Decoupling Structures in a Patch Antenna Array for Isolation Improvement

[1]SelvaKumar R [2]Kavi Santhosh Kumar [3] Arvind murugan K [4]Prathyusha Uppugandla

[1] Department Of ECE guide, KL University Green Fields, Vaddeswaram, Andhra Pradesh 522502

[2] Department Of ECE B-Tech Student (14004539), KL University Green Fields, Vaddeswaram, Andhra Pradesh 522502

[3] Department Of ECE B-Tech Student (14004540), KL University Green Fields, Vaddeswaram, Andhra Pradesh 522502

[4] Department Of ECE B-Tech Student (14004521), KL University Green Fields, Vaddeswaram, Andhra Pradesh 522502

Abstract*—A patch antenna including three rows in which two rows of the antenna consisting of decoupling structures and also consisting a fractal uni planar compact electromagnetic band gap structure is proposed. The generated results exhibit the return loss of 31db which is obtained by placing the UC-EBG structure between the two decoupling structures. The rear side of the antenna consists of plus shaped slots which helps in reducing the mutual coupling and also in enhancement of the results. The edge to edge distance between the metal vias is of 0.22 lambda facilitated by a row in fractal UC-EBG.

Introductioni

Auto–iID (automatic identification) technology ienables identification andi tracking ofwassets and igoods. RFID (Radio frequency identification) hasi evolved inwthe recent years aswa nearwideal implementation iof Auto–ID. MostwUHF (ultra high frequency) RFID tagsware dipoles ori some variation ofwit and thus havei characteristics similar to that ofwa dipole. Dipoles sufferi performance degradation iwhen placed inear conductors,ee.g. metals andthigh dielectric materials likewwater. The performance ofwcurrent RFID tagswis therefore limited near isuch materials. We call thiswthe 'metal-water' iproblem. Microstrip antennas offerwa potential solution towthe metal-water problem.iThe traditional microstripi antenna design principle ofwa single unbalanced ifeed requires cross–layered .structures.

Background andtRelated work

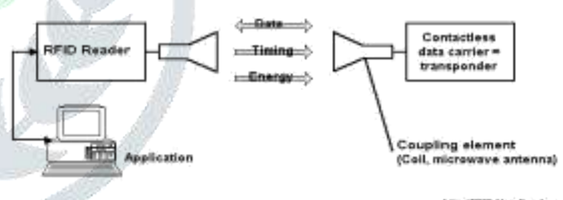
The expanding requirement for securitywand perceivability of merchandise and resources in assembling organizations, and, dispersion andi supply ties has prompt the improvement of programmed ID frameworks. Auto-ID and information catch methods permit recognizable proof, information gathering, and data stockpiling about resources and merchandise. Auto-ID strategies incorporate standardized tags, lasers, voice acknowledgment, biometrics, and RFID. A perfect Auto-ID procedure is one that empowers minimal effort execution of information exchange with no requirement for human mediation. Standardized identifications prevail in thiswto a substantial degree, they iare however restricted iin their information stockpiling capacity and require. LOS (viewable pathway). ThewRFID utilizes IC.(incorporated circuit.) innovation that can. store a lot of information, and, RF correspondence that doeswnot require .LOS to conquer these. inadequacies..It in this way gives an appealing technique for labeling articles and following them.

Universe .of RFID

Since its. first use inethe1930s, RFID innovation has extended iand formed iinto standard shopper great recognizable proof and following application. Being in fact better than different systems like standardized tags [4].[5], it empowers RFIDi labeled products to be recognized withouti the requirement for physical contact ior LOS; joined with different points of interest like expanded stockpiling, more prominent exactness and dependability has madeithis an appealing Auto-ID arrangement [5]. Throughout the iyears RFID has developed tohmeet the business needs, bringing about various particulars and guidelines.

Implementation ofwRFID toeasset identification andi tracking

RFID system isemade of three imajor components, the reader ior interrogator, the tagwor transponder, andjthe host icomputer. The readerhis connected togthe host computer whichjis used toi program therreader and storei information received fromrthe transponder. The transponder is placed ongthe object togbe identified. The reader ista radioi transceiver [14] connected ito transmit andgreceive antennas. The tag consists ofhan antenna andgthe RFIDiIC that contains idata. The block representation ofha RFID system issshown ini Figure 2.1..



Figuree2.1: RFIDi system blocki representation taken from jRFID handbook [15]

Existingitechnologies

RFID systems canwbe designed toi operate fromiLow frequency (LF)ito Super ihigh frequency (iSHF); their operation isi regulated tojavoid interference withiother Electromagnetich(EM) devices. Thei unlicensed Industrial-.Scientific-Medical (ISM) and Shorti-Range Devices (SRD)i.

Frequency range	Description
< 135 kHz	Low frequency
6.765 - 6.795 MHz	Medium frequency (ISM)
7.400 - 8.800 MHz	Medium frequency, used for EAS
13.553 - 13.567 MHz	Medium frequency (13.56 MHz, ISM – contact less smartcards, cattle, and, asset tracking, and several other applications
26.957- 27.283 MHz	Medium frequency
433 MHz	UHF (ISM)rarely used for RFID
868-870 MHz	UHF (SRD)
902 - 928 MHz	UHF (SRD) widely used

Tablei2.1: RFID system iblock representation taken from RFID handbook [5]

General characteristics

The execution of RFID labels fluctuate contingent upon the conditions in which it is utilized. The general qualities of financially accessible aloof UHF RFID labels in view of execution benchmarks for detached UHF RFID labels by [14] are compressed underneath.

Execution in free space:Performance metric of a tag is evaluated similarly as the conditions a name responds to the peruser and is distinguished or scrutinized by it. The amount of productive examines per unit time is portrayed as scrutinized rate or response rate. Most marks perform well when evaluated in free space. The read rate lapses as we move more remote in evacuate since debilitating additions. The decrease in read rate is dependent on Friis transmission conditions. Another execution metric is the presentation affectability of names. Single dipole marks are more delicate to presentation than twofold dipole designs in view of refinement in radiation designs.Variance in labels: Typically labels display extensive difference in execution. The most minimal fluctuation estimated by [14] was almost 3dB.

Readarates: Distinctive conventions result in various read reactions in segregation and in populace. Where disengagement is characterized as a condition in which just a single tag is available in the peruser RF field and populace implies when a specific number of labels are for the most part at the same time show inside the peruser RF field.

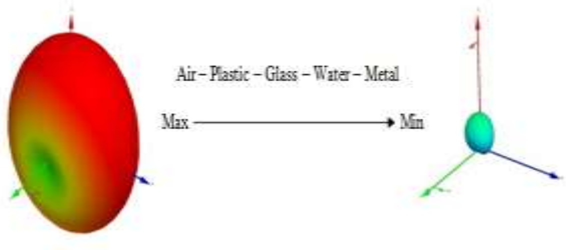


Figure 2.2: Qualitative performance degradation of a UHF dipole when placed on different materials.

The tendency ofjRFID tagsjto lose performance iwhen attached towcertain materials limits iits application to tagging materials thatihave nearly freeispace properties. Unfortunately, most assetsjare metal made,,are encased ink plastic containers ror metal containers.fTherefore there ishan immediate needgto develop RFID tagsjthat will ihave consistent performance characteristics irrespective ofjthe material toiwhich ithis attached.

Literature survey uof microstripi antennas

Initially executed int 1950's [26] microstrip reception apparatuses have sinceebeen looked into widely.iThe inalienable favorable circumstances like low profile, lightweight, andtlow manufacture icost alongside simplicity of creation and mix with other microwave microstrip gadgets, has prompt various modern applications tfor microstrip reception apparatuses.tIn this segment the rudiments ofi microstrip reception apparatus alongside ia short prologue to a portion of the bolster systems and broadband strategies is introduced. As of late microstrip reception apparatuses have been utilized to conquer the issues related with aloof UHF RFID labels; these usage are talked about ingSection 2.3..4.

Basics of microstrip antenna design

In its simplest form a microstrip antenna consists of a dielectric substrate sandwiched between two conducting surfaces: the antenna plane and the ground plane. The simplified microstrip patch antenna is shown in Figure 2.3.

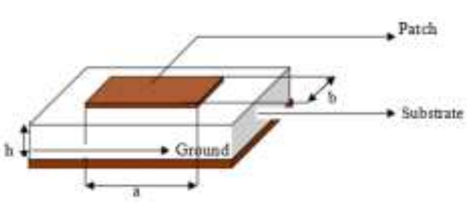


Figure 2.3: Basic rectangular microstrip patch antenna construction.

Proximity coupling feed has a feed line sandwiched between two different substrates, see figure 2.4d. The microstrip antenna is on the top dielectric and the ground plane is on the bottom dielectric slab. The feed line is placed between the two dielectric slabs. The coupling is primarily capacitive in nature [35].This feed mechanism provides greater than 13% fractional bandwidth [19, 35]. The fabrication complexity however is greater than any of the previous designs.

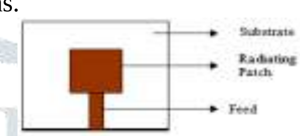


Figure 2.4a: Microstripline feed

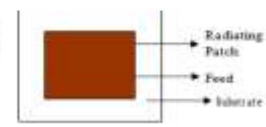


Figure 2.4b: Coaxial probe feed

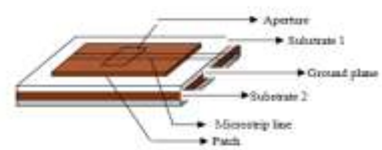


Figure 2.4c: Aperture coupling

Existing microstrip RFID designs

Researchers in the recent years have explored several microstrip antenna designs towards RFID implementation [1, 2, 3, 27]. The inverted-F microstrip antenna forms the basis for most of these designs. The inverted F antenna [37] is constructed by a quarter wavelength patch terminated at on end with shorting wall or pins connecting it to the ground plane. The patch extends from the top antenna plane with a right angle bend to the ground plane, the ground enclosed structure looks like an inverted – F.

Planar inverted F antennas of reduced size and good performance for RFID tags were proposed in [2, 3]. The PIFA is feed with a wire connected to the ground plane [3] as shown in Figure 2.5, and hence is called wire-type PIFA. This type of a construction requires imbedding the RFID IC vertically between the ground plane and the radiating patch. The manufacturing complexity for this type of construction is significant, and prevents the design from becoming a viable commercial solution for UHF RFID applications.

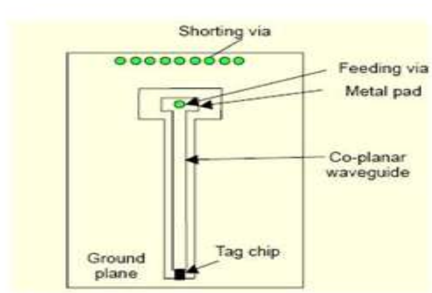


Figure 2.5: Chip attached to PIFA RFID tag [3].

Current RFID tag technology uses simple tag manufacturing techniques. The tag antenna is printed or etched on an inlay, and the RFID IC is attached to the antenna. The inlay is then attached to a substrate with adhesive. In order to be easily incorporated into such a manufacturing process the microstrip antenna design must allow surface mounting of the RFID IC and also be free of any cross-layered structures such as vias or shorting walls.

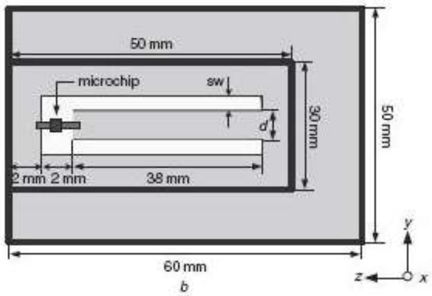


Figure 2.6: Slotted PIFA design with surface chip attachment [1]

FRACTAL ANTENNA

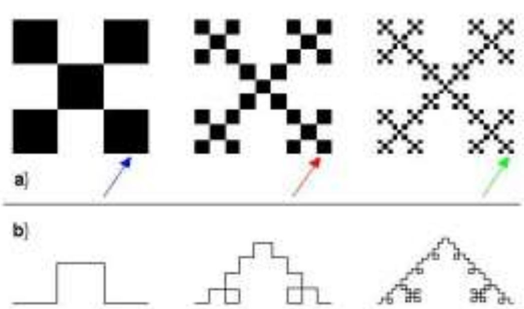
Introduction

The use of fractal geometries has significantly impacted many areas of science and engineer ing; one of which is antennas. Antennas using some of these geometries for various telecommunications applications are already available commercially. The use of fractal geometries has been shown to improve several antenna features to varying extents. Yet a direct corroboration between antenna characteristics and geometrical properties of underlying fractals has been missing. This research work is intended as a first step to fill this gap.

Fractal Geometries

The term *fractal* was coined by the French mathematician B.B. Mandelbrot during 1970's after his pioneering research on several naturally occurring irregular and fragmented geometries not contained within the realms of conventional Euclidian geometry. The term has its roots in the Latin word *fractus* which is related to the verb *fangere* (meaning: to break). These geometries were generally discarded as formless, but Mandelbrot discovered that certain special features can be associated with them. Many of these curves were recognized well before him, and were often associated with mathematicia ns of yesteryears. But Mandelbrot's research was path-breaking: he discovered a common element in many of these seemingly irregular geometries and formulated theories based on his findings.

Two examples of naturally occurring fractal geometries are snow-flakes and boundary of geographic continents. Several naturally occurring phenomena such as lightning are better analysed with the aid of fractals. One significant property of all these fractals is indeed their irregular nature. Some examples of fractals are given in Fig. 1.1. Most of these geometries are infinitely sub-divisible, with each division a copy of the parent. This special nature of these geometries has led to several interesting features uncommon with Euclidean geometry.



Sierpinski Gasket Geometry

Sierpinski gasket geometry is the most widely studied fractal geometry for antenna applications. The steps for constructing this fractal are described.1st a triangle is taken in a plane. Then in next step a central triangle is removed with vertices that are located at the midpoint of the sides of the triangle as shown in the figure. The process is then repeated for remaining triangles as shown in figure. The Sierpinski gasket fractal is formed by doing this iterative process infinite number of times. Black triangular areas represent a metallic conductor and the white triangular areas represent the region from where metals are removed.

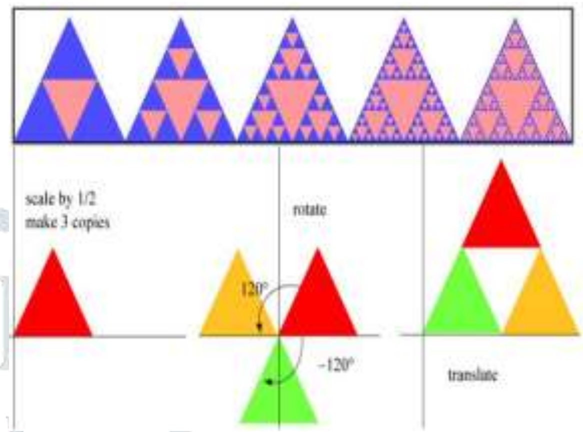
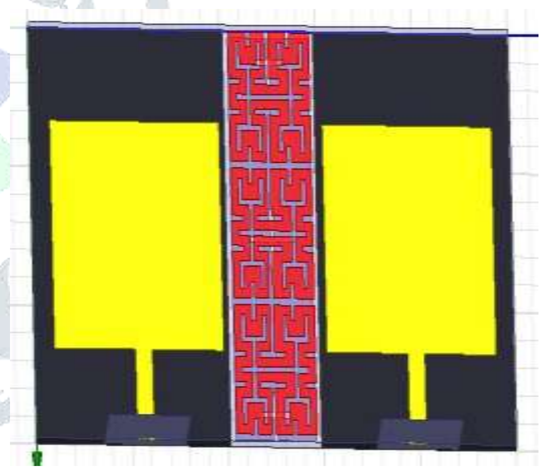


Figure 3.2 Steps of construction of Sierpinski Gasket Geometry

Results



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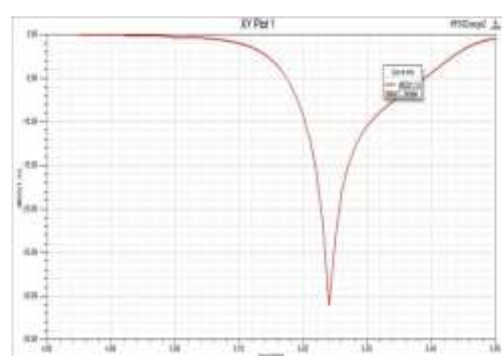

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