3C3-1

A Compact Angular Diversity Technique with Quad Corner Reflector Arrays for 2.4 GHz Applications

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1. Introduction

The usefulness of diversity in wireless communication has been demonstrated. Various diversities with spatial, polarization, and angular techniques have been developed to improve signal-to-noise ratio, bit-error rate channel capacity and power savings in a base station [1-14]. The spatial diversity reception using spatially separated antennas and the directive diversity systems have been used for receiving EM signals [2-4]. The polarization diversity reception consisted with ±45° polarization antennas have been applied to get both vertical and horizontal EM signals scattering from buildings [9-14]. The angular diversity, an alternative to spatial diversity, is positioned in different angular directions [6-8, 11, 12].

The number of directive beams is determined by the number of antennas within the array, and beam steering is achieved by switching control. Generally, lots of antennas were used in spatial diversity, a pair of antenna was constructed to form the polarization diversity, and six antennas were needed in angular diversity. In switching control, the receiver monitors one antenna branch at a time leaving the others open. If the signal level falls below a present threshold, the receiver switches to another branch searching for a better signal level. A compact angular diversity antenna constructed with quad corner reflector arrays and a novel switching control is proposed in this paper. Based on angular diversity technique and collocating switch, the multi-beam patterns with narrow beam-width are provided. The S-parameter frequency responses are presented. In order to verify the advantage of this system, the RMS EVM (Error Vector Magnitude) measurement is used to simulate the interferences of multi-path and the signal source in co-channel.

2. Angular Diversity Antenna Design

The basic angular diversity antenna configuration shown in Fig. 1 is constructed with antenna arrays and switching control. The antenna arrays are consisted of four dipoles in company with corner reflectors. Functional architecture of proposed angular diversity antenna is show in Fig.2. Switched the antenna to transmit or receive is operated by the SPDT1 and SPDT2. When EM signal transmitting, Fig. 2 (a), the signal goes thought a power diver to antenna1, antenna2, antenna3 and antenna4. For EM signal receiving, Fig. 2 (b), the SPDT3 can switch the signal from the antenna 1and 3 to antenna 2 and 4 with better reception.

The quad 90 degrees corner reflectors are adopted herein. The radiators are sleeve dipoles. The reflector arrays are design with 0.5 λ distance between radiator and corner reflector. For practice, the distances are tuning to obtain higher radiation gain and omni-directional radiation patterns. The size of the corner reflector is 20cm by 20cm. Fig.4 are the prototype of radiation

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patterns. When transmitting, Fig. 3 (a), all the four antennas are operated and the omni-directional radiation pattern is presented. For receiving, Fig. 3 (b), the antenna 1and 3 or antenna 2 and 4 are exhibited with directive radiation patterns respectively. In addition, a tuning pad with adjustable tilt is applied to compensate the phase error among microstrip line. The tuning pad showing in Fig. 4 and the S-parameter response is presented in Fig. 5.

3. Measurement and Simulation results

The measurement system is the chamber with VNA HP8722 in DYU antenna laboratory and the Ansoft HFSS simulator is used. Measurement results of frequency responses are presented in Fig. 6 (a) and (b). For the S-parameter results, the band among frequency 2400MHz ~2500MHz is achieved. Fig.5 and Fig6 are far field polar patterns at 2450 MHz. The radiation patterns in Fig. 7 are H plane patterns for transmitting and receiving respectively. The radiation patterns in Fig. 8 are E plane patterns. For transmitting, the omni-directional radiation pattern is presented. For receiving, the antenna 1and 3 or antenna 2 and 4 are exhibited with directive radiation patterns respectively.

The EVM measurement generally simulates the interferences of multi-path and the signal source. Fig. 9 is measurement environment included main signal source, DUT and interference in co-channel. The measurement results are shown in Fig. 10. The red line is the measured RMS EVM results with corner reflector and the green line is without corner reflector. It is evident that the lower flat measured results with corner reflector are presented with better performance.

4. Conclusions

An alternative angular diversity antenna constructed with quad corner reflector arrays and a novel switching control is proposed in this paper. Compared to the conventional angular diversity with six antennas configuration, the simplified angular diversity with four antenna arrays exhibits the compact structure. Due to the quad structure, the receiving architecture consisted with ±45° polarization reception can be applied to the polarization diversity. Based on angular diversity technique and collocating switch, the multi-beam patterns with narrow beam-width (55°) are provided. The omni-directional radiation pattern for transmitting and directive radiation patterns for receiving are achieved for angular diversity. The operation range of 2.40~2.50 GHz (41%) in S-parameters responses determines the desired ISM band for application. The lower flat measured results of RMS EVM are presented with better performance.

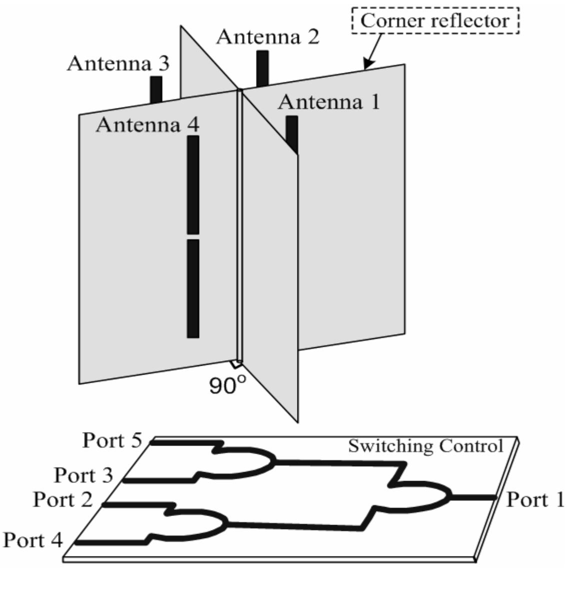
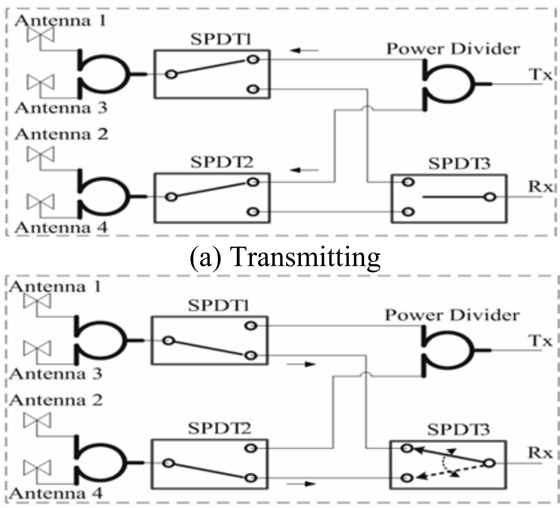
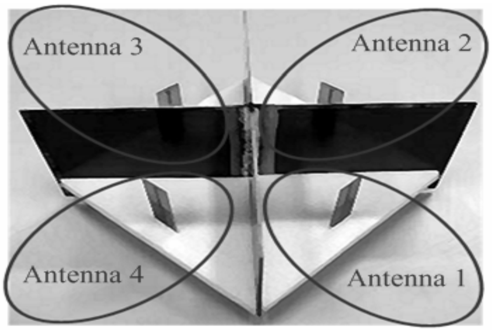


Figure 1: Basic angular diversity antenna

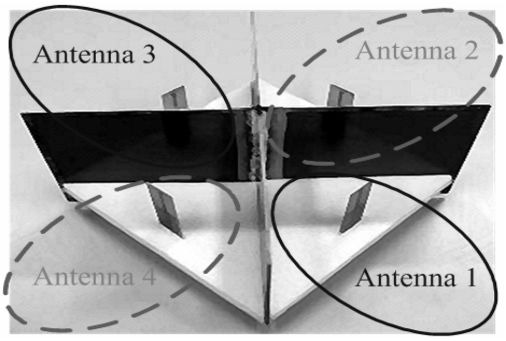


(b) Receiving

Figure 2: Functional architecture of proposed angular diversity antenna



(a) Transmitting



(b) Receiving

Figure 3: Prototype of radiation patterns

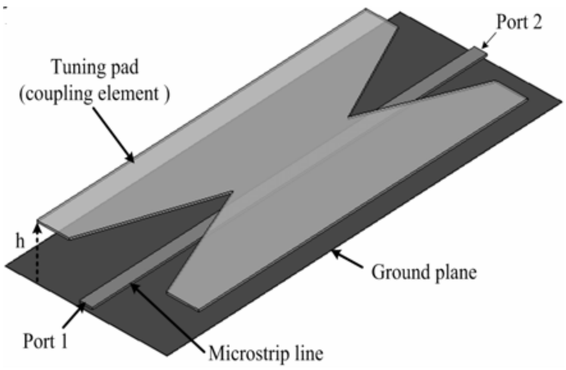


Figure 4: Prototype of phase shifter

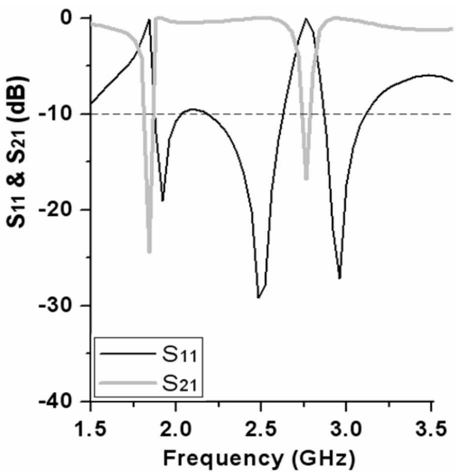
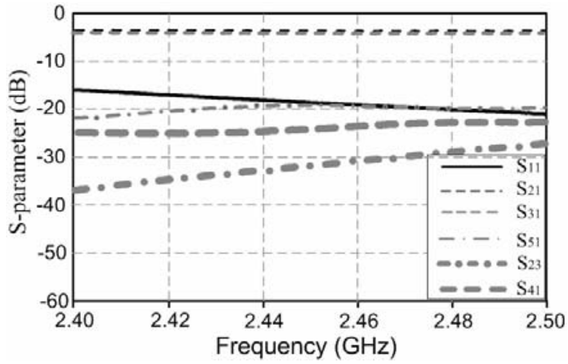
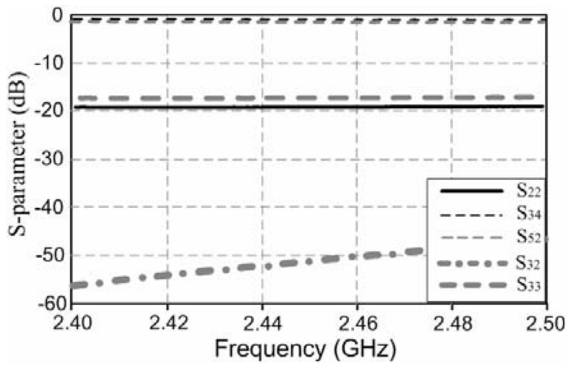


Figure 5: S-parameter response of phase shifter



(a) Transmitting



(b) Receiving

Figure 6: Measurement results of frequency responses

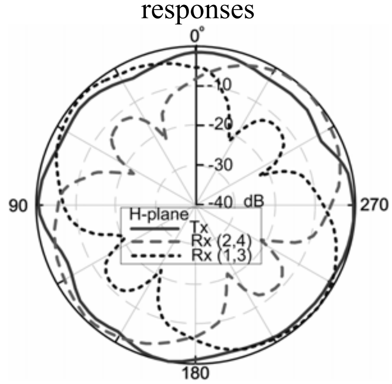


Figure 7: Radiation patterns of proposed angular diversity antenna (H-plane)

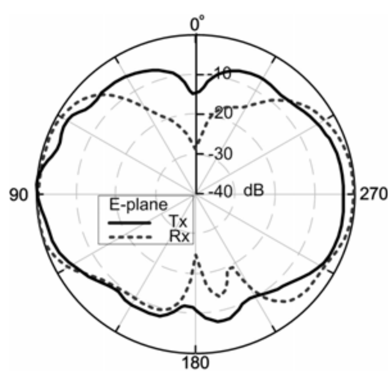


Figure 8: Radiation patterns of proposed angular diversity antenna (E-plane)

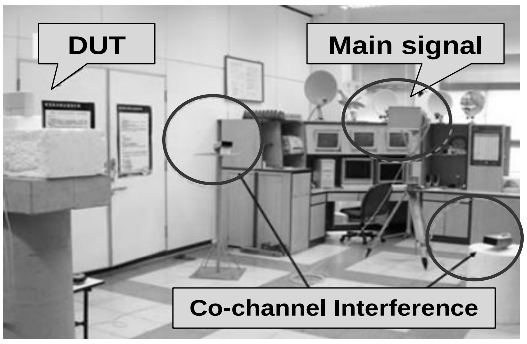


Figure 9: EVM measurement environment

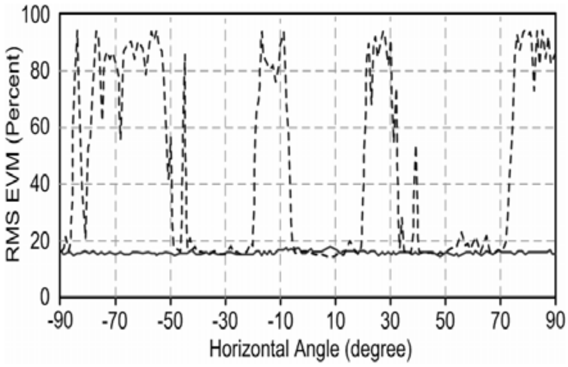


Figure 10: RMS EVM measurement results

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