

# CPW-fed folded-slot antenna for 5.8 GHz RFID tags

S.-Y. Chen and P. Hsu

A coplanar waveguide (CPW)-fed capacitive folded-slot antenna is proposed for the radio frequency identification (RFID) application at 5.8 GHz. The antenna is fabricated on a 30 × 30 mm substrate. The measured bandwidth and antenna gain are 7.5% and 4.2 dBi, respectively. Radiation patterns are almost omnidirectional in the H-plane. These properties and the compact and uniplanar structure make the antennas suitable for use as RFID tags.

**Introduction:** Radio frequency identification (RFID) systems have been widely used recently in supply chain management by retailers and manufacturers to identify and track goods. Most RFID systems consist of a reader/writer and a tag [1]. The reader transmits RF power to the tag, which then sends a unique coded signal back to the reader, while the writer can change the information contained within the tag. Several frequency bands have been assigned to the RFID applications, such as 125 kHz, 13.56, 869, 902–928 MHz, 2.45 and 5.8 GHz. As the operating frequency for RFID systems rises into the microwave region, the antenna design becomes more acute and essential [2, 3]. In addition to the requirements of the impedance and radiation performances, the conformal structure and compact size are the main concerns within the design process. In this Letter, we present a miniature folded-slot antenna with RF performance suitable for RFID tag use at 5.8 GHz.

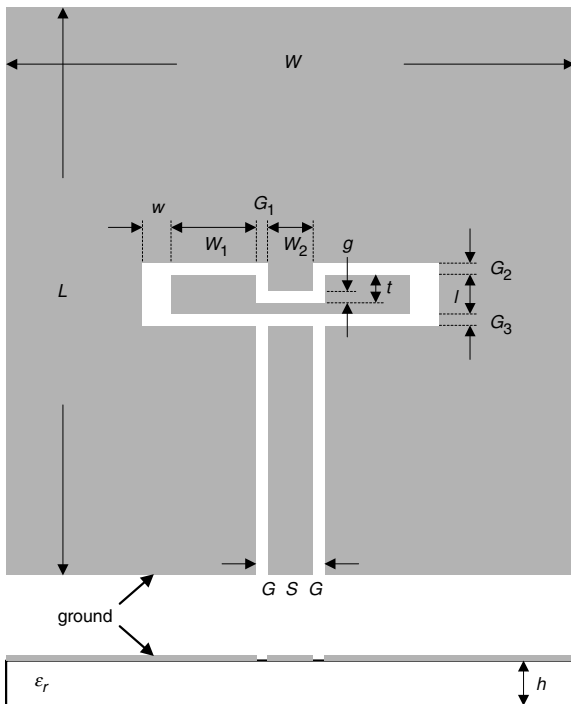


Fig. 1 Geometry of CPW-fed capacitive folded-slot antenna

**Antenna structure:** The geometry of the proposed coplanar waveguide (CPW)-fed capacitive folded-slot antenna is shown in Fig. 1. This antenna has a simple structure with only one layer of dielectric substrate and metallisation. The feeding CPW, of which the central strip is truncated at the lower edge of the folded slot, is capacitively coupled into the folded-slot antenna. The total length of the folded slot will be approximately equal to a guided wavelength  $\lambda_g$  of the slotline at resonance. We chose the capacitive folded slot, since its quality factor is higher and total size is smaller than the inductive one, in which the central strip of the CPW is continued into the central patch surrounded by the folded slot. The input return loss level and the resonant frequency of the proposed design will vary with total length  $L$  and total width  $W$  of the substrate. To facilitate the design and fabrication processes,  $L$  and  $W$  are both fixed at 30 mm, which is slightly longer than a half wavelength in free space at resonance. More compact size, i.e. smaller  $L$  and  $W$ , can be designed in the same

way and fabricated with more precise PCB process. Since the total length of the folded slot is  $\sim 1 \lambda_g$  of the slotline at resonance, to achieve a better input impedance matching condition and simultaneously reduce the antenna size the upper horizontal slot section is protruded inwards with a length  $t$  and width  $W_2$ . Moreover, the width  $w$  of the left and right vertical slot sections in the folded slot are increased to further improve the input match.

**Results:** A 5.8 GHz prototype antenna is implemented with the substrate size  $L \times W = 30 \times 30$  mm and is fabricated on an FR-4 substrate with dielectric constant  $\epsilon_r = 4.3$ , loss tangent  $\tan \delta = 0.02$ , and thickness  $h = 1.5$  mm. The design parameters are:  $W_1 = 3.6$  mm,  $W_2 = 3.0$  mm,  $w = 1.2$  mm,  $G_1 = G_2 = G_3 = g = 0.3$  mm,  $t = 1.6$  mm and  $l = 1.3$  mm. The widths of the strip and slot of the 50  $\Omega$  CPW feedline,  $S$  and  $G$ , are chosen to be 3.0 and 0.3 mm, respectively. A photograph of the 5.8 GHz prototype antenna is shown in Fig. 2. This miniature and uniplanar design can find applications in RFID tags and other wireless handheld devices.

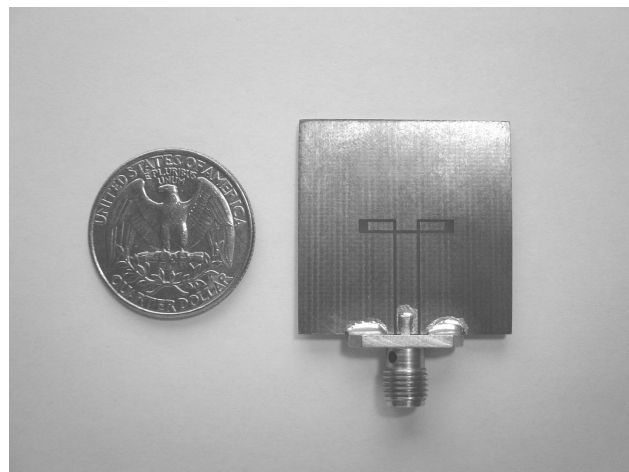


Fig. 2 Photograph of 5.8 GHz prototype antenna

Simulated and measured input return losses are shown and compared in Fig. 3. Throughout the design process, simulations were carried out on a package software IE3D [4] from Zeland. The measured input impedance bandwidth (return loss >10 dB) of the prototype antenna is  $\sim 7.5\%$  (5.67–6.11 GHz), while the simulated bandwidth is  $\sim 6.2\%$  (5.62–5.98 GHz). The simulated and measured results are in good agreement. The E- and H-plane radiation patterns measured at 5.85 GHz are shown in Figs. 4a and b, respectively. The radiation patterns are broadside and bidirectional in the E-plane and almost omnidirectional in the H-plane, and the measured peak antenna gain is 4.2 dBi. It should be mentioned that, if the substrate width  $W$  is made narrower, then the radiation pattern will become more uniform in the H-plane; however, all other parameters have to be readjusted to obtain a new input match.

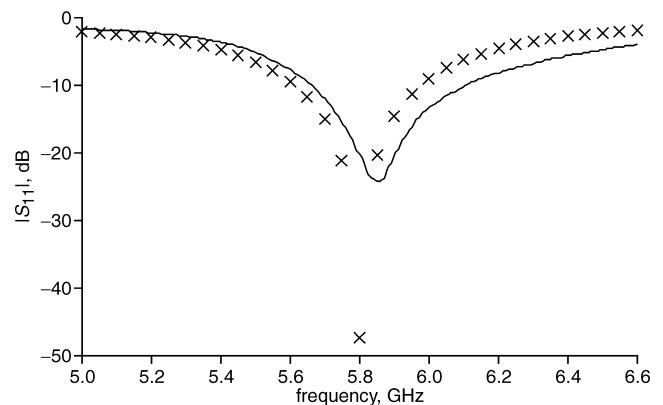
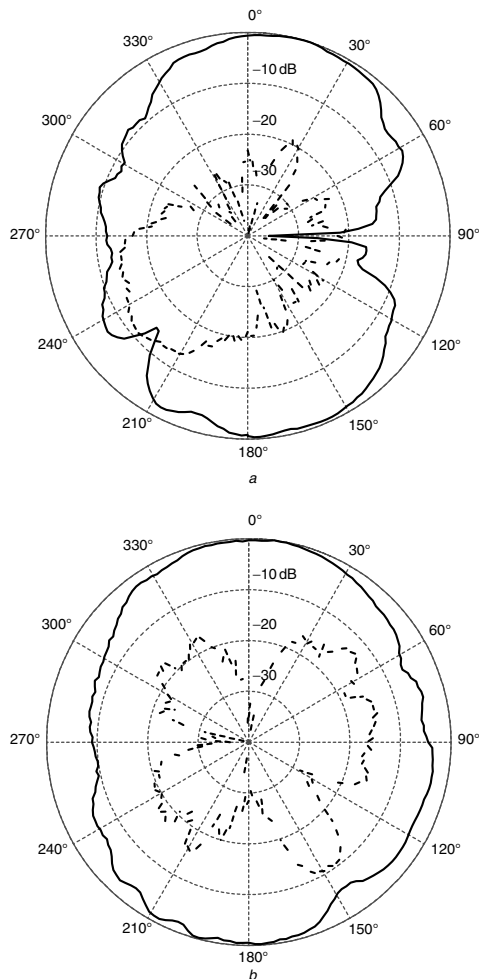


Fig. 3 Simulated and measured input return losses of prototype antenna  
 × × simulated  
 — measured



**Fig. 4** Radiation patterns of prototype antenna measured at 5.85 GHz  
*a* E-plane pattern  
*b* H-plane pattern  
 — co-polarisation  
 ---- cross-polarisation

*Conclusions:* A CPW-fed capacitive folded-slot antenna suitable for use as 5.8 GHz RFID tags has been presented. The miniature prototype has been designed and implemented to have the bandwidth and antenna gain of 7.5% and 4.2 dBi, respectively, and the radiation pattern measured at resonance is almost omnidirectional in the H-plane. Moreover, the present antenna is mechanically robust and easy to fabricate and design. This design is based on the RFID needs but is also applicable to other fields of wireless applications.

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- 4 Trade mark of Zeland Corp