Makara Journal of Technology

Volume 18 | Issue 3 Article 2

12-3-2014

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Recommended Citation

Hadinegoro, Rastanto; Ningsih, Yuli Kurnia; and Surjati, Indra (2014) "Ultra-Wideband Notched Characteristic Fed by Coplanar Waveguide," *Makara Journal of Technology*: Vol. 18: Iss. 3, Article 2.
DOI: 10.7454/mst.v18i3.2951
Available at: https://scholarhub.ui.ac.id/mjt/vol18/iss3/2

Makara J. Technol. 18/3 (2014), 105-108
doi: 10.7454/mst.v18i3.2951

Ultra-Wideband Notched Characteristic Fed by Coplanar Waveguide

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Abstract

In this paper, a novel Ultra-Wide Band (UWB) notch patch antenna with co-planar waveguide (CPW) fed is presented. This antenna only used one layer and the patch antenna is constructed on the first layer and back to back with CPW fed and bottom part is ground plane. The width notch is used to achieve the UWB characteristic. The results shown that the impedance bandwidth is 1130 MHz (1.662–2.792 GHz) or about 50.7% for VSWR $\leq$2.

Abstrak

Karakteristik Ternotsa Jalurlebar Ultra yang Diumpan dengan Pandugelombang Koplanar. Makalah ini memperkenalkan sebuah penemuan baru, yaitu antena *patch* notsa Jalurlebar Ultra (UWB) yang diumpan dengan pandu gelombang koplanar (CPW). Antena ini hanya mempergunakan satu lapisan, dan antena *patch*-nya dirakit dengan umpan CPW pada lapisan pertama dan pada bagian yang saling memunggungi, sedangkan bagian bawahnya adalah bidang tanah (*plane ground*). Notsa lebar digunakan untuk mencapai karakteristik UWB. Hasilnya menunjukkan bahwa jalurlebar impendansinya adalah sebesar 1130MHz (1,662–2,792 GHz) atau sekitar 50,7% untuk VSWR $\leq$2.

Keywords: CPW, notch, triangular, UWB

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1. Introduction

Ultra-Wide Band (UWB) technology is one of the most promising solutions for future communication systems due to its high-speed data rate and excellent immunity to multi-path interference. UWB is known as a Radio Frequency (RF) technology that transmits data in binary form, using extremely short duration impulses over a wide spectrum of frequencies. It has a marvelous quality of delivering data over 10 to 100 meters and does not require any kind of dedicated radio frequency, so is also known as carrier-free, impulse or base-band radio. it also transmits information over a large bandwidth (>500 MHz). It has bandwidth exceeding the lesser of 500 MHz or 20% of the arithmetic center frequency, according to Federal Communications Commission (FCC) [1]. As the key components of UWB system, the feasible UWB antenna design some challenges including the ultra wideband performances of the impedance matching and radiation stability, very high-speed data rates, the compact antenna size, low cost, light weight, low profile, conformal, and compatibility with integrated circuits [2,3]. Low power consumption, good immunity to multipath effect has become a very promising solution for indoor wireless radio, imaging and radars, low manufacturing cost for consumer electronics applications and it has attracted significant attention and developed rapidly in modern wireless communication [2,3].

With many advantages, such as light weight, low fabrication costs, planar configuration, and capability to integrate with microwave integrated circuits, the Microstrip antenna (MSA) is the one of the most commonly used antenna types in UWB application. MSA with UWB application has been achieved by several techniques: The most common technique for increasing the impedance bandwidth is in CPW-fed slot antenna. For example, these have been carried out in various slot geometries like bow-tie slot, wide rectangular slot, circular slot and hexagonal slot, as well as inclusion of slots in the patch, such as the U-patch antenna [4], and for a simple CPW-fed combined square slot antenna, the impedance bandwidth (-10 dB return loss bandwidth) can reach about 30% [5]. Using of parasitic patches in single layer and multilayer configurations. However, using parasitic patches increases the overall size of the microstrip antenna [6].

Furthermore, since the CPW conductors are also used as the ground plane for the microstrip patch, the feed substrate used in conventional microstrip aperture coupling is no longer needed. Reconfigurability, tunability, as well as bandwidth improvements without detracting from the major advantages of microstrip antennas are important subjects of research. CPW-fed antenna has received considerable attention owing to its preferable characteristics, such as easy fabrication, low profile and wide bandwidth. Several CPW-fed UWB antenna designs have been reported in the literature. These can differ, among other factors, by the shape of the conductor and the configuration of the ground plane. In this paper present, a one-layer microstrip antenna with a novel feeding technique that uses a CPW-fed combined notch patch antenna to produce UWB. Notch technique usually is used to produce dual-band antenna [7] but in this paper notch technique used to produce UWB. Details of the antenna design and the simulation results are discussed.

2. Experiment

The proposed antenna has been designed for UWB. The geometry and configuration of antenna for UWB can be calculated by equation (1), for design a microstrip antenna shaped triangular.

$$a = \frac{2c}{3 f_r \sqrt{\varepsilon_r}} \qquad (1)$$

A CPW-fed antenna not only performs better with respect to bandwidth and radiation pattern, but also is easily manufactured, which has increased its importance. They also allow easy mounting and integration with other micro-wave integrated circuit and RF frequency devices. The geometry and parameters of the notch antenna with CPW is shown in Fig. 1. The antenna is etched on FR4 substrate and having a relative permittivity (ε_r) = 4.3 substrate of thickness (h) = 1.6 mm and loss tangent (tan δ) = 0.0265.

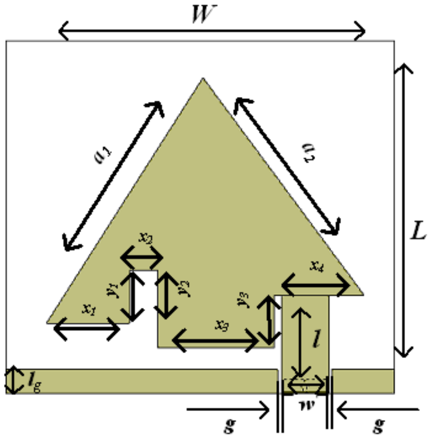

Figure 1. Geometry and Dimension of the Proposed Antenna

The size of the antenna is *W x L* = 55 mm x 50 mm. The antenna is excited by a 50Ω microstrip line. The width of the 50 Ω microstrip line is 6.7 mm, and the gap of the CPW line is *g* = 0.5 mm and dimension of ground plane is (l_g) = 3.5 mm.

3. Results and Discussion

The analysis and performance of the proposed antenna is explored to get the best impedance matching. The analysis of the antenna carried out by varying parameter. At the first iteration with parameter $x_1 = 15.1$ mm, $x_2 = 1$ mm, $x_3 = 19.5$ mm, $x_4 = 9.2$ mm, $y_1 = 9$ mm, $y_2 = 13$ mm, $y_3 = 9.5$ mm simulation result is shown Figure 2 return loss show less than -10dB with range frequency operation (1.636–2.293 GHz) is produced bandwidth 657 MHz.

Second iteration with parameter $x_1 = 15.1$ mm, $x_2 = 1$ mm, $x_3 = 18.5$ mm, $x_4 = 10.2$ mm, $y_1 = 9$ mm, $y_2 = 12.5$ mm, $y_3 = 9$ mm simulation result is shown Figure 3 return loss shows less than -10 dB with range frequency operation wider than first iteration is produced impedance bandwidth (1.592–2.281 GHz) 689 MHz is shown Figure 3.

Third iteration with parameter with parameter $x_1 = 15.1$ mm, $x_2 = 1$ mm, $x_3 = 19.5$ mm, $x_4 = 9.2$ mm, $y_1 = 9$ mm, $y_2 = 12.5$ mm, $y_3 = 9$ mm simulation result is shown

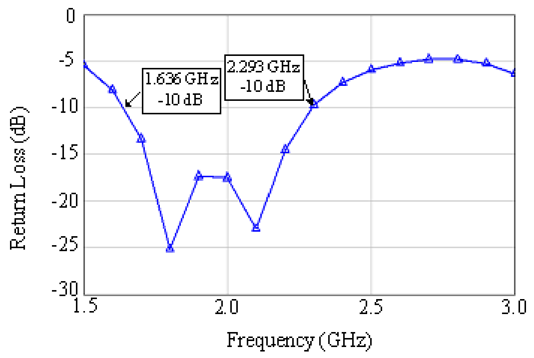

Figure 2 Simulation Results Iteration – 1

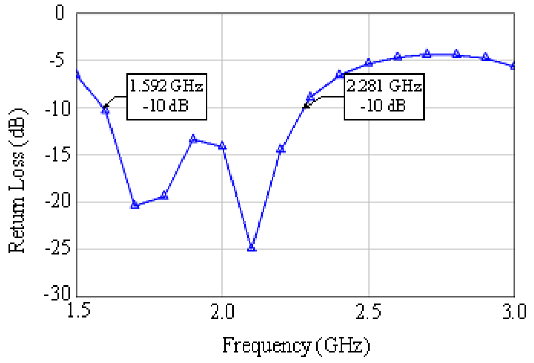

Figure 3. Simulation Results Iteration – 2

Figure 4 return loss shows less than -10dB with range frequency operation wider than second iteration is produced impedance bandwidth (1.641–2.349 GHz) 708 MHz.

Fourth iteration with parameter with parameter x_1 = *15.7 mm*, x_2 = *1 mm*, x_3 = *19.5 mm*, x_4 = *9.2 mm*, y_1 = *10 mm*, y_2 = *12.5 mm*, y_3 = *9 mm* simulation result is shown Fig. 5 return loss shows less than -10 dB with range frequency operation wider than second iteration is produced impedance bandwidth (1.546–2.333 GHz) 787 MHz.

Fifth iteration with parameter with parameter x_1 = *15.7 mm*, x_2 = *1 mm*, x_3 = *19.5 mm*, x_4 = *9.2 mm*, y_1 = *10 mm*, y_2 = *11.5 mm*, y_3 = *8 mm* simulation result is shown Fig. 6 return loss shows less than -10 dB with range frequency operation wider than second iteration is produced impedance bandwidth (1.550–2.433 GHz) 883 MHz.

Sixth iteration with parameter with parameter x_1 = *14.5 mm*, x_2 = *2 mm*, x_3 = *18.5 mm*, x_4 = *10.7 mm*, y_1 = *8 mm*, y_2 = *11 mm*, y_3 = *7.5 mm* simulation result is shown Figure 7 return loss shows less than -10 dB with range frequency operation wider than second iteration is produced impedance bandwidth (1.631–2.602 GHz) 971 MHz.

Seventh iteration with parameter with parameter x_1 = *11.6 mm*, x_2 = *4 mm*, x_3 = *16.5 mm*, x_4 = *12.7 mm*, y_1 = *7.5 mm*, y_2 = *11 mm*, y_3 = *7.5 mm* simulation result is shown Fig. 8 return loss shows less than -10 dB with range frequency operation wider than second iteration is produced impedance bandwidth (1.662–2.792 GHz) 1130 MHz.

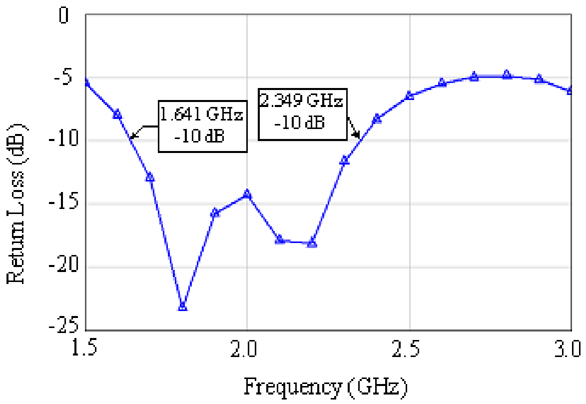

Figure 4. Simulation Results Iteration – 3

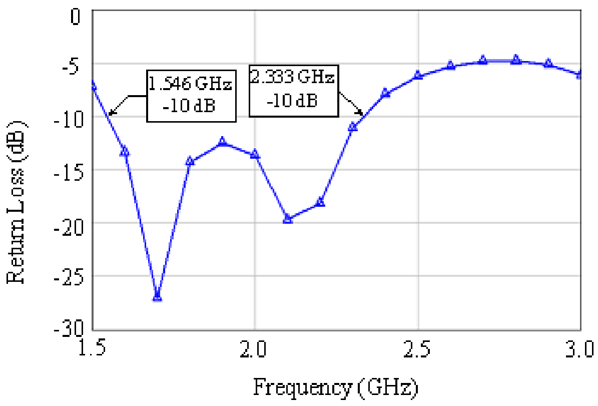

Figure 5. Simulation Results Iteration – 4

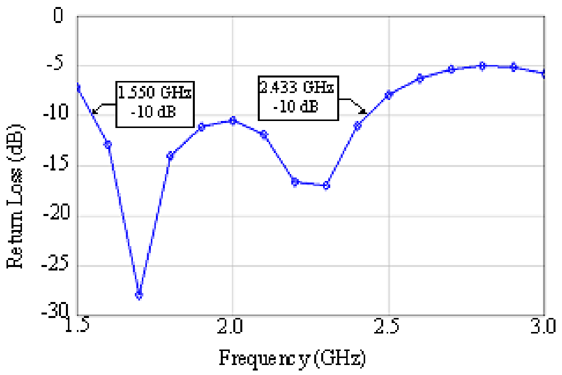

Figure 6. Simulation Results Iteration – 5

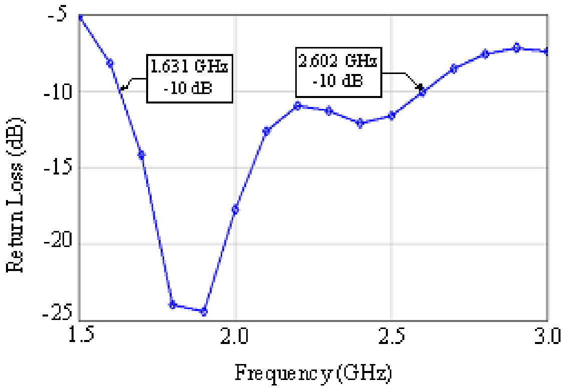

Figure 7. Simulation Results Iteration – 6

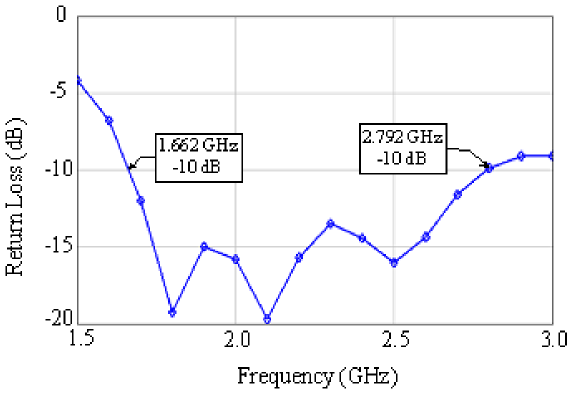

Figure 8. Simulation Results Iteration ke – 7

To make simple the iterations are shown in Table 1 and Table 2, for the bandwidth results is shown Table 3.

Table 1. Iteration Width *x*

Iteration	Parameter			
	x_1 (mm)	x_2 (mm)	x_3 (mm)	x_4 (mm)
1	15.1	1	19.5	9.2
2	15.1	1	18.5	10.2
3	15.1	1	19.5	9.2
4	15.7	1	19.5	9.2
5	15.7	1	19.5	9.2
6	14.5	2	18.5	10.7
7	11.6	4	16.5	12.7

Table 2. Iteration Width *y*

Iteration	Parameter		
	y_1 (mm)	y_2 (mm)	y_3 (mm)
1	9	13	9.5
2	9	12.5	9
3	9	12.5	9
4	10	12.5	9
5	10	11.5	8
6	8	11	7.5
7	7.5	11	7.5

Tabel 3. Impedance Bandwidth Results

Iteration	Range Frequency	Impedance Bandwidth
1	1.636GHz – 2.293GHz	657MHz
2	1.592GHz – 2.281GHz	689MHz
3	1.641GHz – 2.349GHz	708MHz
4	1.546GHz – 2.333GHz	787MHz
5	1.550GHz – 2.433GHz	883MHz
6	1.631GHz – 2.602GHz	971MHz
7	1.662GHz – 2.792GHz	1130MHz

4. Conclusions

A novel configuration of Ultra-Wide Band (UWB) frequency notch patch antenna microstrip fed by CPW has been studied and simulated. To achieve UWB by adjusting the notch so the impedance bandwidth becomes wider.The impedance bandwidth of the proposed antenna is 1130MHz (1.662–2.792 GHz) or about 50.7% for VSW R $\leq$ 2.

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