# BROADBAND CHARACTERISTIC OF INVERTED-F ANTENNA
# BY PARALLEL RESONANCE MODE

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## 1. Introduction

Many efforts have been devoted to achieve a broadband of inverted F antenna (IFA) characteristic [1]- [3]. Moreover the broadband method for small antenna have been proposed in [4] ,[5]. In order to achieve the broadband characteristic, almost of these were made to generate two or more resonance in the vicinity frequency area by the addition element. However these cases have not cleared the detail mechanism of the broadband method. This report has proposed a novel broadband method for IFA by adding a line element, which generates a parallel resonance mode. The proposed antenna is added a line element in the vicinity of the feeding point. This added element is fixed to parallel along the open end element of IFA, more the length between these two open ends is fixed half-wavelength. Then the proposed antenna operates as an antenna, which is merged a parallel resonance antenna and IFA, which is a serial resonance mode. At last the broadband is achieved by generating two resonances in the vicinity frequency range by adjusting each resonance frequency independently.

## 2. Proposed antenna model

Fig. 1 shows the proposed IFA. This IFA includes the parallel resonance mode antenna, which is configured by line-element #1 and #2, and added element. IFA is serial resonance antenna, therefore this antenna is achieved the broadband characteristic by merged two different resonance modes, which is parallel resonance and serial resonance. The validity of proposed method is investigated by simulation. We employ NEC2 for a simulation tool and Fig.1 also shows the wire-grid model of NEC2.
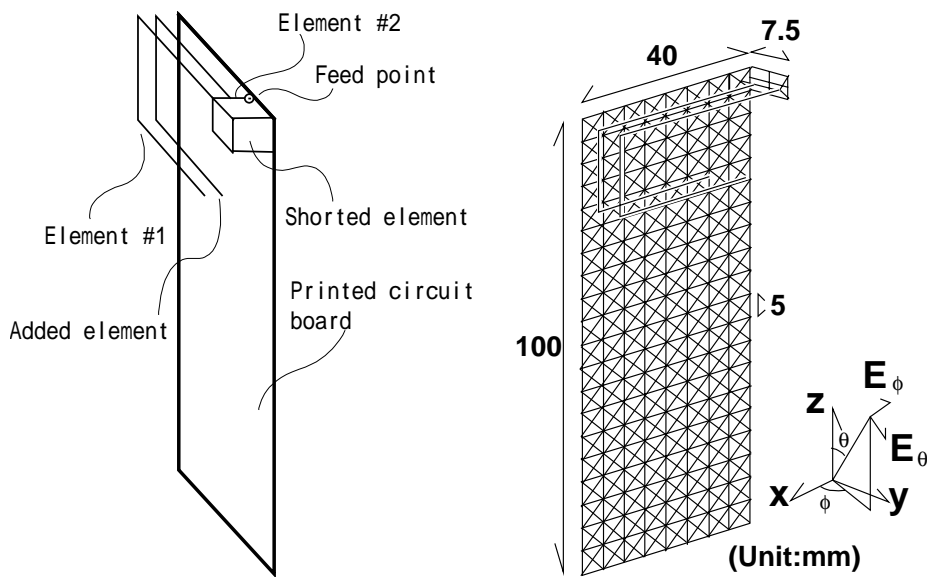
**Fig.1   Proposed inverted-F antenna**

## 3.   Impedance characteristic

The impedance matching procedure is parted to three. First an added element is removed and the part of serial resonance mode is trimmed to match the antenna impedance with a feed line's. This part is for the impedance matching of first half of the frequency band, in which the serial resonance is dominant. Second, the shorted element is removed and the part of parallel resonance is trimmed to match. This part is for the impedance matching of second half of the frequency band, in which the parallel resonance is dominant. Then, third, the width of shorted element is trimmed. Fig.3 shows the impedances of the proposed antenna and its serial resonance part along 'e' the width of shorted element. The impedance of serial resonance part is depend on 'e', therefore, the trimming of 'e' control the first half of its active band.
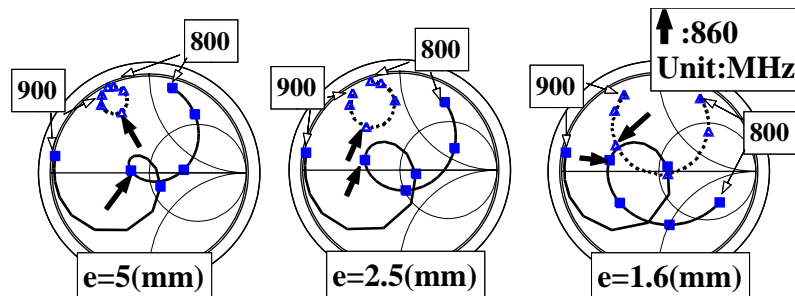


**Fig. 2   e vs impedance characteristic**

## 4. Radiation characteristic

It is easy to expect for such an antenna, which has two resonance modes, that its radiation pattern is changed with the dominant resonance mode. Figure 3 shows the radiation pattern of proposed antenna. This figures show the patterns at the frequency of VSWR=2. These patterns show that the radiation pattern is not changed with resonance mode. The reason why the unchangeable of the pattern is that the radiation from the phone box is dominant in the case of a small antenna mounted on a cellular phone. However the gain is decreased in 870MHz, where the parallel resonance mode is dominant.
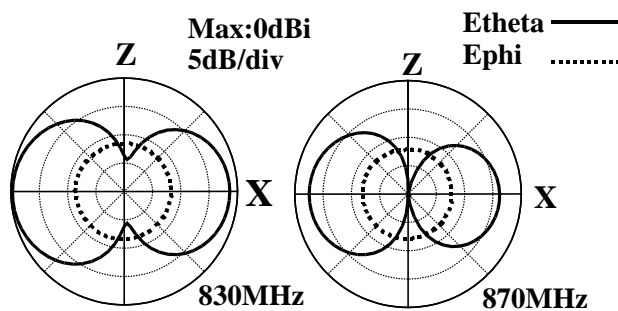


Fig.3 Radiation pattern of proposed antenna

Figure 4 (a) shows the mismatching loss and efficiency of the proposed antenna. This graph shows that the efficiency of the proposed antenna is degraded. This degradation is caused by the increase of the conductivity loss on the antenna element and PCB. In order to improve the efficiency, the antenna height is made enlarge, because this enlargement is made the radiation resistance to be increased. Figure 4 (b) shows the mismatching loss and efficiency of the antenna of its height = 9.5mm. This graph shows that the efficiency is improved and the broad band is achieved in comparison with the characteristic of a conventional IFA in Fig.4 (c).
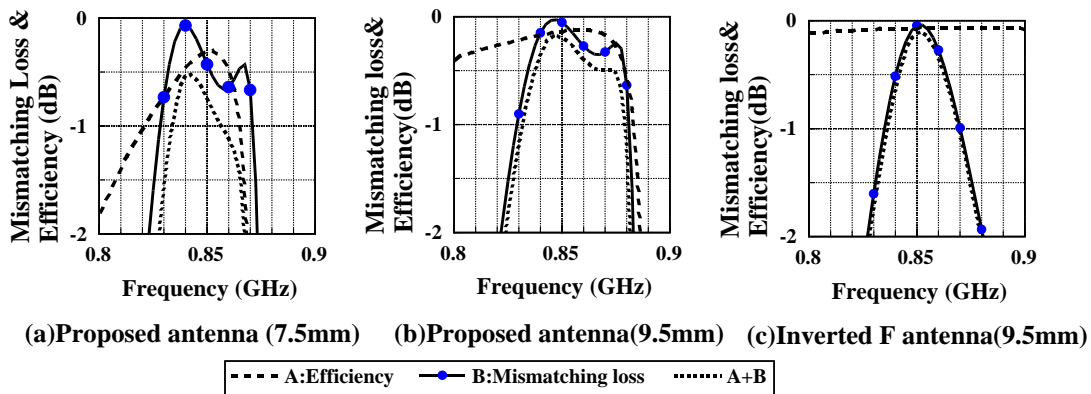


(a)Proposed antenna (7.5mm)    (b)Proposed antenna(9.5mm)   (c)Inverted F antenna(9.5mm)

A:Efficiency    B:Mismatching loss    A+B

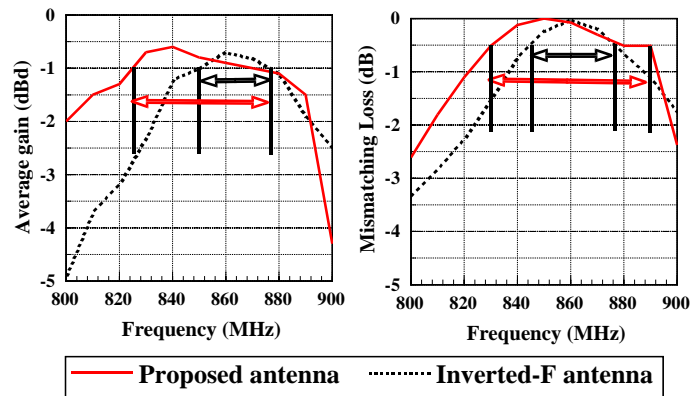Fig. 4 Mismatching loss and efficiency

**Fig. 5 Average gain and mismatching loss**

Figure 5 shows that the experimental results of average gain on Z-Y plane and mismatching loss. The average gain results shows that proposed antenna achieved the double band of conventional IFA at −1dBd. Also, the results of mismatching loss show same at VSWR<2.

## 6. Summary

This report has proposed a novel broadband method for inverted F antenna by adding a line element, which generates a parallel resonance mode. The proposed method degrade the antenna efficiency, however the enlarge the antenna height improve this degradation. Finally, the both results of simulation and experiment show that this method is valid for the broadband of inverted-F antenna.

## Reference

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