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A Survey on Polarization Reconfigurable Antenna

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Abstract: ***A reconfigurable antenna is an antenna capable of modifying dynamically its frequency and radiation properties in a controlled and reversible manner. Reconfigurable antennas have mechanism such as RF switches, varactors, mechanical actuators etc. that enables redistribution of the RF currents over the antenna surface and produce reversible modifications over its properties. The polarization characteristics of the radiation waves can be changed in real time by using the polarization-reconfigurable antennas for communication systems. Polarization reconfigurable antennas are capable of switching between different polarization modes. The capability of switching between horizontal, vertical and circular polarizations can be used to reduce polarization mismatch losses in portable devices. In this paper different ways of obtaining polarization reconfigurablity is discussed.***

Keywords: Planar antenna, polarization-reconfigurable antenna, substrate integrated waveguide (SIW), dual-mode antenna

1. Introduction

Antennas are the most essential and significant elements of any wireless communication system. The properties of these antennas, however, are fixed according to design and cannot be changed. These properties have restrictions on the overall system performance as the antenna cannot change its characteristics in response to the changing parameters of the wireless medium. A reconfigurable antenna, on the other hand, can dynamically change its properties in polarization, frequency, and radiation pattern. Antenna polarization is a very important consideration when choosing and installing an antenna. Most communications systems use vertical, horizontal or circular polarization.[1] The polarization of each antenna in a system should be properly aligned. Maximum signal strength between stations occur when both stations are using identical polarization.

Vertical and horizontal are the simplest forms of antenna polarization and both fall into a category known as linear polarization. Circular polarization is another form which can be used in areas such as satellite applications where it helps overcome the effects of propagation deviations, ground reflections and the effects of the spin that occurs on many satellites.[1] Another form of polarisation is elliptical polarisation. It occurs when there is a mix of linear and circular polarization. A linear polarized antenna radiates entirely in one plane containing the direction of propagation. Linear polarization is by far the most widely used form for most radio communication applications.[3] When the electric field of the antenna is perpendicular to the Earth's surface it is vertically polarized. Vertical polarization is often used for mobile radio communications. When the electric field is parallel to the Earth's surface the antenna is horizontally polarized. Horizontal polarization shows a marginal improvement for long distance communications using the ionosphere.[3] In a circular polarized antenna, the plane of polarization rotates in a circle making one complete revolution during one period of the wave. If the rotation is clockwise looking in the direction of propagation, the sense is called right-hand-circular (RHC). If the rotation is counter clockwise, the sense is called left-hand-circular (LHC). Circular polarization is used for satellite radio communications. Section II deals with the classification of antennas.[1]

2. Classification

A. Circular Microstrip Antenna

A single-feed circular microstrip antenna is used. A circular patch of radius is etched on a sheet of RT/duroid 5880 printed circuit board. The ground plane dimensions are 100x100 mm. The length and width of the insets are deter(high-frequency LP, low-frequency LP, RHCP, and LHCP). The geometry of the antenna designed is modified according to the on- and off-states of the PIN diodes and features the resulting capability of polarization diversity.mined by the size of the PIN diode. The feed line is composed of a 50Ω microstrip and three matching stubs PIN diodes to allow for the matching of four different polarization states. Antenna has two main polarized states; linear polarization (LP) and circular polarization (CP). The characteristics of this antenna are divided into four cases depending on the bias of the PIN diodes

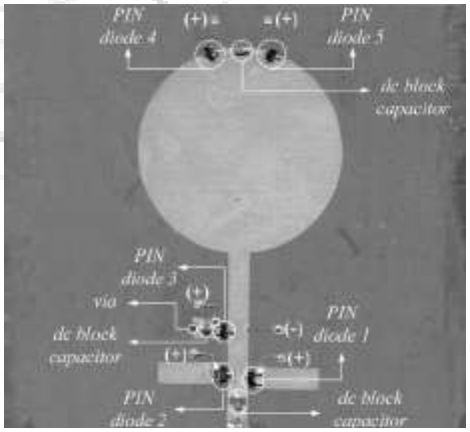

Figure 1: Photo of circular path reconfigurable antenna

B. Eccentric Annular Ring Slot Antenna Design

A microstrip-fed reconfigurable eccentric annular ring slot (EARS) antenna with switchable polarization is used. In order to generate orthogonal circular polarization (CP) radiations, two identical perturbation slots (PS) are loaded below the eccentric ring-shaped slot. A PIN diode is used to switch across each PS, the antenna can switch between left-hand CP (LHCP), right-hand CP (RHCP), and linear polarization (LP). An annular ring slot antenna (ARSA) is used because ARSA architectures can be easily reconfigured as a CP radiation type by loading different kinds of perturbation slots (PS) or coupling strips (feeding lines) across the slot. To achieve broad CP bandwidth (up to 140 MHz) microstrip line fed ARSA designs top loaded with a circular patch. For this EARS design, an LP radiation at TM11 can be easily achieved, and in order to further induce the two orthogonal CP radiations, the technique of loading symmetrically a pair of identical PS below the eccentric annular slot is used. Different polarization states (between LP, LHCP and RHCP) at approximately 2.4 GHz can be manipulated by simply switching between the two PIN diodes that are incorporated into the perturbation slots.

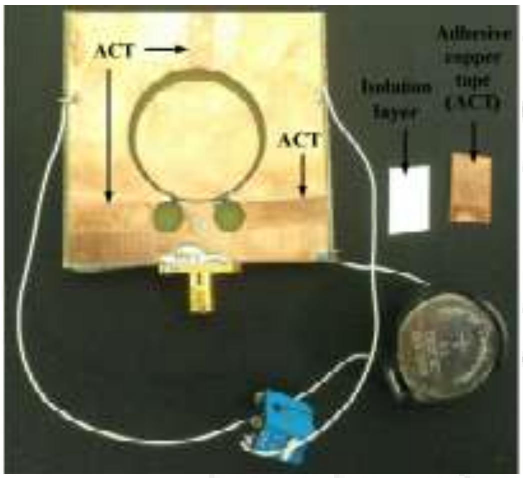

Figure 2: Photo of fabricated antenna

The configuration between three polarizations is realized by switching the two PIN diodes via the DIP switch.

C. Omni-directional Antenna Combining Dipole and Loop Radiators

A polarization-reconfigurable omni-directional antenna combining a dipole and a loop radiator is used. The omni-directional circular polarization(CP) waves can be generated in the azimuthal plane by adopting two metal probes act as the dipole and printed spoke-like metal strips fabricated on two substrates that act as the loop.


Figure 3: A photo of fabricated omni-directional antenna

There are 48 p-i-n diodes which are placed on the two substrates to alter the current direction of the loop, for reconfigurablity. The polarization states of this antenna can be switched between left-hand circular polarization (LHCP) and right-hand circular polarization (RHCP). The antenna is fed by a microstrip line, and the feeding substrate also contains a transition part and dc bias network in it. The antenna is designed at 1.575 GHz, such that it can be utilized for global position systems. The combination of a dipole and a loop is implemented by two metal probes and with spoke-like metal strips fabricated on the substrates. A double-sided parallel-strip transmission line and the transition are used to feed the dipole. The structure consists of three planar substrates with printed spoke-like metal strips that are connected by two metal probes and six metal pins around the circumference. The antenna was fabricated on Rogers RT/duroid 5870 substrate. [3]

D. Planar Polarization-reconfigurable Antenna

A planar polarization reconfigurable antenna with a simple switching topology is realised. A dual mode substrate integrated waveguide (SIW) cavity is adopted for the element antenna having two input ports. Four radiation slots are etched on the top surface of the SIW cavity for generating the circularly polarized radiation, whose radiation phases can be adjusted by switching the input port. Two input-ports are adopted to adjust the phase distributions of the radiating slots etched on the top surface of the SIW cavity input ports are used to feed individually the antenna and a square substrate integrated waveguide (SIW).

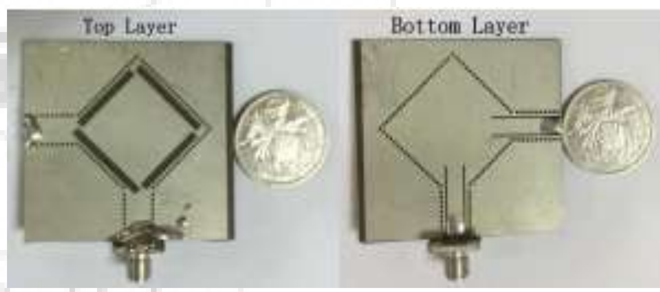

Figure 3: A picture of fabricated antenna

The 1.57 mm thickness Rogers 5880 substrate is used in this design, which has a relative dielectric constant of 2.22 and a loss tangent of 0.0009 at 10 GHz.. Grounded coplanar waveguide (GCPW) lines are used to feed the SIW cavity. Four rectangular slots are etched along the four metallic-via arrays on the top layer, When the SIW cavity is fed individually by the port 1 or port 2, it can support two resonating modes, i.e. the TE210–like and TE120–like mode. Then those four slots are excited with the same magnitude but different phases. The phase-shifting between neighbouring slots is 90 degrees or -90 degrees, depending on the excitation of the dual-mode SIW cavity. Then a right hand circular polarization (RHCP) or a left hand circular polarization (LHCP) is generated accordingly. CPW line is designed to have 50-ohm characteristic impedance for the proposed element antenna. A switch is used to connect two power-

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divider together for realizing reconfigurable polarizations. LHCP is obtained when the switch is switched on at the left side, the RHCP is obtained when the switch is switched on at the right side, and the LP is obtained when the switch is switched on both sides. [4]

3. Conclusion

There has been a rapid development in wireless communication. Antennas with multiple parameters are needed. Reconfigurable antennas are able to alter polarizations independently to accommodate changing operating requirements. Antenna polarization reconfiguration can help provide immunity to interfering signals in varying environments as well as provide an additional degree of freedom to improve link quality as a form of switched antenna diversity. They can also be used in active read/write tracking/tagging applications.

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