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# Dual-frequency (2.4 ㎓, 5.8 ㎓) CPW-fed Active Antennas

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## 1. Introduction

Recently, wireless communication services have stimulated developments of compact, lightweight, small and thin systems. Especially, the requirements for various performances in compact systems lead to the developments of RF front-ends and they are crucial factors to implement reduced and efficient transceiver systems. Therefore the antennas employing amplifiers or oscillators have been interested because of their enhanced performances of bandwidth, signal amplification and noise figure.

This study presents a dual-frequency (2.4 ㎓, 5.8 ㎓) active antennas for a receiver. The proposed active antennas are designed to connect the output port of a wideband antenna to the input port of active devices directly, where the input impedance matching conditions are optimized by adjusting the length of feed line to be around $1/20\lambda_0$ (@5.8 ㎓). The measured bandwidth (VSWR≤2) provides the range of from 2.0 ㎓ to 3.1 ㎓ and from 5.25 ㎓ to 5.9 ㎓, showing the simultaneous operation at 2.4 ㎓ and at 5.8 ㎓. Signal amplifications obtained by active antennas are measured to be 17.0 ㏈ at 2.4 ㎓ and 15.0 ㏈ at 5.2 ㎓. The measured noise figure is 1.5 ㏈ at the operating frequencies.

## 2. Geometry of Dual-frequency Active Antenna

The active antenna geometry is shown in Figure 1. The proposed active antenna is designed with a wideband antenna and two amplifiers which are interconnected with impedance matching of CPW transmission line circuits. The output ports of amplifiers are impedance matched to be 50Ω at 2.4 ㎓ and at 5.8 ㎓, respectively by using lumped components [1][2].

The layout of active antenna is printed on one side of FR-4 epoxy substrates, of which relative permittivity and loss tangent are 4.4 and 0.05. As shown in figure 1, the output port of wideband antenna and the input port of active device are connected directly. The input matching conditions of this dual-frequency (2.4 ㎓, 5.8 ㎓) active antennas are optimized through the adjustment of the length of feed line to be around $1/20\lambda_0$ (@5.8 ㎓)

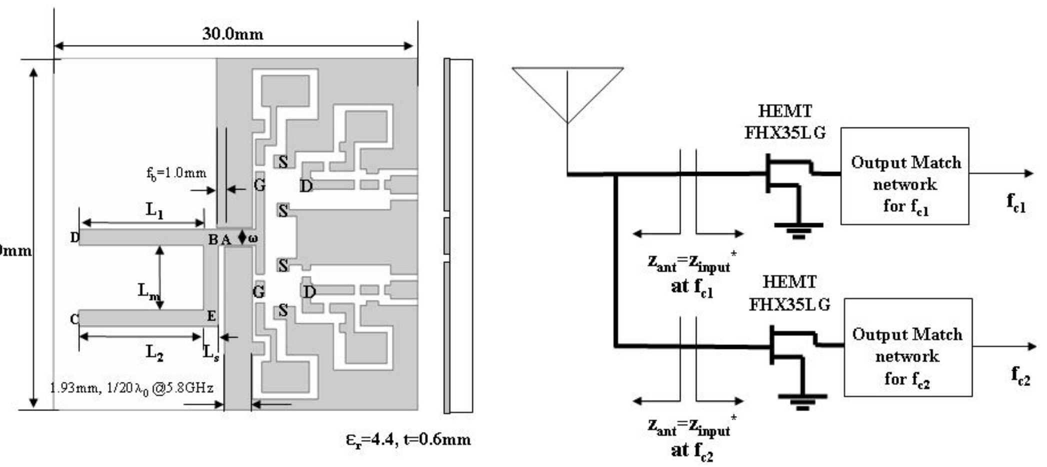


Figure 1. The geometry and block diagram of proposed active antenna

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# 3. Design of Dual-frequency Active Antennas

## 3.1 Wideband antennas

Figure 2 shows the measured return losses ($s_{11}$) and radiation patterns of wideband antennas connected to the gate of the active devices. As shown in figure 1, two resonant frequencies are excited by L-shaped monopole ($\ell_1$=A-B-E-C, $\ell_2$=E-B-A) and the intermediate resonant frequency is built up by I-shaped open stub ($\ell_3$= A-B-D) [3].

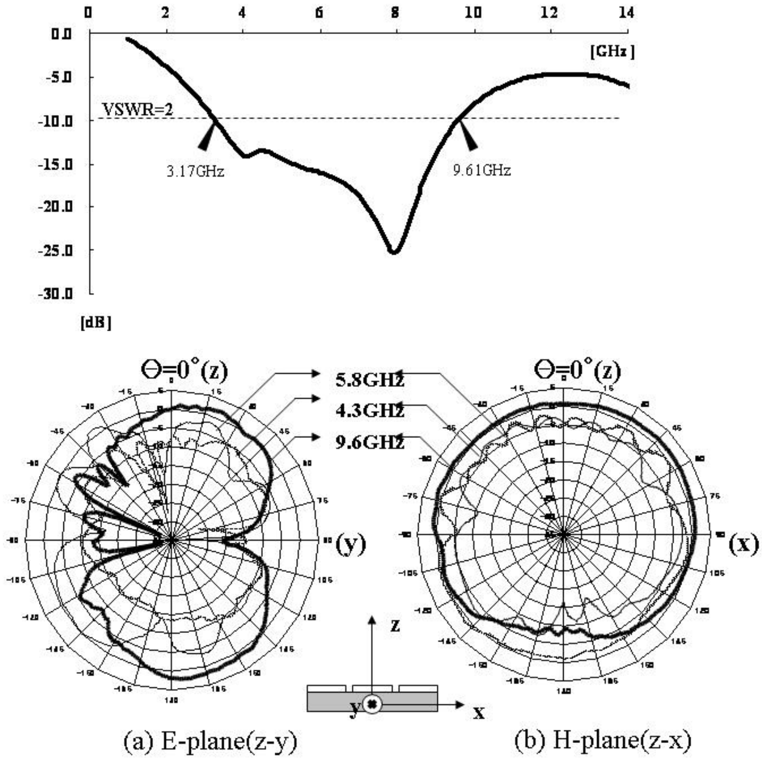


Figure 2. The return losses ($s_{11}$) and radiation patterns of the wideband antenna

The radiation patterns of a proposed antenna are measured in the anechoic chamber sized by 16.0m (L)×11.0m (W)×9.5m (H). The Agilent E8361A PNA and MIDAS ver. 5.06 are used in this measurement. Figure 2 shows that the proposed antenna radiates omni-directionally and symmetrically in the H-plane and E-plane. Especially at 9.2㎓, the degradations of co-polarization patterns in H-plane are caused by the L-shaped structure of the proposed antenna, which is originated by the lateral part of the L-shaped monopole. The measured antenna gains range from 1.4 dBi to 4.6dBi against the operating frequencies. Figure 2 shows that a proposed CPW-fed L-type planar monopole antenna operates in the wideband range like a monopole antenna [3].

## 3.2 Impedance Matching Conditions

Figure 3 shows the procedure of input impedance matching of a proposed active antenna at 2.4㎓ and at 5.8㎓. The input matching conditions of a dual-frequency (2.4㎓, 5.8㎓) active antenna can be optimized when the length of feed line is designed to be around $1/20\lambda_0$ (@5.8㎓) because the input impedances of the active devices ($Z_{gate}$) are $(0.93+j0.21)Z_0\Omega$ at 5.8㎓ and the output impedances of the wideband antennas ($Z_{out\_5.8GHz}$, $Z_{out\_2.4GHz}$) are $(1.0-j0.25)Z_0\Omega$ and $(0.6-j0.9)Z_0\Omega$, which can satisfy the conjugation matching conditions between the output of the antenna and the input of active devices [4].

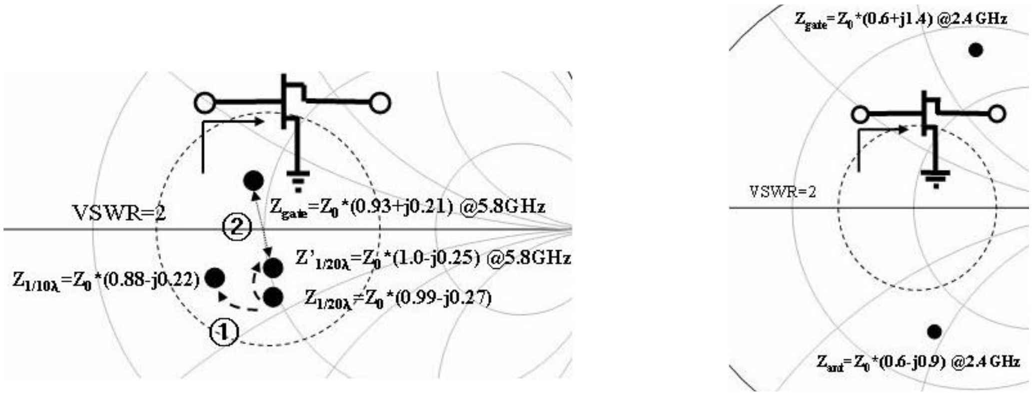


Figure 3. The input matching conditions at 5.8 ㎓ and at 2.4 ㎓

Figure 4 shows the output matching circuits at 2.4㎓ and at 5.8㎓ and an implemented active antenna. The output matching conditions of proposed active antenna can be optimized by controlling matching circuit parameters. As shown in figure 5, the output matching circuits are implemented with lumped components and two signal paths of the active antenna is formed through the active devices and matching components.

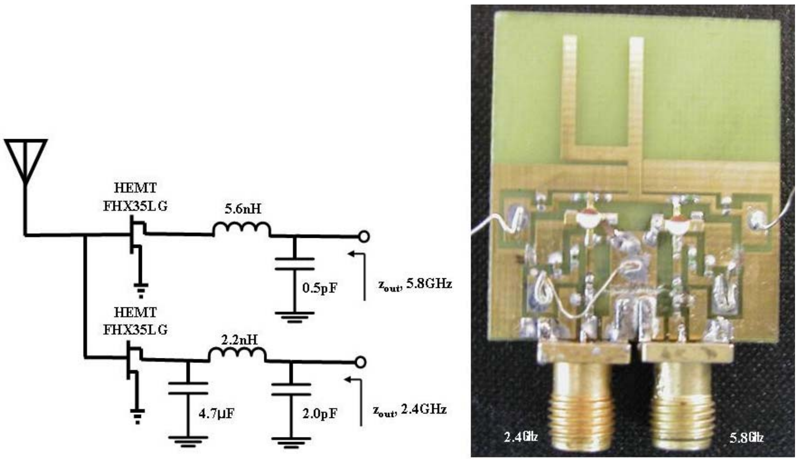


Figure 4. The circuits of proposed dual-frequency (2.4 ㎓, 5.8 ㎓) active antennas

Experimental results for impedance matching of the proposed dual-frequency active antennas show the return losses ($s_{11}$) when two active devices are biased ($V_g$=-0.6V, $I_d$=4.0V, $I_d$=12.0㎃) simultaneously, as shown figure 5.

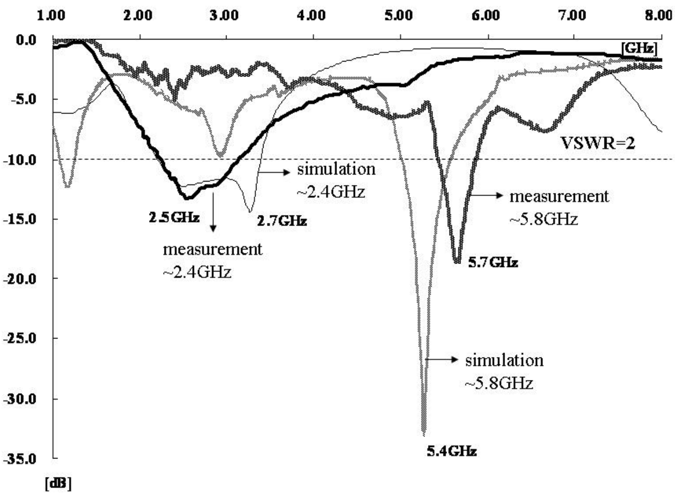


Figure 5. The return losses ($s_{11}$) of the proposed dual-frequency (2.4 ㎓, 5.8 ㎓) active antennas

## 4. Experiments and Results

Figure 6 shows the measured signal amplification levels of the proposed dual-frequency (2.4GHz, 5.8GHz) active antennas. The signal amplifications are measured in an anechoic chamber with the wideband antennas which transmit signals (0.0dBm) generated by signal generator (Agilent 83712B). Figure 6 shows that the frequency ranges of signal amplifications are from 1.4GHz to 3.6GHz (@2.4GHz) and from 4.9GHz to 6.0GHz (@5.8GHz). The measured peak gains are 17.0dB (@2.4GHz) and 15.0dB (@5.8GHz) and noise figure is 1.5dB at the operating frequencies.

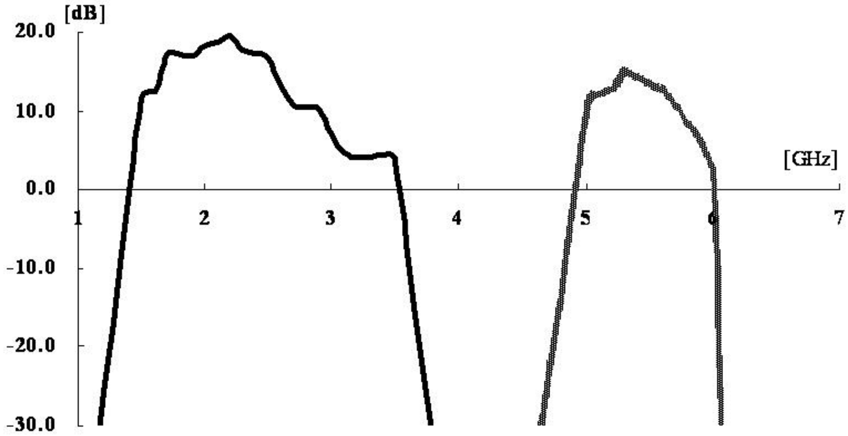


Figure 6. The signal amplification characteristics of the proposed dual-frequency (2.4 GHz, 5.8 GHz) active antennas

## 5. Conclusions

The CPW-fed dual-frequency (2.4 GHz, 5.8 GHz) active antennas are designed and implemented. The input impedance matching conditions of proposed active antenna are optimized by adjusting the length of CPW feed line to be around $1/20\lambda_0$ (@5.8 GHz), which make it possible to connect the output port of wideband antenna to the input port of active devices directly. The proposed active antenna shows that it can be applicable to wireless communication systems for IEEE 802.11 a/b/g bands.

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