

A Planar Microstrip Antenna with Enhanced Triple-Bands Notched Characteristics for UWB Applications

Ramdani Laala¹

¹ MBES College Of Engineering, Ambajogai / Dr. BAMU Aurangabad

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Abstract

A compact printed ultra-wideband (UWB) monopole antenna with triple band-notched characteristics is presented. The antenna consists of a square patch and a modified grounded plane. In order to realize Triple band notched bands characteristics, a T-shaped Strip insert in the square slot of the radiation patch and a pair of U-shaped parasitic strips beside the feed line is used. To remit the potential interference with coexisting wireless systems operating over 3.3-3.6 GHz, 5.15-5.35 GHz, or 10.12-10.3 GHz bands, the overall dimensions of the proposed antenna are 31mm × 26 mm × 1.6mm. The measured and simulated results are introduced and show that the proposed compact antenna has a stable and omni directional radiation patterns across all the relevant bands.

Index terms— microstrip antenna, band notched uwb antenna, monopole antenna.

In the literature, various techniques have been applied in the UWB antenna to achieve the single band notched function. The widely used methods are etching slots on the patch or on the ground plane, i.e., such as Challenges of the feasible UWB antenna design include the wide impedance matching, radiation stability, low profile, compact size, and low cost for consumer electronics applications. For some UWB applications which does not require overall compact size of the transmitter or receiver, appropriately designed band pass filters or spatial filter such as a frequency selective surface (FSS) above the antenna can be used to suppress the dispensable bands [4]. However for the UWB systems which demand a compact, less complex and low cost design, frequency band rejection function may be employed in the antenna itself, which includes embedding optimal shaped slot in the radiating patch or in the ground plane. The main problem of the frequency rejected function design is the difficulty of controlling width of the band-notch in a limited space. Furthermore, strong couplings between two band-notched characteristic designs for adjacent frequencies are obstacles to achieving efficient dual band-notched UWB antenna. [5] Many techniques have already been proposed to design band-notched antennas, for example, 'L' shaped slot and a twisted 'J' shaped slot, Square Aperture Strip, by etching two round shape slots, U-shaped slot, and by adding Strip like parasitic strip, U shaped antenna, [5][6][7][8][9][10][11][12] And most of the techniques is like the adding Strip and elements and integrate with the feed line of the antenna like Capacitive Loaded Line Resonators (CLLRs), SCRLH resonator structure, band rejected elements, self-complementary structure. [13][14][15][16] [17][18][19][20][21]. And Most of the MIMO antenna technique also evolved for this Notch performance [22] adding two capacitive loaded loops (CLLs) close to the micro-strip feed line, [23] T-shaped Strip-loaded ring resonator (SLRR) [24] embedding a Strip that is located to the hollow center of feed [25] ground plane and a T-shaped exciting Strip [26,27] monopole antenna with notches at four frequencies is presented. Notch characteristic at desired frequencies are obtained using smaller rectangular metallic strips. [28] A T-shaped Strip embedded in the square slot of the radiation patch and a pair of U-shaped parasitic strips beside the feed line is used [29].

In this paper, a compact, micro strip fed, monopole UWB antenna with triple band notched characteristics is presented. This work adds perturbation in the surface current density of the radiating element and the feed element. Initially a reference antenna is designed, which exhibits radiating characteristics in the frequency band 3-11 GHz. In this design, the micro strip line fed triple band notch planar antenna consists of rectangular radiating

patch and a partial rectangular ground plane is proposed shown in Figure 1. The patch with a dimension of $m \times n$ is printed on the top side PCB substrate while the partial ground plane having a side length f is printed on the bottom side. The proposed antenna has a compact size of 31×26 mm and is printed on 1.6 mm thick Fr4 dielectric substrate with dielectric constant 4.4 and loss tangent 0.02. It is composed of a 50 Ω micro strip feed line, a planar radiating patch with two round shape Strip and rectangular ground plane with a pair of C-shaped Strip to band stop function.

1 A. Uwb Monopole Antenna

The evolution process for the compact UWB antenna. UWB monopole antenna the designed antenna of optimized dimensions is implemented with a low-cost on Fr4 substrate shown in fig 2. To improve the bandwidth of the antenna, the partial ground plane is modified by cutting triangular shape slots at its top edge. The width of the micro strip feed line is chosen as 1.4 mm to achieve the characteristic impedance of 50 Ω . The dimensions of the designed antenna after optimization are as follows: $a=2$ mm, $b=2$ mm, $s=15.5$, $f=11.5$ mm, $m=12$ mm, $n=14$ mm, $g=1$ mm, $K1=8$ mm, $K2=3$ mm. The length of the U-shaped slot can be calculated by, $L_{slot} = \frac{c}{f} \sqrt{\epsilon_{eff}}$ [1].

Where c and ϵ_{eff} are the speed of light in free space and the approximated effective dielectric constant, respectively. C. Dual Band Notched Uwb Antenna Then for wideband isolation there is a fork shaped a Strip introduced into the ground plane of the antenna, due to that mutual coupling get reduced. Fig. 1. shows the proposed triple band notched UWB antenna. For more specifications of antenna dimensions of a Strip and the more branches get added and enhance the isolation but there is effect on impedance bandwidth. Fig. 4 shows the decreasing in mutual coupling of the antenna due to Strip structure. So the fork Strip here not only performs the role of an isolator, but also acts as a compensating radiator for the UWB antenna [6]. In wireless communication application occurs in UWB such as WLAN IEEE802.11a and HIPERLAN/2 WLAN operate at 5.15-5.35 GHz and 5.725-5.825 GHz respectively. In order to reduce the electromagnetic interference, the stop band filter 5-6 GHz is often required for UWB system. However, the UWB systems with extra filter circuits are more complex and expensive. As can be seen, the current distributions are mainly concentrated in the signal line and near the gap between the radiator and the ground plane. These sensitive locations therefore have been selected for the band-notched elements in this presented work. The mechanism of frequency rejection could be illustrated and discussed using current distributions along the radiating element. Fig. 7 is the cases of wave radiation at frequencies of 3.2 GHz and 5.25 GHz and 10.2 GHz, respectively. It is seen that the current concentrates along curved edges and two sides of patch. As a result, the antenna can achieve radiate wave at those frequencies. Fig. 7(b) is the case of rejected frequency at 5.25 GHz. It can be observed that the current only concentrates around c-shaped slit and strongly concentrates at the small gap on the top c-shaped slit. There is no current distribution at the other parts of patch. This operational antenna can be considered as transmission line as the mode published and postulated in [7,9].

2 III.

3 Parametric Analysis a) The Effect of T1 and T2.

A parametric study of the triple band-notched UWB antenna has been conducted by computer simulation to explore how the dimensions of the different resonant elements affect the performances of band notches. Therefore, we need to investigate the individual resonant effects based on length, width, and position. Basically, the length and width of the each resonator acts as the inductance, and the distance between the adjacent arms acts as the capacitance. The couplings between the resonators and the main radiator act as the filter to create a notch band at certain frequency as explained in detail in [18,19]. The Simulated radiation patterns of antenna 3 at frequencies 3.24 GHz, 4.22 GHz and 9.12 GHz are illustrated in Figure 12. The radiation pattern is bidirectional in E-plane (yoz -plane) and omni directional in H-plane (xoz -plane) at 3.24 GHz and 4.12 GHz. It can be regarded as a monopole which features a doughnutshaped pattern at the fundamental mode. As the frequency increases, the radiation pattern in H-plane (xoz -plane) is quasi-omni directional, and the crosspolarization component becomes larger at 4.22 GHz. At 9.12 GHz, as the higher-order modes exist, the pattern in the H-plane (xoz -plane) is similar to the shape of a four-leaved clover, and the cross-polarization component is large. Figure ?? gives the measured peak gains and the radiation efficiency of the antenna from 3.24 GHz-13 GHz. It can be seen that sharp gain drops of the antenna with notch bands occur both in 3.4-3.7 GHz and 5.15-5.825 GHz and 10.1-10.3 GHz bands. As discussed in the last section, with the increase of frequency, the efficiency of the antenna is decreased for the dielectric loss and conductor loss. In addition, it can be observed that the measurement decreases sharply in the notched band.

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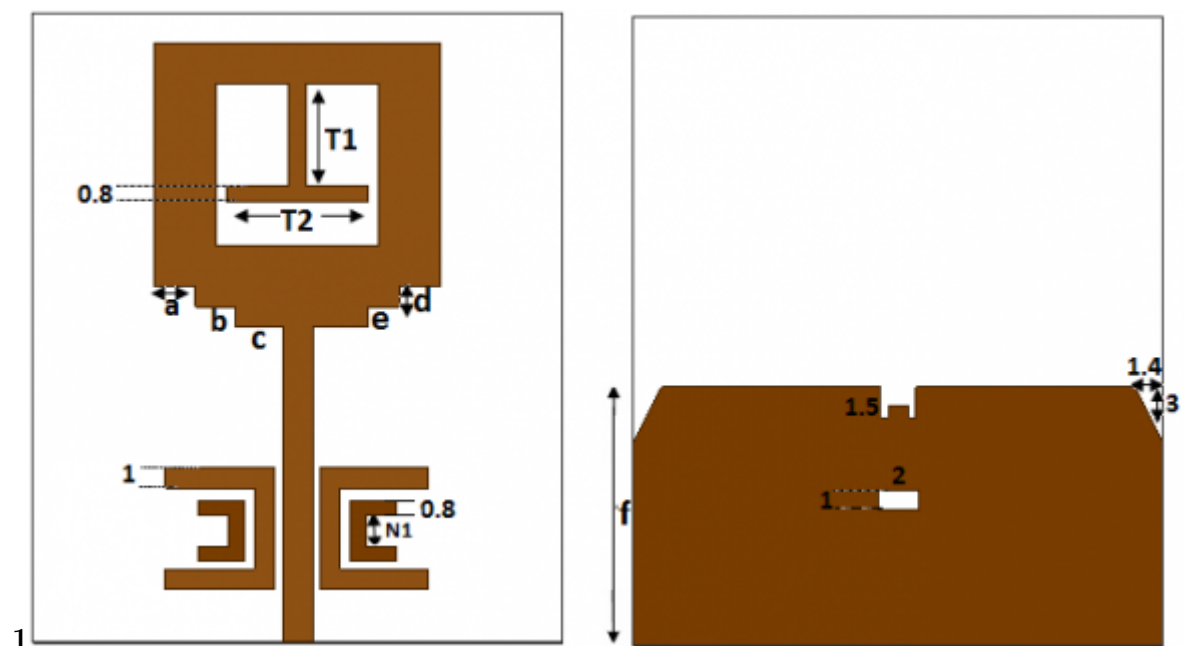


Figure 1: Fig. 1 :

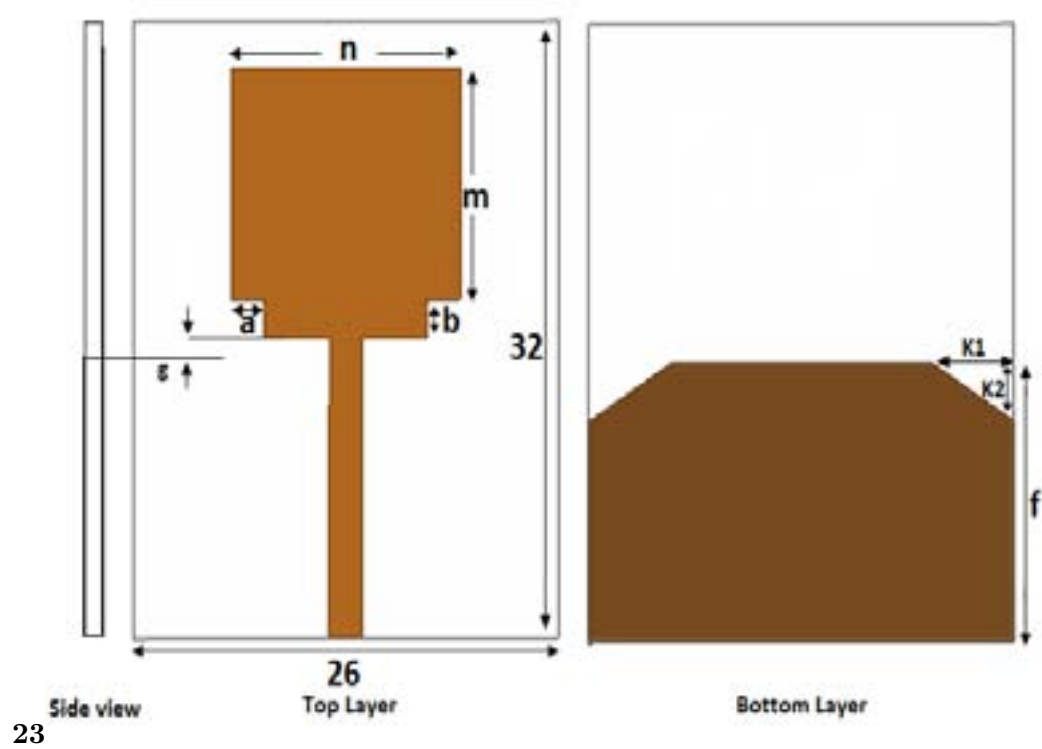


Figure 2: Fig. 2 :Fig. 3 :

3 PARAMETRIC ANALYSIS A) THE EFFECT OF T1 AND T2.

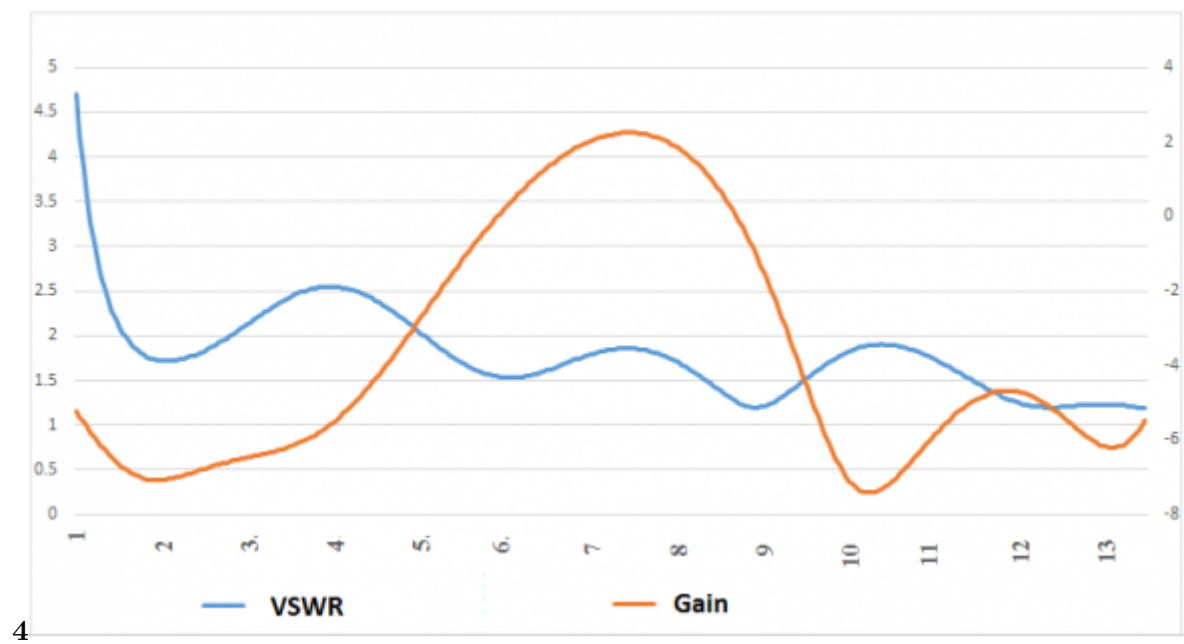


Figure 3: Fig 4 :

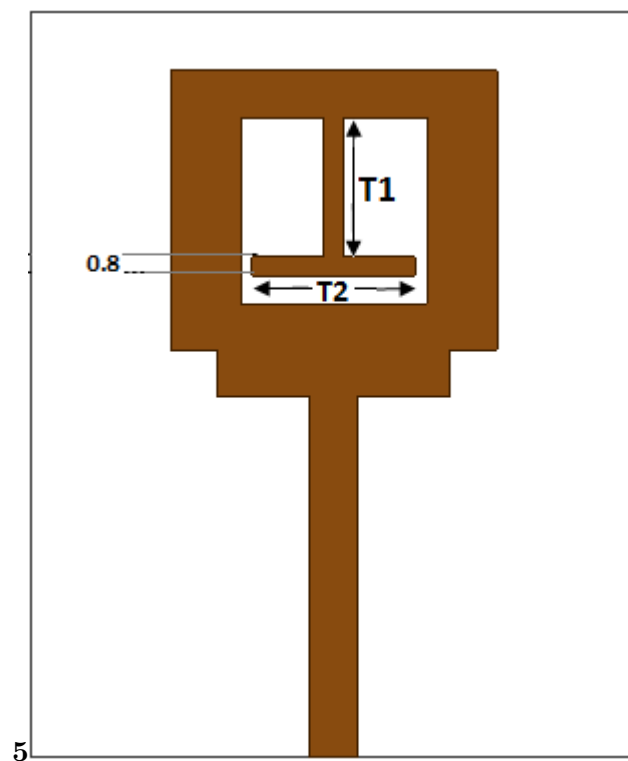


Figure 4: Fig. 5 :

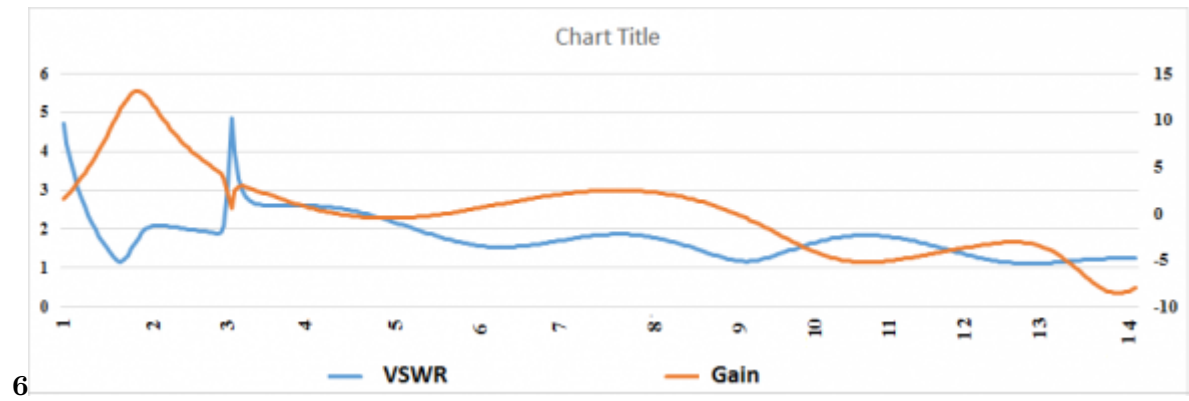


Figure 5: Fig. 6 :

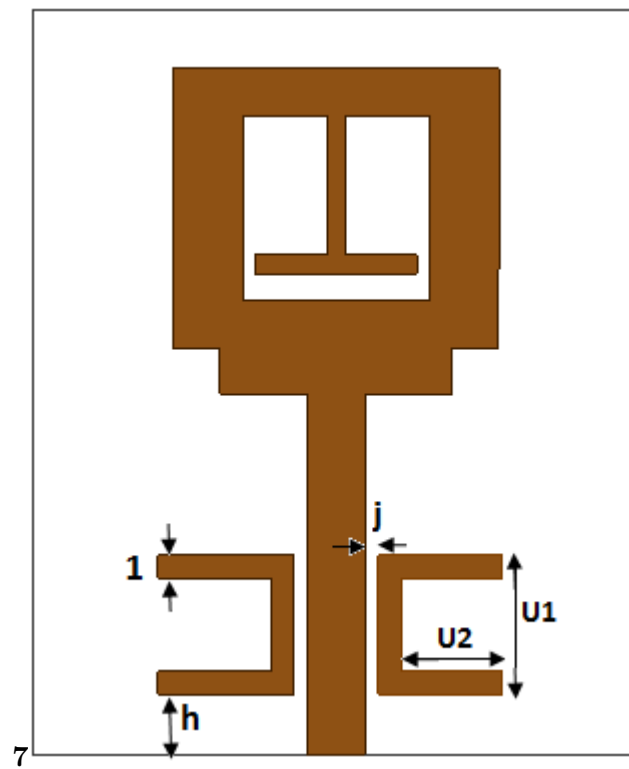


Figure 6: Fig. 7 :

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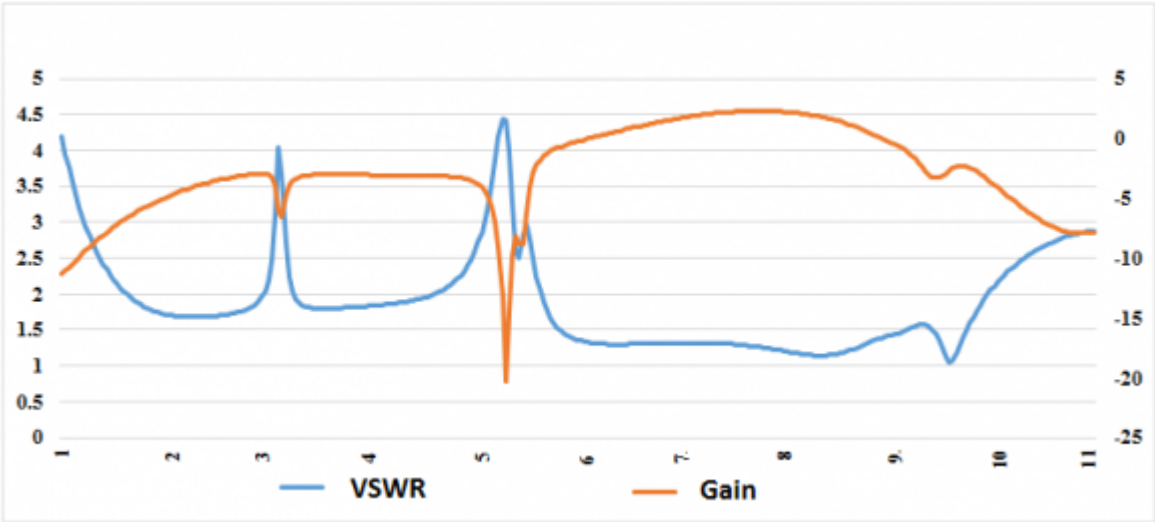


Figure 7: Fig. 8 :Fig. 9 :Fig. 10 :Fig. 11 :

12

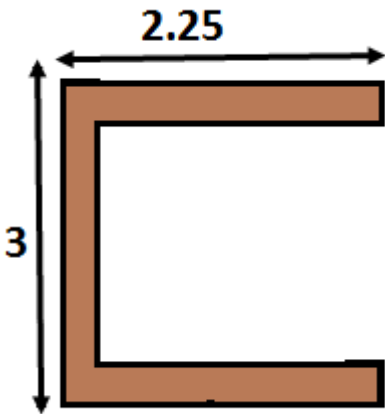


Figure 8: Fig. 12 :

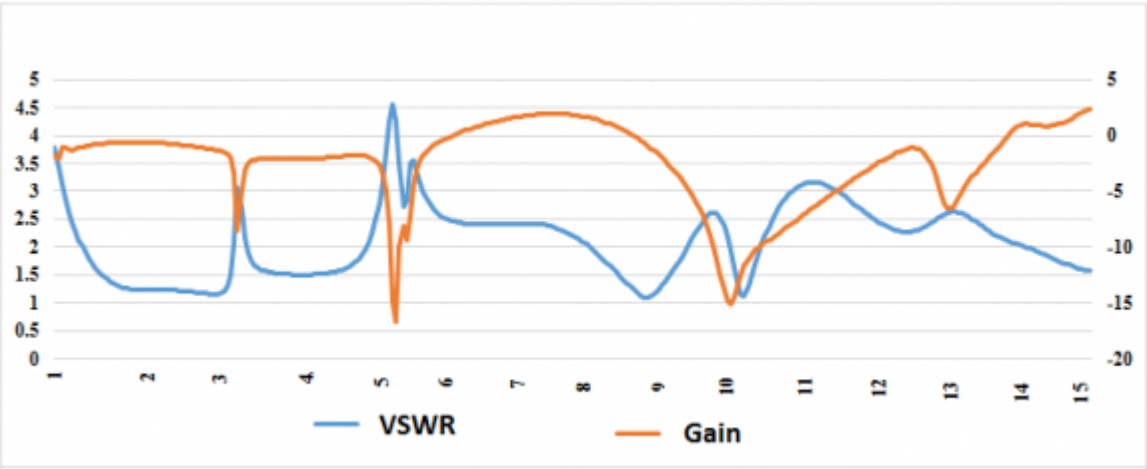


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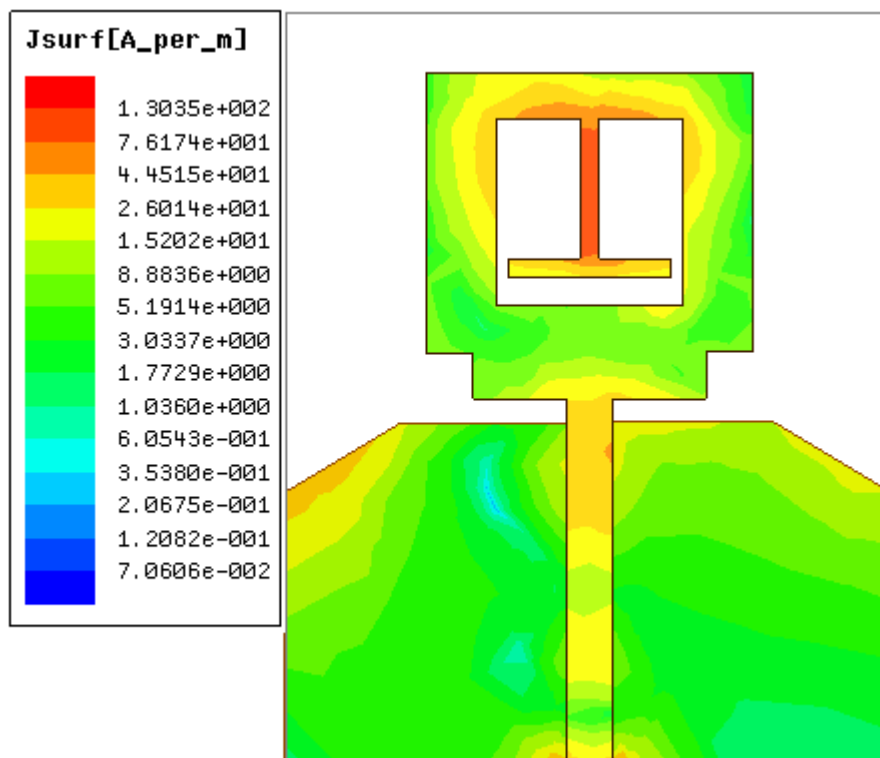


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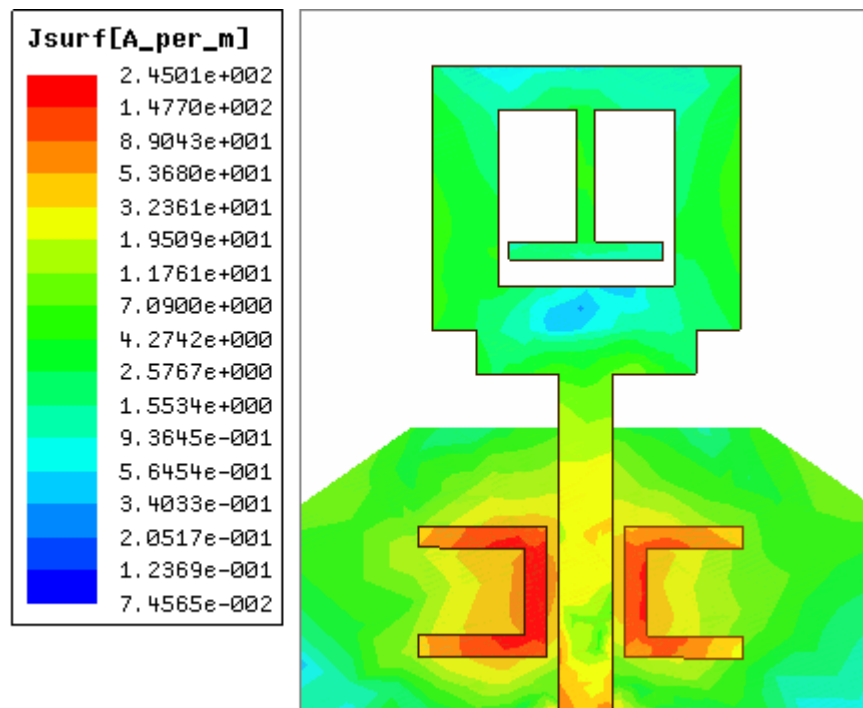


Figure 11:

3 PARAMETRIC ANALYSIS A) THE EFFECT OF T1 AND T2.

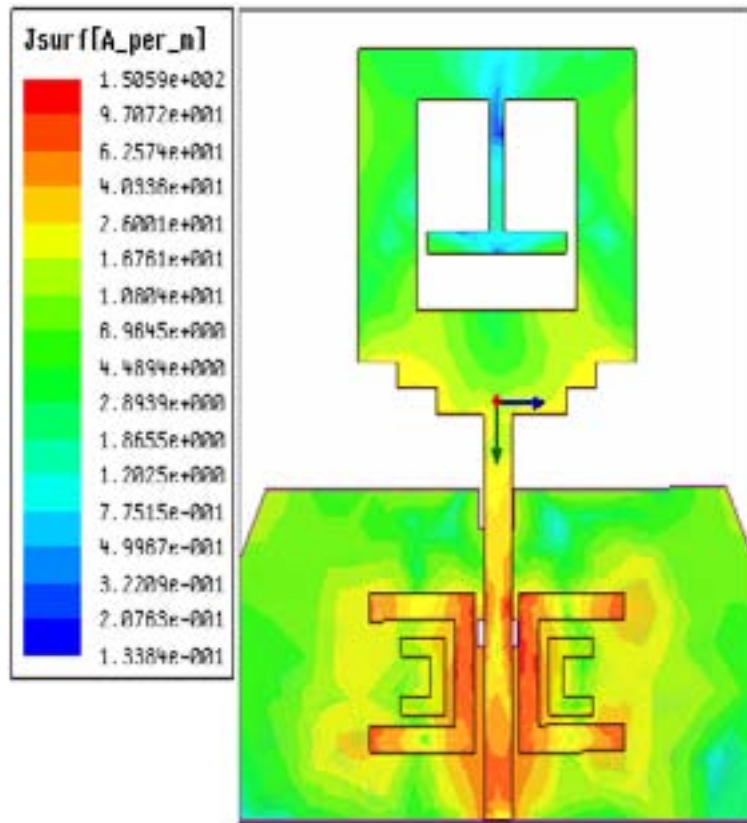


Figure 12:

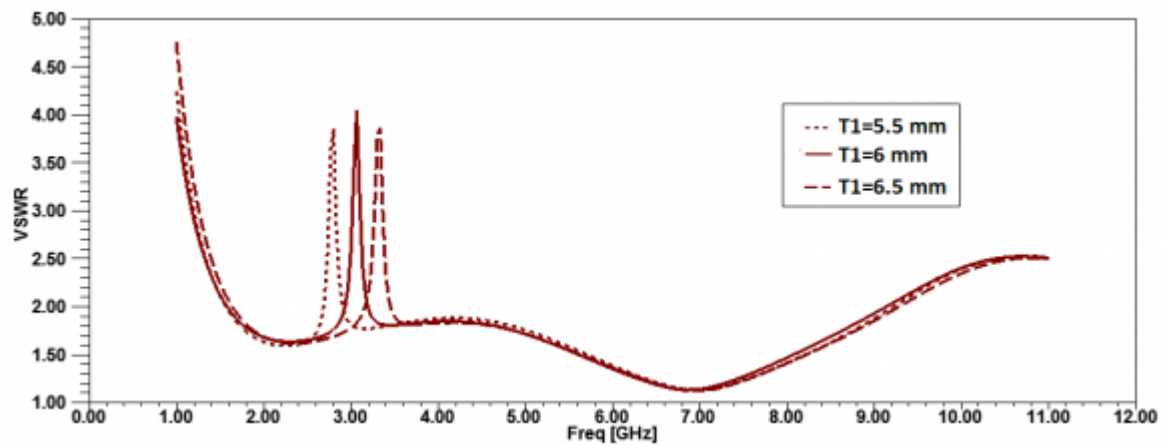


Figure 13:

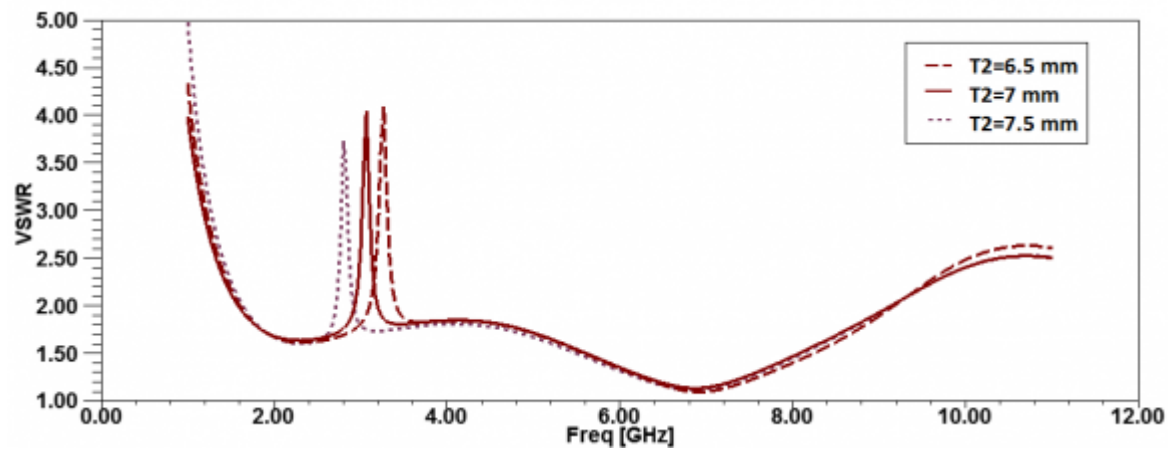


Figure 14:

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