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A Novel Printed Dual Polarized Broadband Antenna – The Fourclover Antenna

Seong-Youp Suh*†, Warren Stutzman††, William Davis††, Alan Waltho†, Kirk Skeba† and Jeffrey Schiffer†

†Radio Communications Lab, Intel Corporation
RNB 6-49, 2200 Mission College Blvd, Santa Clara, CA 95052-8119, USA
Email: {seong-youp.suh, alan.e.waltho, kirk.w.skeba, jeffrey.schiffer}@intel.com

††Virginia Tech Antenna Group
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0111, USA
Email: {stutzman, wadavis}@vt.edu

1. Introduction

There is high demand for broadband wireless communications to support more users and to provide more information. Examples of broadband technologies are multi-functional wireless communications and ultra-wideband (UWB) technology. Multi-functional wireless communications is a technology accommodating several wireless communication services in a single communication device. Ultra-wideband (UWB) is a promising technology bringing convenience and mobility to high-speed wireless interconnects in devices for the digital home and office.

Broadband antennas are an essential front-end component for both technologies. Many UWB antennas provide single linear polarization [1-4]. But dual-linear UWB antennas can enhance channel capacity and propagation performance Dual-polarized antennas are typically narrowband. In addition to dual polarization, it is also desired that the antenna structure be low-profile

2. Antenna structure

In this paper, a low-profile, dual-linearly polarized broadband antenna, the Fourclover antenna [5] is presented. The Fourclover antenna shown in Fig. 1 evolved from the Foursquare [6], Fourpoint [5], and Fourtear antenna elements [5], but provides broader bandwidth than the predecessors. The Fourclover antenna element is composed of four identical clover-shaped, flat metal pieces etched on the top of a printed circuit board. The opposing metal pieces form a radiating pair and the two pairs are orthogonally positioned for dual linear polarization.

A hardware test model , constructed as shown in Fig 1, was designed for operation in the frequency range of 1 ~ 10 GHz. The Fourclover antenna element has a size of 128 mm x 128 mm, corresponding to the electrical size of 0.42 λ x 0.42 λ at the lowest operating frequency of 1.0 GHz. The antenna element is placed 38 mm above a finite ground plane as shown in Fig. 1(b). The ground plane size is 432 mm x 432 mm, corresponding to the electrical size of 1.42 λ x 1.42 λ at the frequency of 1.0 GHz. The antenna structure provides high gain (7 ~ 9 dBi) and unidirectional radiation patterns similar to a dipole antenna above a ground plane [7]. The antenna size can be scaled to meet a specific frequency band of interest. For the UWB application (3.1 ~ 10.6 GHz), the antenna is scaled to the size of 42 mm x 42 mm x 13 mm (W1 x W1 x H).

The antenna elements are printed on a dielectric material of Duroid 5870 (ε_r = 2.33) with a thickness of 0.79 mm ($\cong$ 31 mils). Opposing pair feed points are excited 180° out of phase and the orthogonal pair acts as parasitic elements. Dual coaxial cables are used to excite

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out of phase signal. The printed antenna element is supported with foam (ε_r = 1.1), providing minimum dielectric effect.

3. Antenna simulation and measurement

The Fourtear antenna performance was computed using a commercial FDTD code, Fidelity by Zeland, Inc. The antenna was also measured in the Virginia Tech Antenna Group (VTAG) anechoic chamber. The computed and measured results agreed very well as shown in Fig 3. Figure 3 (a) shows the Fourclover antenna impedance, which does not change significantly over 10:1 frequency band. Note that the VSWR (voltage standing wave ratio) shown in Fig. 3 (b) is referenced to 188.5-Ω, which is the theoretical impedance value of frequency independence antennas [8]. Figure 2 shows the radiation patterns measured in the frequency of 1.4 GHz. Even though all patterns are not presented, the unidirectional patterns that are nearly constant over the frequency range of 1 ~ 2.5 GHz. A dip in the main beam and high side lobes are observed in the radiation patterns measured at upper end of operating frequency band due to phase cancellation between direct and reflected waves. Maximum gain is about 7 ~ 9 dBi with half-power beamwidth of 60°/80° in the E- plane and H-plane, respectively.

4. Conclusions

In this paper, a novel broadband antenna was proposed. Both computed and measured results were presented . The Fourclover antenna provides several prominent features such as low-profile and compact structure, broadband characteristics, and dual linear polarization. Investigation results indicate that the Fourclover antenna is a promising dual-linear antenna element for both multi-functional wireless communications and UWB technology.

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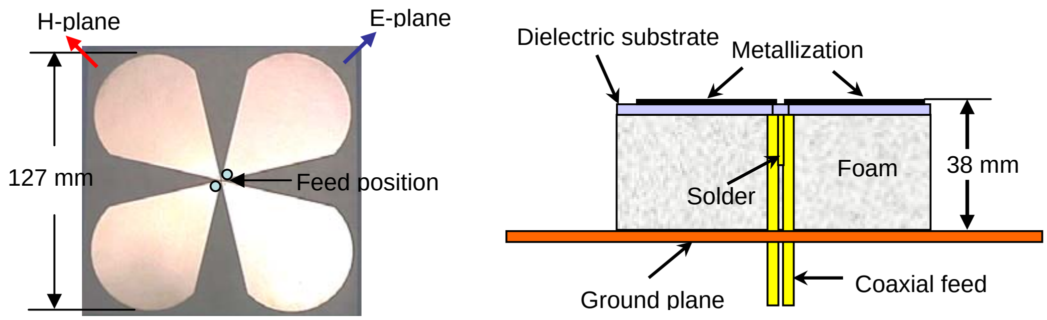


(a) Top view (b) Side view

Figure 1. The Fourclover antenna geometry.

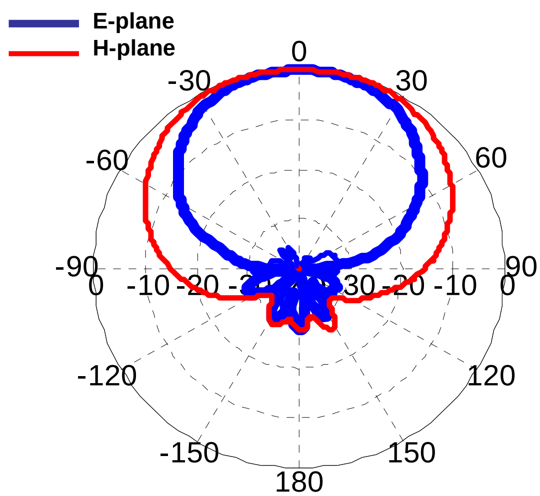
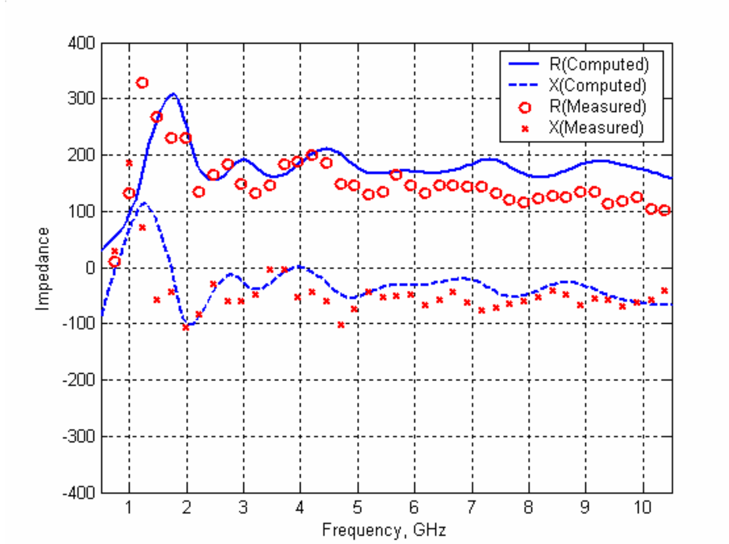
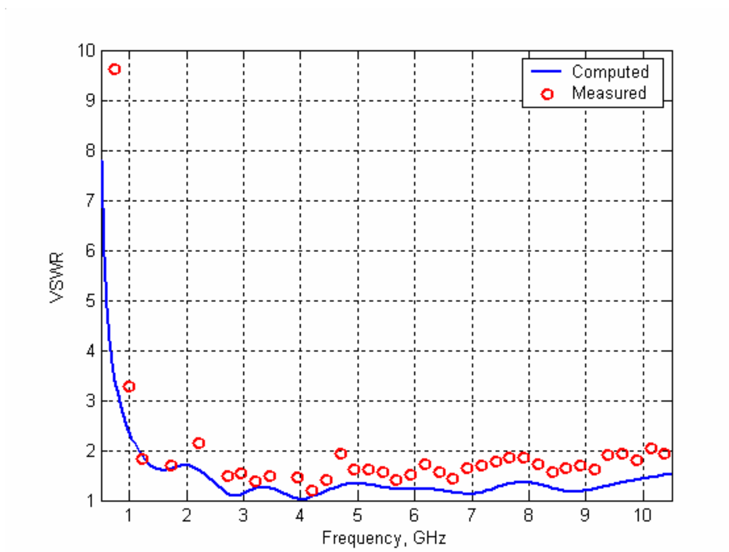


Figure 2. Measured radiation patterns at the frequency of 1.4 GHz of the Fourclover antenna shown in Fig. 1.



(a) Antenna impedance



(b) VSWR (referenced to 188.5 -Ω)

Figure 3. Computed (solid or dashed) and measured (circles or crosses) antenna impedance and VSWR (referenced to 188.5 -Ω) of the Fourclover antenna shown in Fig. 1.