Dual Polarization Inset-Fed Microstrip Patch Antenna

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1. Introduction

In various application of dual polarization antenna, the microstrip antenna element has offers three excellent advantages relative to other types of antennas [5]-[7]; low weight, low profile with conformability and low manufacturing cost. Recently, in many wireless communication and radar system, a dual polarized is greatly desired. In practices, a dual-polarized microstrip antenna can be realized by feeding the rectangular microstrip patch at two orthogonal edges, through edge feed or probe feed, which excites TM_{01}-and TM_{10}-mode with orthogonal polarizations [1]–[4]. Both the element itself and its array often achieve isolation of about -20dB [1]–[3].The most reported technique for achieving dual polarization is using different feed mechanisms such as aperture-coupling a single patch with crossed narrow slots or two offset narrow slots [5]. This technique requires a relatively complicated feed arrangement [6] or a complex multiplayer construction [7] to reduce the coupling between the two feed lines and therefore adds complexity to the fabrication process.

In this letter, the design of inset fed microstrip antenna is proposed at 45º and -45º to achieve the optimum performance of the return loss, antenna gains and polarization loss. A design of the broadband dual-polarized microstrip antennas is proposed by using the simply inset feed technique but slant at desired rotation. In most applications, the requirement of propagation can be met with a single patch structure. However, in some cases, sharp beamwidth was required, as well as maintaining a low profile structure, which arise the development of microstrip patch array antennas. Both design of array antennas in this paper were connected using parallel feed quarter-wave transformer impedance matching technique.

2. Design Procedure

Corresponding to the optimum design, an antenna has been fabricated and tested. Details of the antenna design and its measured performance are presented and discussed. There were several ways to design microstrip antennas such as transmission line, inset fed, proximity and aperture models. Details of the designed broadband dual-polarized microstrip antennas is proposed by using the inset feed technique [9].The parametric study on the single patch antenna is done first to understand the characteristics of the antenna.

This paper is focusing on the combination of the same antenna to obtain a better response by developing the arrays. For this project, a parallel or corporate feed configuration was used to build up the array. In parallel feed, the patch elements were fed in parallel by using transmission lines. The transmission lines were divided into two branches according to the number of patch elements. The quarter-wave transformer impedance matching technique was applied to divide the power equally to all patches. The impedances of the line were translated into length and width by using Microwave Office 2006. Figure 1 show the circuit layout of 1x2 array antennas. This design can produce better high gain and broadband compared single element. The position of the patch antenna is oriented at 45º and -45º to obtain dual- polarized radiation. The design of 2x2 and 1x4 and 2x4 array antennas also has been investigated. In both design, the improvement of return loss, VSWR, and antenna gain was investigated. The feeding type of 2x2 and 2x4 array antenna is using coax probe. Whereas, the 1x2 and 1x4 array antenna are using quarter wavelength transmission line feeding technique.


Fig. 1: Fabrication design of 1x2 array antenna

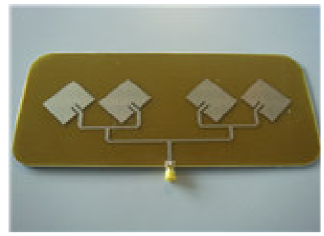


Fig. 2: Fabrication design of 1x4 array antenna


Fig. 2: Fabrication design of 2x2 array antenna

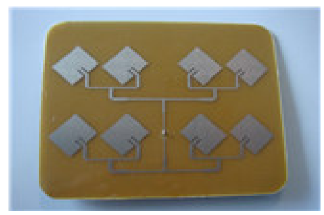


Fig. 4: Fabrication design of 1x4 array antenna

3. Simulation

After all dimensions have been calculated, the design would then be simulated in Microwave Office 2006 software to obtain the return loss, radiation pattern, and VWSR. The simulation results for dual polarized 1x2 array antennas were 1.376 and -17.66 dB for VSWR and return loss respectively. While, the simulation result for dual polarizations 1x4 array antennas were 1.370 and -22.33 dB. Fig. 5 and 6 shows that the combination results of 1x2, 1x4 and 2x2 array antennas. All simulation data are tabulated in Table 1. Again, this proves that the combination of more patches in the array antenna can improve the return loss and better high gain performances.

Table 1: Simulation result for dual polarized array antennas

	DUAL POLARIZED ARRAY ANTENNA		
	1 x 2	**1 x 4**	**2 x 2**
Resonant Freq (GHz)	2.4	2.4	2.4
Return loss (dB)	-17.60	-21.08	-19.4
VSWR	1.35	1.37	1.24
BW (%)	4.42	4.41	5.46

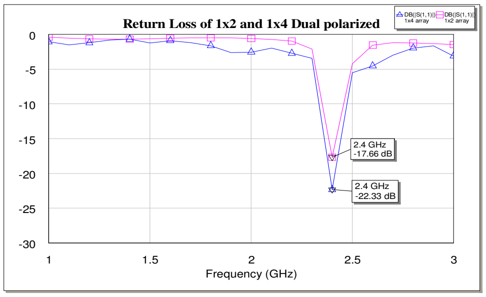


Fig. 5**:** Return Loss [dB] for 1x2 and 1x4 array antenna.

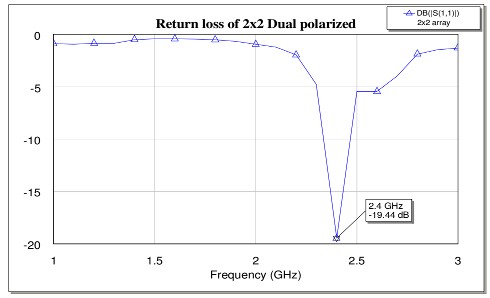
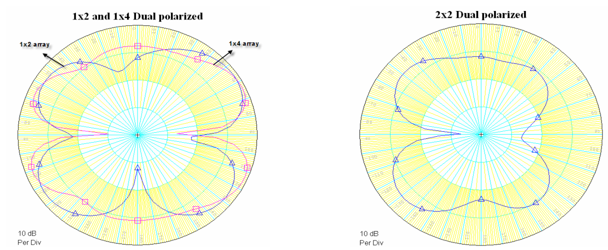


Fig. 6**:** Return Loss [dB] for 2x2 array antenna.



(a) (b)

Fig. 7**:** (a) Radiation Pattern for 1x2 and 1x4 Dual-Polarized Array Antenna
(b) Radiation Pattern for 2x2 Dual-Polarized Array Antenna

Fig. 7 (a) had shown the combination of radiation pattern for 45º and -45º polarizations 1x2 and 1x4 array antennas, respectively. Fig. 7 (b) show the simulation results for 45º and -45º dual-polarized 2x2 array antennas radiation pattern at the resonant frequency.

4. Measurement Results

The same parameters involve in the simulation were measured using Advantest R3767 CG Network Analyzer. The return loss is below -10 dB within the frequency range between 2.51-2.61 GHz, corresponding to a bandwidth of 4.22%. For the measurement setup of radiation pattern, the reference of transmitter is using monopole antenna. Figure 10 plots the radiation pattern measured at two principle plane for 45º polarized 1x2 patch array antenna, respectively.

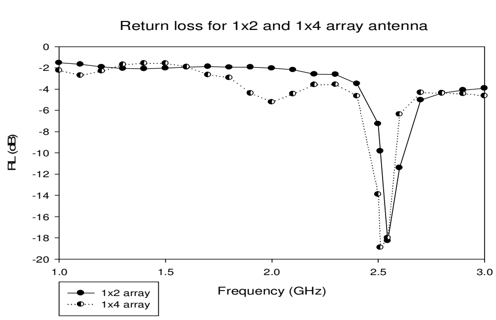


Fig. 8**:** Return Loss [dB] for 1x2 and 1x4 array antenna.

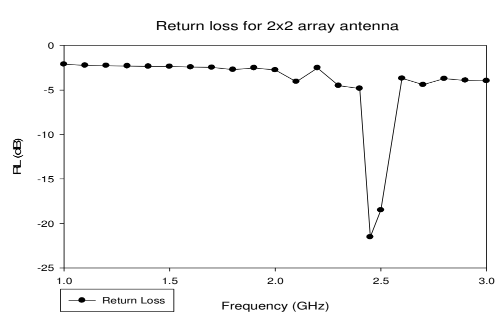
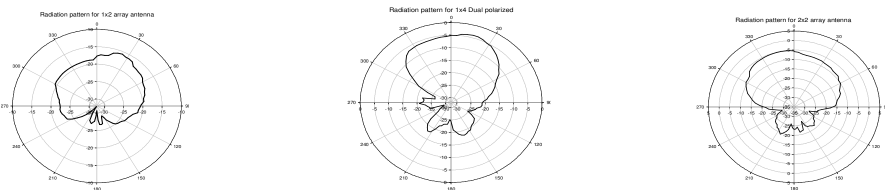


Fig. 9**:** Return Loss [dB] for 2x2 array antenna.



(a) (b) (c)

Fig. 10: (a) Measured radiation pattern of 1x2 patch array antenna
(b) Measured radiation pattern of 1x4 patch array antenna
(c) Measured radiation pattern of 2x2 patch array antenna

Table 2: Comparison between simulation and measurement result for dual polarized array antennas

	DUAL POLARIZED ARRAY ANTENNA					
	1 x 2		**1 x 4**		**2 x 2**	
	Sim	Meas	Sim	Meas	Sim	Meas
Resonant Freq (GHz)	2.4	2.54	2.4	2.51	2.4	2.48
Return loss (dB)	-17.60	-17.28	-21.08	-18.19	-19.4	-21.03
VSWR	1.35	1.18	1.37	1.16	1.24	1.17
BW (%)	4.42	3.45	4.41	4.77	5.46	3.61

5. Conclusion

Tables 2 show the comparison results between simulation and measurement. This tables show the values were slightly different. However the antennas still operate at resonant frequency around 2.4GHz with low VSWR. The VSWR and return loss have been observed for both single and 1x2 patches array antenna. It can be concluded that the responses from the 1x4 patches were better compared to the 1x2 array antenna and single patches antenna. Although the results from the measurement were not exactly same as in the simulation, it was still acceptable since the percentage error was very small due to the fabrication process has been done manually.

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