

# CPW-fed to CPS Dipole Antenna of Microstrip Tapered Balun with Triangular Loop Director

Hyeonjin Lee<sup>†</sup>

**Abstract** – A CPW-fed to CPS dipole antenna of triangular loop director by microstrip tapered balun is proposed for dual and wide band operations, in this paper. The proposed antenna is consisted of a CPW-fed to CPS transform, microstrip tapered balun element, CPS dipole driver and triangular loop director. A dual and wide bandwidth of the proposed dipole antenna is realized by introducing the triangular loop director and taper matching element. The operated frequency bandwidth is 1GHz (2.14~3.14 GHz) and 1.9 GHz (4.6~6.5 GHz) to return loss criterion of less than 10 dB. The measured return loss of the proposed antenna showed good results of the dual and wide band operating frequency and the radiation pattern. The proposed antenna is able to support WLAN wireless communications applications.

**Keywords:** CPW-fed to CPS transformer, Dipole antenna, Dual and wide-band, Microstrip tapered balun, Triangular director

## 1. Introduction

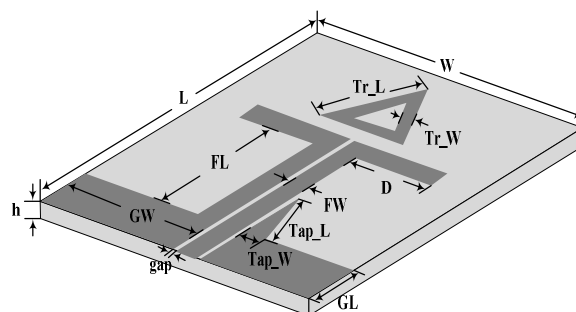
Recently, coplanar transmission lines have become more acceptable for many microwave applications. A coplanar transmission lines have several features which make them attractive for use in microwave integrated circuit (MIC) and monolithic microwave integrated circuit (MMIC) structures. Coplanar waveguide (CPW) and coplanar strip (CPS) transmission lines have become more attractive for many microwave and millimeter-wave applications [1]. A conventional CPW-fed to CPS dipole antenna consists of a driven element, a reflector, and some directors. This printed dipole antenna structure is simple to build, light weight, and low cost. The proposed dipole antenna had not director, directly, but instead parasitical triangular loop to the director. The CPW-fed CPS dipole antenna can achieve a relatively high gain with low cost [2]. Traditionally, CPW-fed to CPS dipole antennas are designed using wire dipole or printed dipole antennas. In 1991, Huang presented a design of the CPW-fed CPS dipole antenna based on microstrip patches [3]. In recent years, an interesting configuration of the printed CPW-fed to CPS dipole antenna has been researching printed dipole, which was modified and optimized for wanted characteristic [4-6]. The driver is fed by the odd-mode current of a CPS [7-8]. The CPS line is connected to a microstrip line through a microstrip tapered balun CPW-fed. A wide band frequency of the CPW-fed to CPS dipole antenna is realized by introducing the triangular loop director. In this paper is compared the operated bandwidth between the proposed CPW-fed to CPS dipole antenna to the conventional antenna.

The simulation process was carried out using Hfss software. These antennas were fabricated using inexpensive Fire Retardant-4 (FR4) board, using wet etching techniques.

## 2. Design of Dual and Wide-band CPW-fed to CPS Dipole Antenna

The proposed antenna is printed on a 1.52 mm-thick dielectric substrate with  $\epsilon_r=5.3$ , the fed structure consists of a CPW-fed to CPS transmission line with microstrip tapered balun as shown in Fig. 1.

The CPW-fed to CPS dipole antenna and triangle loop director is printed on single plane of the substrate. The microstrip tapered balun is printed on ground plane the same side acts as the matching element. A driver length of approximately a quarter wavelength (D) at 6 GHz is used in the design, where D is about 14 mm. The length of the parallel strips (CPS) is about  $FL=\lambda/2$ . The CPS transmission line is designed to act as a half wavelength transformer between the driver and the CPW to CPS line. The CPW and the CPS are operating in the odd-mode at all



**Fig. 1.** The geometry of proposed antenna.

<sup>†</sup> Corresponding Author: Dept. of Electrical and Electronic Engineering, Dongkang College University, Korea. (hyeonjin@dkc.ac.kr)  
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**Table 1.** Design parameters of proposed antenna

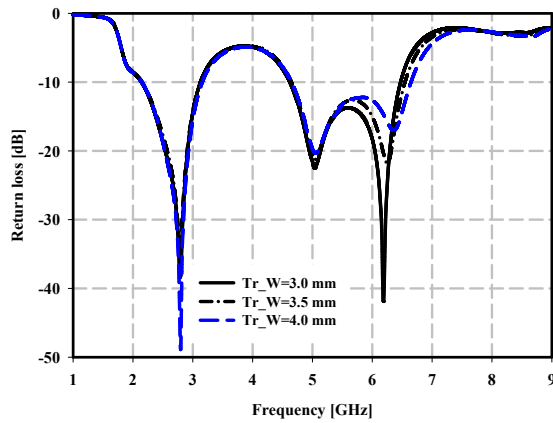
parameter	value	parameter	value
FL	20	D	14
FW	4.4	Tr_L	
Tap_L	10	Tr_W	14
Tap_W	7	GW	11
gap		GL	

frequencies. Using this fed structure, the return losses are reduced compared to the designed convention dipole antenna [5]. The parameters for this proposed antenna are shown at Table 1. In this design, the total length of the dipole is  $50 \times 50 \times 1.572$  [mm], which is much shorter than used in a conventional CPW-fed CPS dipole antenna.

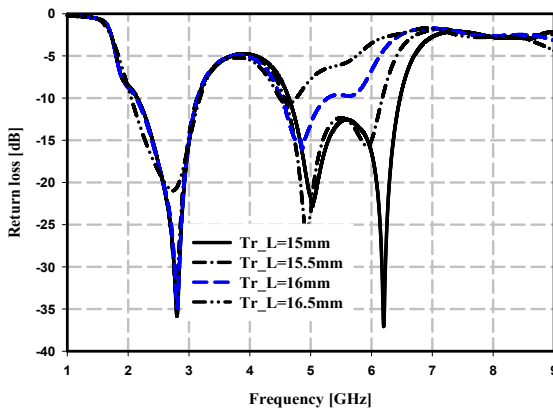
### 3. Experimental Results

Fig. 2 is shown the reflection coefficient according to change value of Tr\_W at structure of Fig. 1. Here, the maximal resonance properties obtained at 3 mm when value of Tr\_W changed from 3 to 4 mm. According decreased the width of Tr\_W, return loss coefficient of the first and second resonance show satisfactory result.

Fig. 3 is shown the reflection coefficient according to



**Fig. 2.** Return loss against variable Tr\_W.



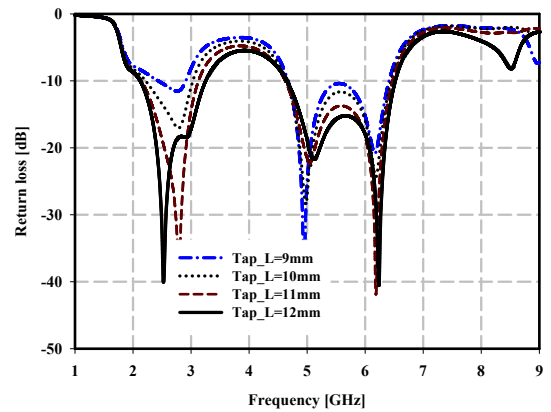
**Fig. 3.** Return loss against variable Tr\_L.

change value of Tr\_L at structure of Fig. 1. When value of Tr\_L changed from 15 to 16.5 mm by step 0.5mm, the maximal bandwidth property obtained about 15 mm. According increased the length of Tr-L, return loss coefficient of the first resonance band show satisfactory result, but second resonance band were unsatisfactory return loss coefficient.

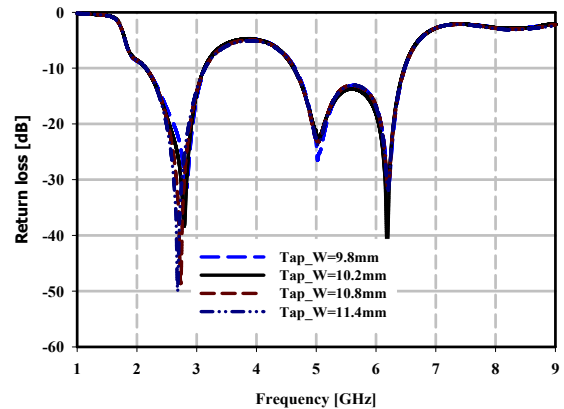
Fig. 4 is shown the reflection coefficient according to change value of Tap\_L at structure of Fig. 1. When value of Tap\_L changed from 9 to 12 mm by step 1 mm, the properties of maximal bandwidth obtained as Tap\_L was 12 mm. According to decrease the length of Tap\_L, return loss coefficient of the first resonance band shown bad characteristic and the second resonance band shown unsatisfactory characteristic.

Fig. 5 is shown the reflection coefficient according to change value of Tap\_W at structure of Fig. 1. When value of Tap\_W changed from 9.8 to 11.4 mm by step 0.4 mm, the properties of maximal bandwidth obtained as Tap\_W was 10.2 mm. According to be variable the length of Tap\_W, the first and the second band of proposed fat dipole antenna didn't transform nearly characteristic of return loss coefficient as shown Fig. 5.

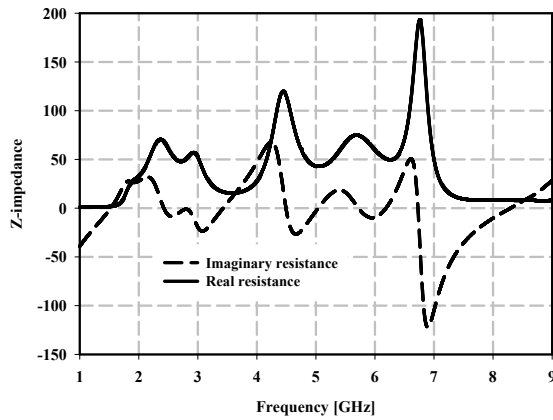
The impedance of proposed fat dipole antenna was shown Fig. 6. The real impedance of solid line matched



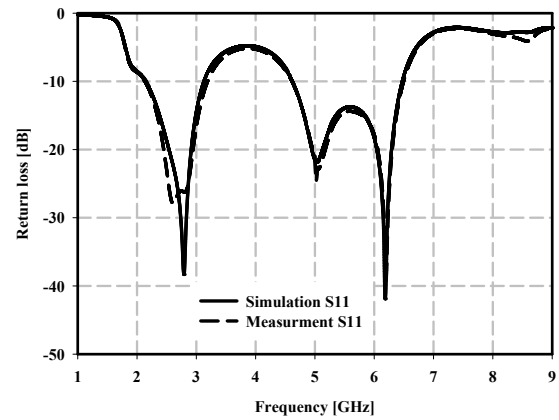
**Fig. 4.** Return loss against variable Tap\_L.



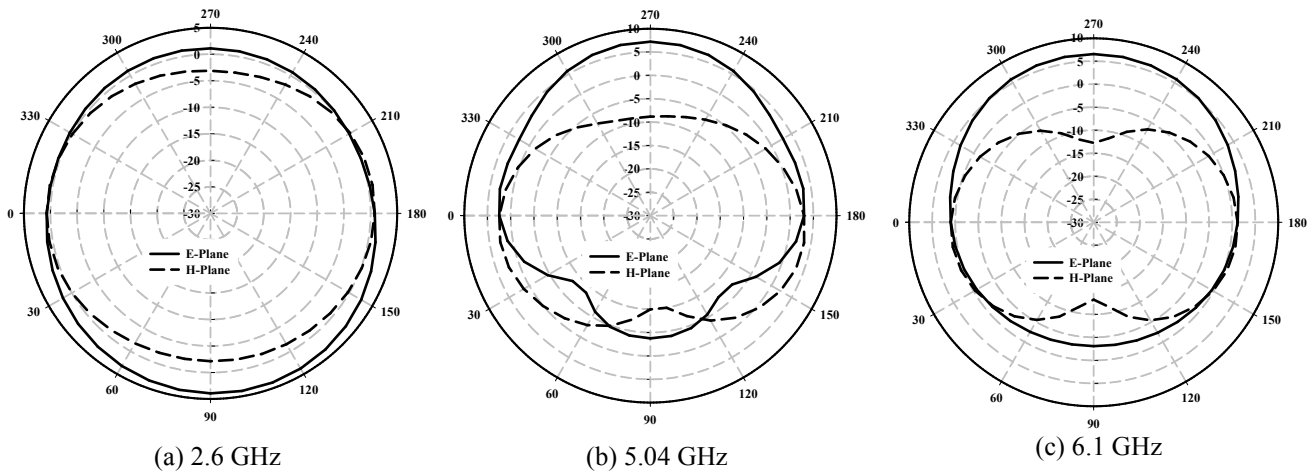
**Fig. 5.** Return loss against variable Tap\_W.



**Fig. 6.** Real and imaginary impedance of the proposed antenna.



**Fig. 7.** Simulated and measured return loss of proposed antenna.



**Fig. 8.** Radiation patterns for proposed antenna at 2.6, 5.045, 6.1 GHz.



**Fig. 9.** Photograph of manufactured antenna

around normal value of characteristic impedance and the imaginary impedance of dot line converged around zero value, as shown Fig. 6. Therefore, the proposed antenna could obtain good radiation gain, because it was good optimized.

The measured and simulated return loss of the proposed dipole antenna is shown in Fig. 6. This antenna had two distinct operating frequencies of 2.06~3.06 and 4.65~6.55 GHz, respectively. The return loss bandwidth of proposed antenna was about 1GHz and 1.9GHz. Also, this antenna is shifted to low frequency band frequency of 1.9GHz from general resonance band of 6GHz.

The far-field radiation patterns were measured the both electrical and magnetic field planes, that is to say E-plane and H-plane patterns for 2.4 GHz, 5.04 GHz, and 6.01 GHz are shown in Fig. 9.

The dual frequency antenna was constructed and tested. The antenna pattern for the dual frequency antenna is virtually identical to the pattern shown in Fig. 8. The radiation pattern as well as the E and H-plane are typical of normal dipoles. Because there is no ground plane, radiation is obtained in a full 360 degrees.

#### 4. Conclusion

This paper is presented a wide band operated antenna that is realized by introducing the triangular loop director. This proposed antenna used to CPW-fed to CPS with MTB. The MTB is microstrip patch of triangle type that is bottom side of broad width. This antenna achieved a frequency bandwidth of 40% and showed good radiation characteristics. A wide band frequency of the proposed antenna is realized by introducing triangle loop director. The measured return loss shows very good matching at normal characteristic impedance. It was design a simple and effective feeding structure, had adequate operational bandwidth, and had suitable radiation patterns such that it was commercially suitable for use in WLAN applications.



**Hyeonjin Lee** He received Ph.D degree in microwave engineering from Chonnam National University. His research interests are microwave engineering, antenna design and electromagnetic analysis.

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