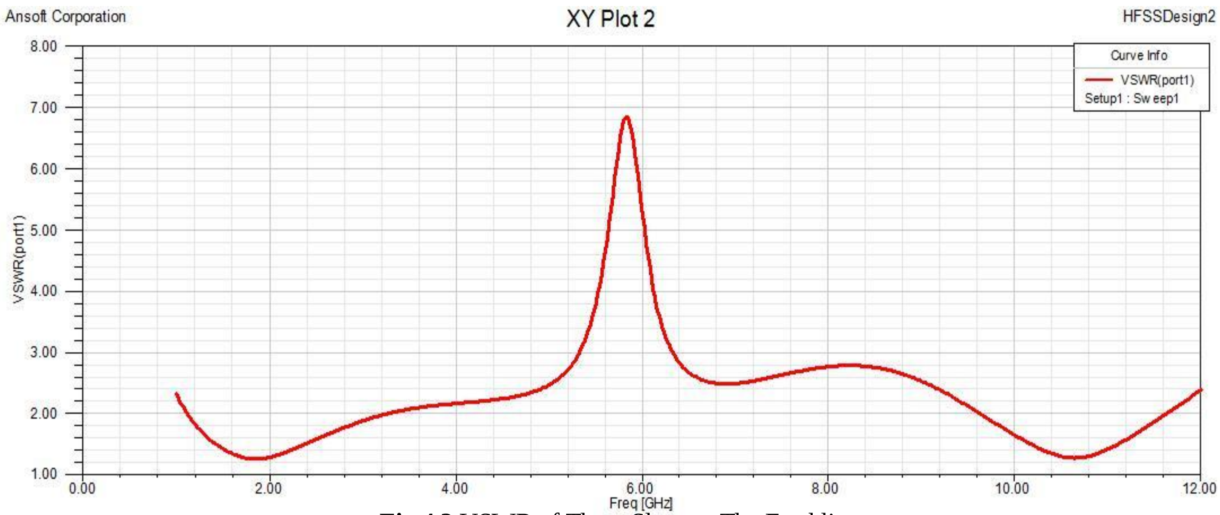

Fig.4.2 VSWR of Three Slots on The Feed line

5. RESULTS AND DISCUSSIONS

The proposed antenna and the reference antenna are simulated by Ansoft HFSS v12, fabricated and then measured by the Agilent N5230A network analyzer. The proto-type of the antenna are shown in Fig. 5.1.

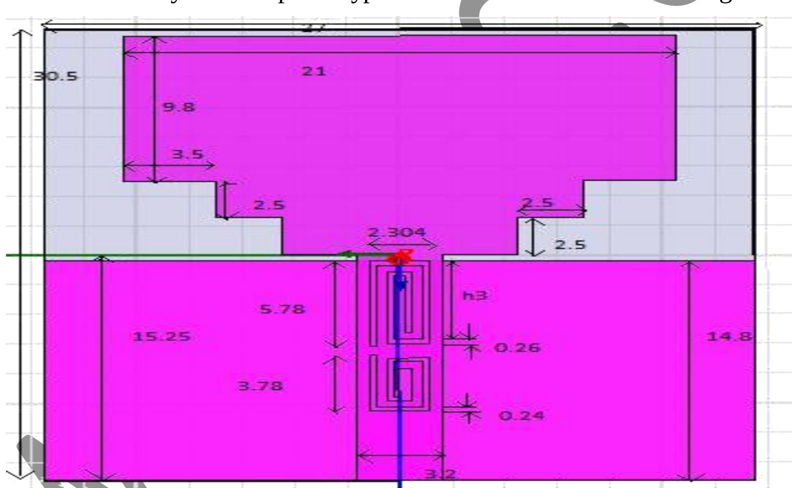

Fig. 5.1 Configuration of The Three-Band Notched Antenna

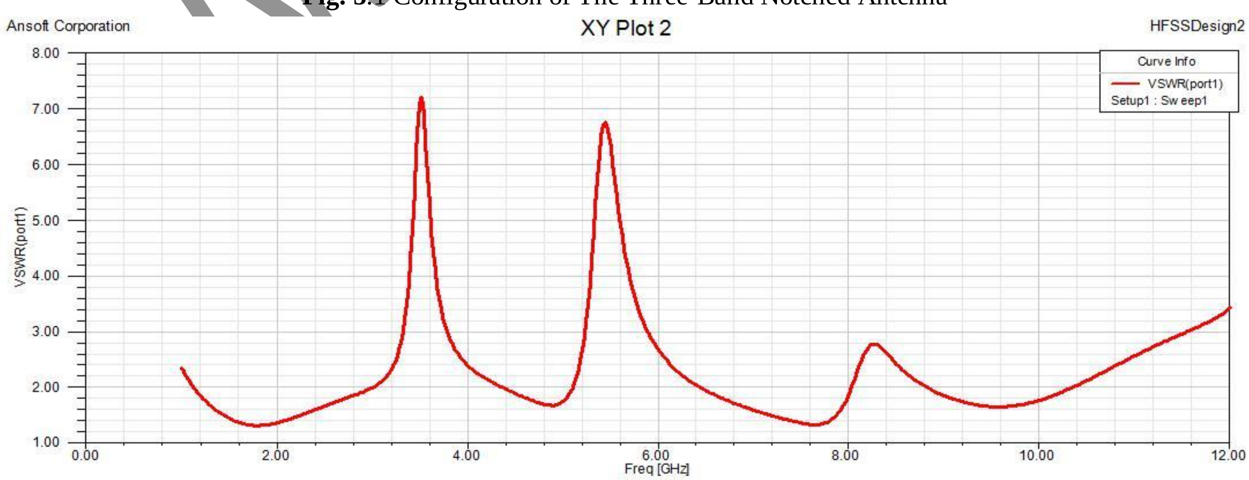

Fig. 5.2 VSWR of Three Band Notched Antenna

Fig. 5.3 Group Delay of Three Band Notch Antenna

By optimization dimensions of the two different slots, the three band-notched antenna can be obtained as shown in Figure. The proposed antenna consists of two slots etched on the feeding line. The length of the longest slot on the micro strip controls the lowest notched band frequency according to (1). The slot is similar to a resonator, the length of the first slot determines the frequency at 3.1 GHz, and the 8.3-GHz notched band is coupled of the first slot. The length of the second slot determines the frequency at 5.0 GHz; the second slot couples the next notched band at the higher frequencies, which does not appear in the UWB band. When changing the length of the h3 , the first stop band and the third stop band spectrum will change at the same time. The second stop band is less affected. When changing the length of the h5, the second stop band spectrum will change; the first stop band and third stop band are less affected.

The VSWR obtained for the UWB antenna with three notched bands is shown in Figure. According to the results, simulation and measured coincide well in frequencies about VSWR. The second stop band difference is bigger, which may be affected because the second stop band of the ring from welding port nearly impact is bigger.

CONCLUSION

A configuration of multiband and compact monopole UWB antenna fed by a microstrip line is presented. By inserting slots into the microstrip feedline, we can achieve a band-notched ultra wideband antenna. This antenna is designed to cover 1.1–10.4 GHz with good impedance bandwidth and a stable radiation pattern and provide sufficient rejection band notches for 3.1–4.3, 5.0–6.3, and 8.0–8.8 GHz. The potential interferences between the UWB and WiMAX, WLAN, and ITU systems can be reduced to the minimum.

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