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# Wideband Planar Coupled-Feed Antenna for Internet of Things Applications

Man Ho Tsoi
Department of Mechanical Engineering The Hong Kong Polytechnic University Hong Kong, China
man-ho.tsoi@connect.polyu.hk

Yat Sze Choy
Department of Mechanical Engineering The Hong Kong Polytechnic University Hong Kong, China
yatsze.choy@polyu.edu.hk

Ka Ming Wu
Innovation Technology Co., Ltd., Hong Kong, China
ericwu@innovation.com.hk

Steve W. Y. Mung
Department of Electronic and Information Engineering The Hong Kong Polytechnic University Hong Kong, China
mungwaiyin@hotmail.com

Joseph S. M. Yuen
Innovation Technology Co., Ltd., Hong Kong, China
josephyuen@innovation.com.hk

***Abstract*— In this paper, a compact wideband antenna is proposed for Internet of Things (IoT) applications. This proposed antenna consists of one top metal strip and one bottom metal patch on the printed circuit board (PCB). By adjusting the length of the strip, the frequency range of this antenna is easily adjusted and tuned. This proposed antenna has the advantages of simple and planar structure as well as wide frequency range. This proposed design shows that the overall result is the same as result of conventional individual antenna. Both simulated and experimental results were performed, which show the overall performance is suited for IoT applications.**

***Keywords*— Internet of Things (IoT), planar antenna, coupled-feed, printed circuit, broadband antenna, patch antenna.**

## I. INTRODUCTION

The Internet of Things (IoT) refers to the data interconnection and exchange because connectivity of electronics, sensors and networks. The outcome allows data collection and data upload to the cloud [1]. Different technologies such as NB-IoT from 3GPP, Bluetooth and Zigbee were proposed to serve these applications. A multiband and multi-standard circuit becomes significant to make the hardware simple and compact for circuit designers. Therefore, a broadband RF front-end as well as a broadband antenna are important to serve these multi-band and multistandard operations for transmission and reception [2-5].

Different planar wideband antennas [2-5] were proposed to replace conventional single antenna in each band/standard [6]. Coupled-feed method [4-5] has been demonstrated with bandwidth enhancement among these structures. In this paper, the proposed antenna is designed on 2-layer printed circuit board (PCB) with one top metal strip as feed line and one bottom metal patch in which coupling between the patch and the feed line. Compared to those multilayer structures, this structure is more compact and lower cost. Simulated and experimental results show that the bandwidth is more than 45%. This bandwidth covers multi-band and multi-standard such as 4G LTE, Bluetooth, Zigbee as well as future 5G bands.

## II. STRUCTURE OF PROPOSED ANTENNA

The antenna structure is shown in Fig. 1 which consists of one top metal strip and one bottom metal patch. The size of the bottom patch is 18 mm x 24 mm ($Wm$ x $Lm$) and the width $W$ of the top strip is 1.5 mm with length $L$. This 2-layer coupled-feed method makes the bandwidth enhancement [4- 5]. The length $L$ of the strip is used to adjust the frequency range of the antenna because more coupling occurs when the feed line is longer [7]. And the frequency range is shifted to the lower side with longer length $L$ because of the wavelength is longer as well [8]. Fig. 2 shows the simulated results with length $L$ equal to 29.3 mm and 24.3 mm which were simulated on FR4 substrate of 0.8 mm thickness. The simulated results show that longer strip ($L$ = 29.3 mm) has lower frequency range as well as narrower bandwidth compared to shorter strip ($L$ = 24.3 mm).

## III. IMPLEMENTATION AND EXPERIMENTAL RESULTS

This proposed antenna in Fig. 1 was designed and simulated on FR4 substrate of 0.8 mm thickness. Fig. 3 shows the picture of the fabricated antennas with both lengths, $L$ = 29.3 mm and 24.3 mm. Fig. 4 shows simulated (dashed line) and measured (solid line) $S$-parameters, $S11$ of antenna with $L$ = 29.3 mm and 24.3 mm. In Fig. 4, the simulated and measured results shown are close to each other with both bandwidth more than 45%. The return losses of the antennas are better than 10 dB within this bandwidth. The radiation patterns are carried out by antenna measurement system in Fig. 5(a) and Fig. 5 also shows the measured radiation patterns of design with length $L$ equal to 24.3 mm at frequencies under 1.88 GHz, 1.95 GHz, 2.35 GHz and 2.45 GHz which are the frequency bands of WCDMA/LTE, Bluetooth and Zigbee. The maximum gains (dBi) are 3.1, 3.2, 3.4, 4.0 and 4.2 at 1.88 GHz, 1.95 GHz, 2.35 GHz, 2.45 GHz and 2.6 GHz respectively, which are also shown in Fig. 6 with different bands.

## IV. CONCLUSION

This paper proposes an antenna with 2-layer coupled-feed structure for IoT applications. The measurement results show more than 45% in bandwidth which covers the frequency bands of WCDMA/LTE, Bluetooth and Zigbee. The performance shows that it has good performances compared to the conventional individual antenna used in each band/standard. This wideband, planar and low cost antenna shows that it is suited for IoT applications.

## ACKNOWLEDGMENT

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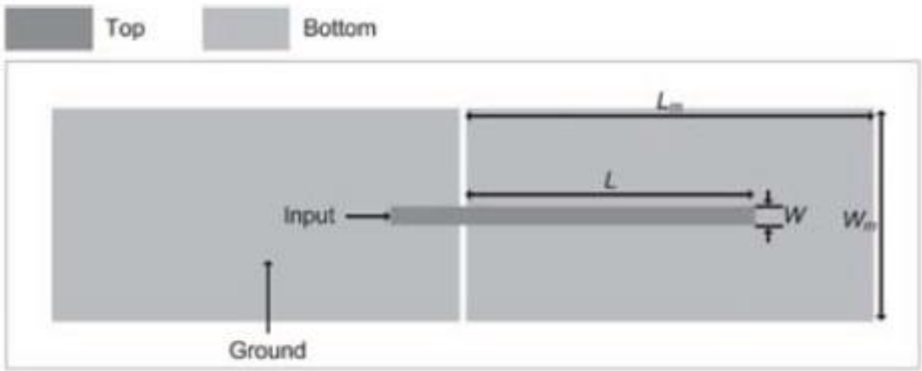
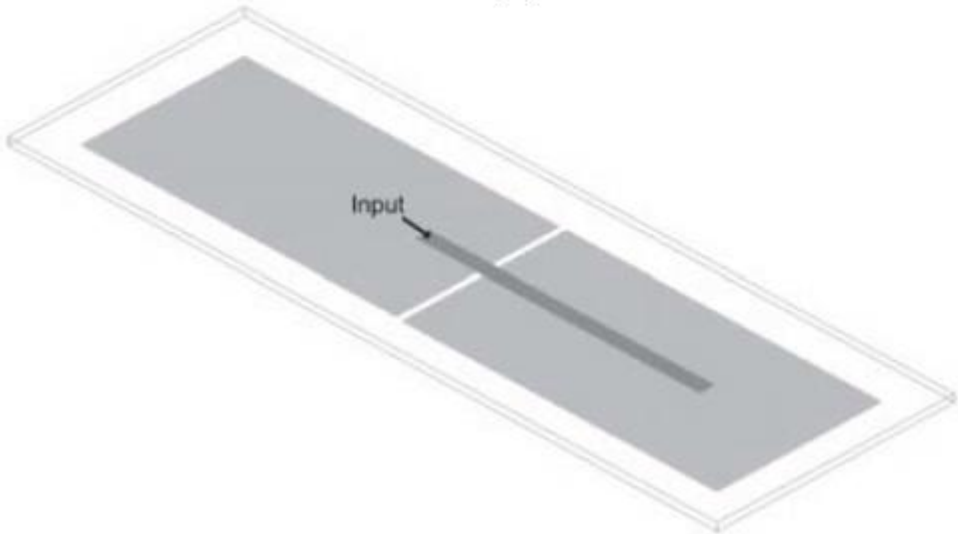



(a)




(b)

Fig. 1. Structure of proposed antenna: (a) Top view; (b) Three-dimensional view.

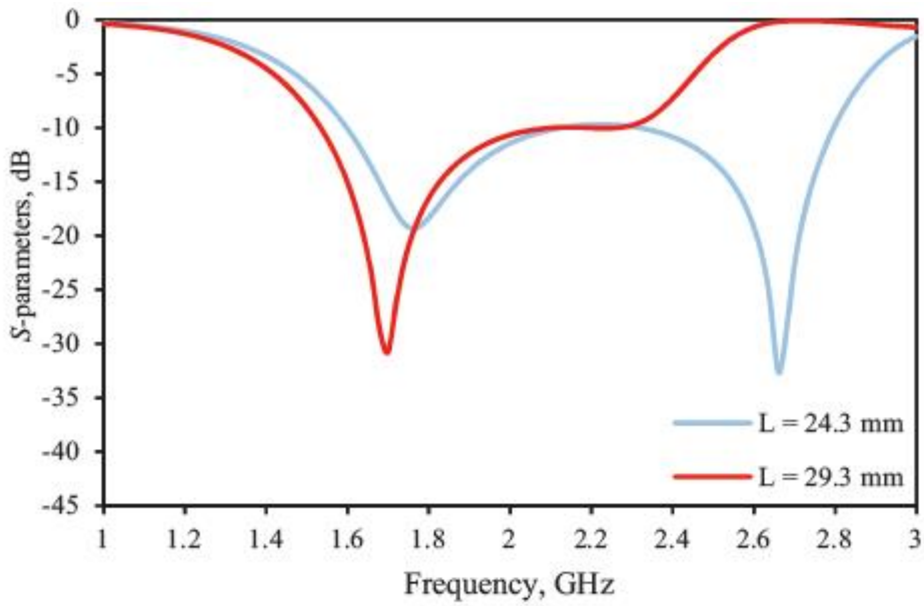



Fig. 2. Simulated *S*-parameters, $S_{11}$ of antenna with $L$ = 29.3 mm and 24.3 mm.

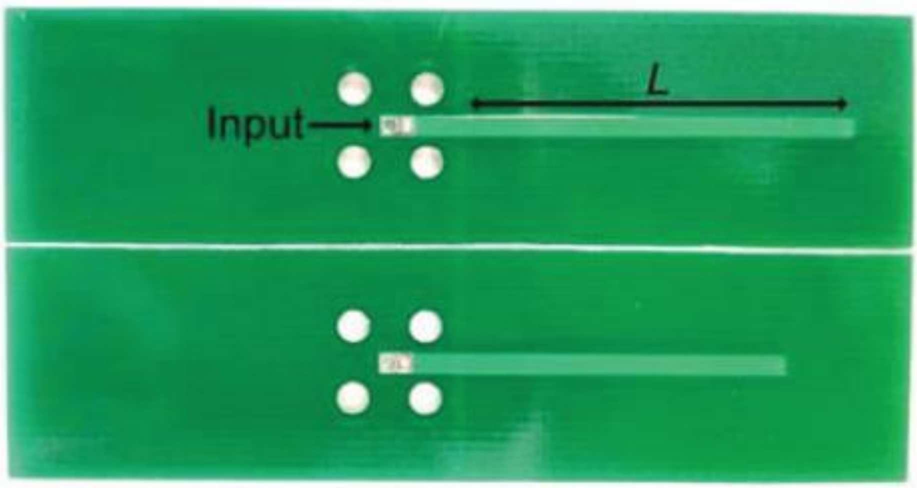



Fig. 3. Photo of fabricated antennas, $L$ = 29.3 mm (Top) and 24.3 mm (Bottom).

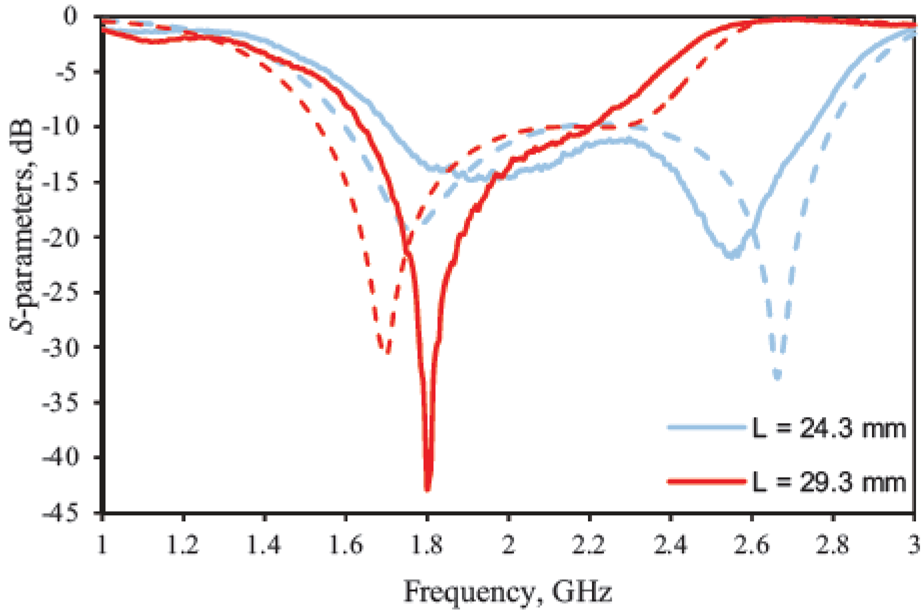
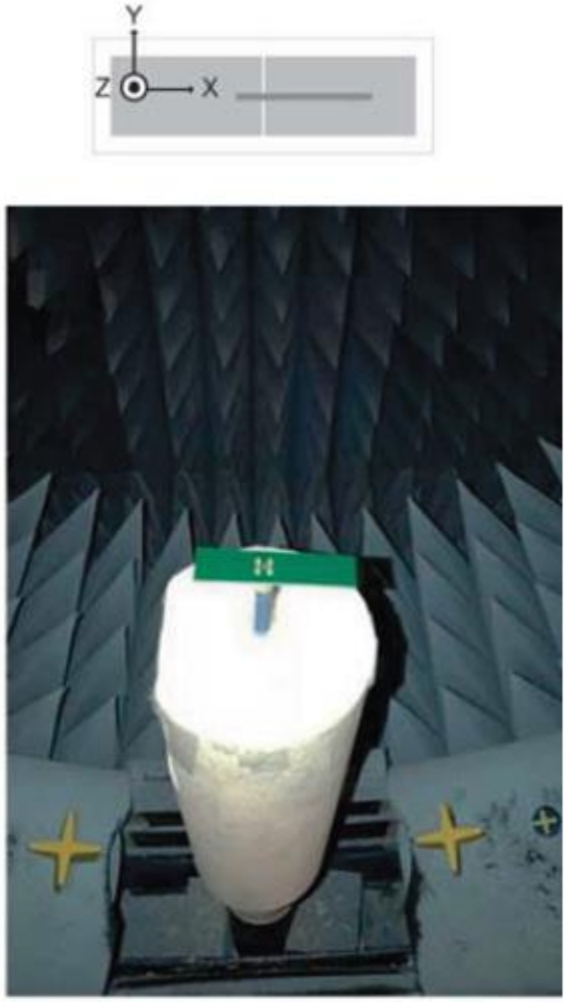
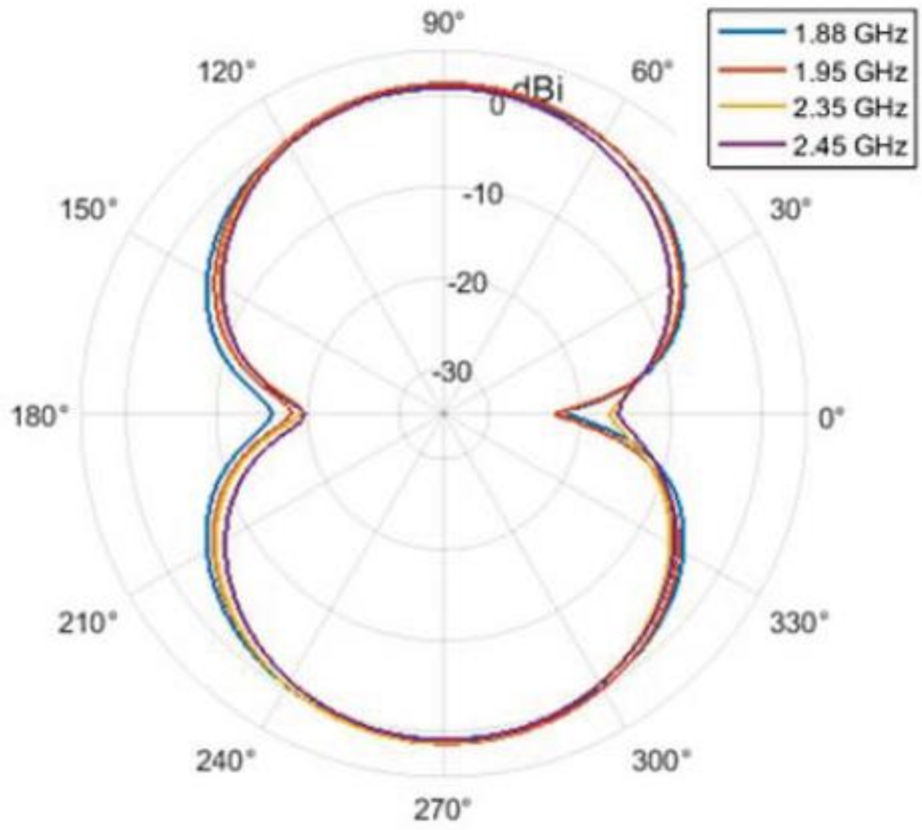



Fig. 4. Simulated (dashed line) and measured (solid line) *S*-parameters, $S_{11}$ of antenna with $L = 29.3$ mm.

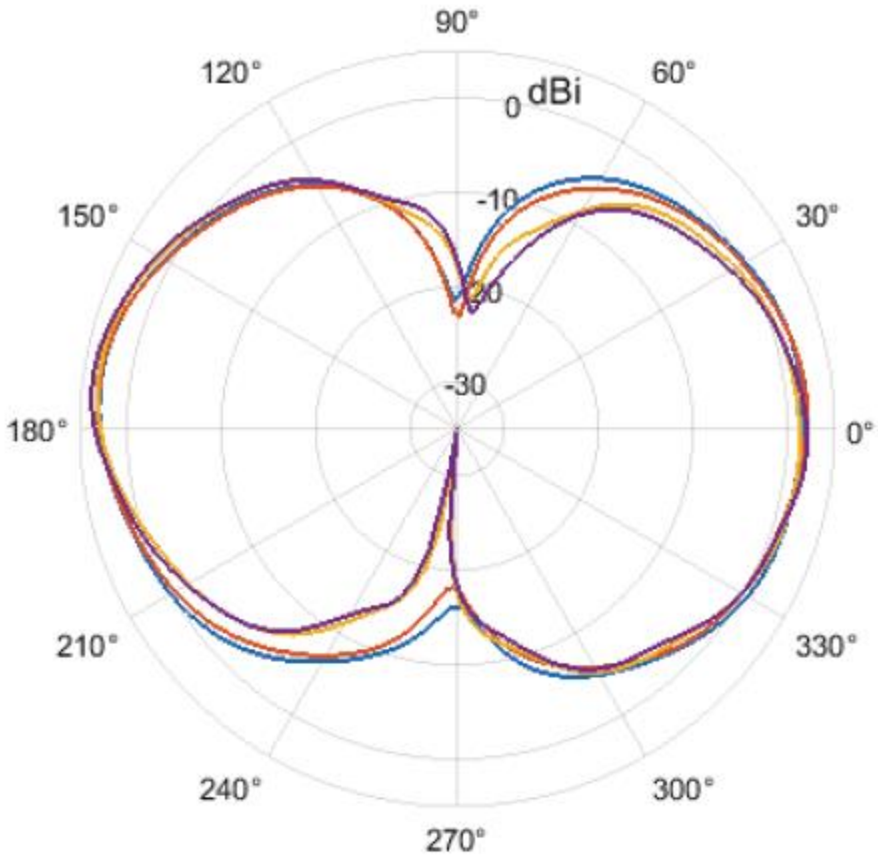



(a)

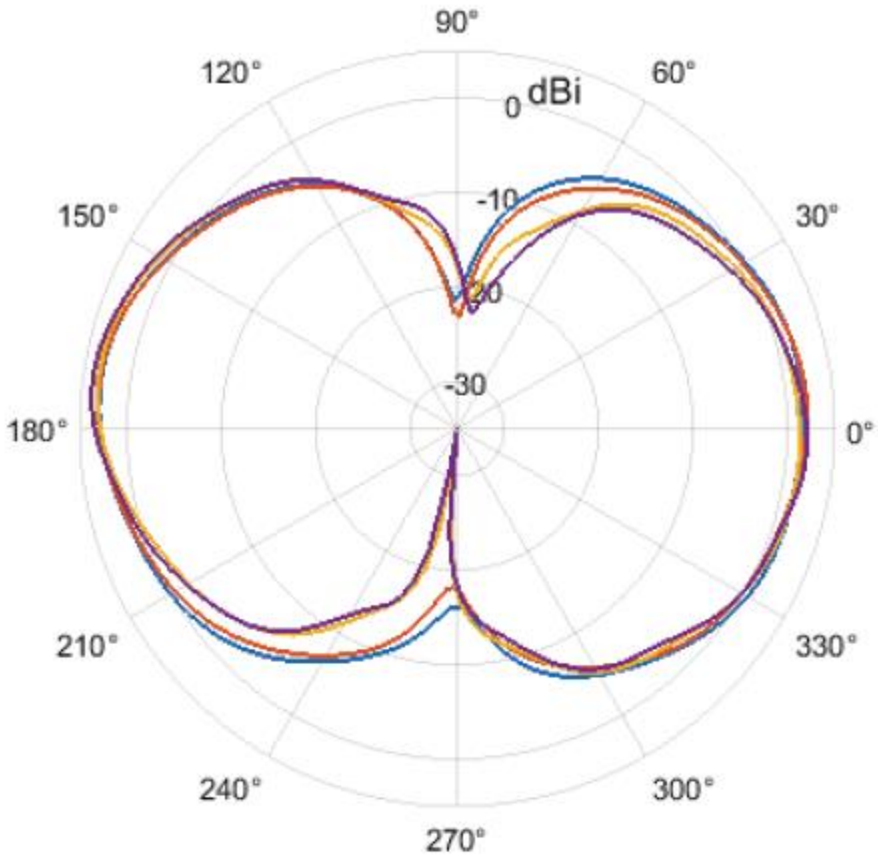


90°
120°
60°
dBi
0
-10
-20
-30
150°
30°
180°
0°
210°
330°
240°
300°
270°
1.88 GHz
1.95 GHz
2.35 GHz
2.45 GHz


(b)




(c)




(c)

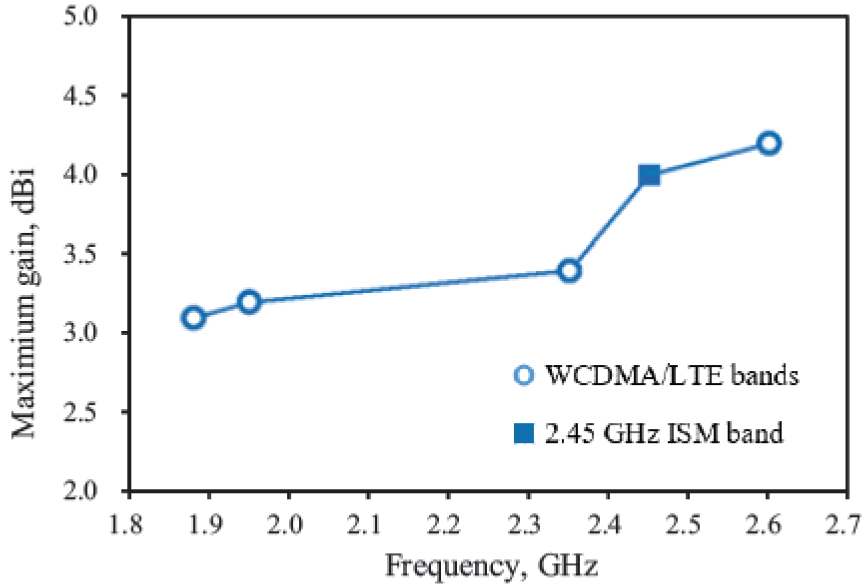



Fig. 6. Measured maximum gain (dBi) versus different bands.