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Implementation of Polarization Diversity for MIMO Application

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Abstract: While using single frequency and polarization when a signal undergoes successive reflections in a closed urban environment the parameters like phase, frequency and amplitude change .As a result of which the bit error rate increases in order to overcome this problem previously multi band operations were carried out in mobile communication ,but recently the density of users and urban growth have led to increased problems in bit error rate and demand for more number of bands, since available frequency can increase to a certain limit, this work proposes the use of multiple polarization technique for transmission of single signal. As such a same signal with different polarization will undergo different losses and when received one signal out of the two will be of better quality. Using dual polarization we can effectively increase the efficiency of reception and reduce the bit error rate as the receiver gets an option for the signal to be received, it dynamically selects out of the available dual polarized signals which has better quality. Dual polarized transmission and reception can be achieved through a single micro strip antenna thus the input infrastructure required does not change significantly and hence the overall cost change is insignificant compared to the benefits achieved.

Keywords: ADS, Momentum, VSWR, Axial ratio, polarization, MIMO, Hexa band receiver, S-Parameters

1. Introduction

Many wireless service providers have discussed the adoption of polarization diversity and frequency diversity schemes in place of space diversity approach to take advantage of the limited frequency spectra available for communication. Due to the rapid development in the field of satellite and wireless communication there has been a great demand for low cost minimal weight, compact low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies. Through the years, microstrip antenna structures are the most common option used to realize millimeter wave monolithic integrated circuits for microwave, radar and communication purposes. Compact microstrip antennas capable of dual polarized radiation are very suitable for applications in wireless communication systems that demand frequency reuse and polarization diversity. The aim of the project is to design and fabricate a dual frequency and dual polarized microstrip patch antenna. An in-depth explanation of antenna pattern measurement techniques used to determine the performance of dual polarized antennas and of some antenna characteristics that are unique to antennas used in a polarization diversity scheme. The performance comparison is based on radiation pattern, bandwidth, return loss, vswr and gain

2. Square Slot with Stub Load

For enhanced area reduction central slot with extended arms can be used. By exciting the patch using a coaxial probe feed along the diagonal line of the square patch, it is expected that dual frequency operation based on the two resonant frequencies of the perturbed TM(10) and TM(01) modes can be generated. Figure shows the layout of the square slot antenna.



Below shows the radiation pattern of antenna. From figure it is evident that this kind of structure even though gives good return loss but does not give good bandwidth. One of the reason can be improper impedance matches at the feed point. But important thing is that it gives return loss 0f -25dBat high frequency like 4 GHz.





3. Existing Liu Wu Design

Liu and Wu suggest a scheme for single layer dual polarised slotted patch antenna as shown in figure. It yields very good return loss but at cost of increased complexity. The modification suggested latter on and which was fabricated avoids such complexity and exploits the fact that as slot length tends to zero highest resonant frequency can be attained. The Liu and Wu design adds extra L-shaped slots to reduce the polarization loss from multiple reflection between transmitting and receiving polarizations at arbitrary angles. This design is suitable for application to modern wireless communication systems.





Figure 3: Linear and circular polarization

Fig 3: Linear and circular polarization graphs depicting nonuniform radiations



Figure 4: Liu Wu Design

Dimensions

L-shaped slots

W = 1.5mm L = 9mm. Spacing from adjacent radiating walls is 1.5 mm. The square patch for L-shaped slot is 12mm X 12mm.Main Resonating patch W = L = 14.5mm.With stub arms of dimension 3.06mm X 3.06mm. The slots in the main patch are used to capacitive couple the

power from port1 and port 2. The dimensions of coupling slots are 1mm X 3mm. Figureshows the polarization and the return loss for the Liu and Wu design.



Figure 5: Reflection at port 1

4. Proposed New Design

The proposed new design removes the complexity of the existing system and increases the efficiency. It also operates at two different frequencies further enhancing the overall characteristics of the system as more number of users can be handled at a single time during transmission.



Figure 6: Modified antenna

4.1 Output Analysis

S Parameters:

S parameters of the design at S11 and S22 give the reflection of the input signal. It helps us to determine at which frequency the antenna will have a minimum reflection so that we have maximum transmission into the system.

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Figure 7: S11 and S22 reflections

From above graphs we get frequency of transmission and reception with minimum reflection, such that S11 has minimum reflection frequency at 2.240 GHz and 4.579 GHz, S22 has minimum reflection at 2.031 GHz and 4.579 GHz.

Output Characteristics

1. At frequency 2.24 GHz

a) Directivity



The above graph shows the directivity of the antenna, from above it can be concluded that the radiation is uniformly distributed throughout the radiation area.

b) Effective Area



Figure 9: Effective area at 2.24ghz

The above graph shows that the effective area of radiation is distributed between -90 to +90 degree theta.

c) Overall Efficiency



Figure 10: Overall efficiency at 2.24ghz

The graph shows that the radiated power is maximum at the central axis that is 0 degrees.

d)Efficiency





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2).At frequency 4.57 ghz

a) Directivity



Figure 12: Directivity at 4.57ghz The above graph shows the directivity at 4.57ghz frequency.

b) Power efficiency



Figure 13: Power efficiency at 4.57ghz





Figure 14: Overall efficiency at 4.57ghz

d) Efficiency



Figure15: Efficiency at 4.57 ghz The above graph shows the efficiency is 90% .

Practically implemented antenna using copper PCB:

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Figure 21: Practical Implementation

5. Conclusion

Through the course of study while analyzing various antenna designs it was found that using single polarization the quality of reception is not appreciable the bit error rate is high, a solution to the problem was found in the use of dual polarization antenna. A dual polarized antenna was designed and implemented physically as well and it was found that the overall efficiency is drastically improved with better directivity and uniform power radiation.

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