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Expand Energy Over Distance Via Sensor-based Radio Frequency Identification(RFID) Technology

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***Abstract*:- Although coexistent, we have persistent in progressing the technology (constructing a wireless-communication technology) for better enrichments in time ahead, We want draw to your attention to wireless biosensors because the development of Wireless Biosensor is essential for our studies and practical knowledge (or application) in different area like medical diagnostic, research, defence and ecological monitoring etc, it's enormously complex and careful detection for application (like food detection, humidity, bacteria growth etc). Our motive is to focus on Expand Communication Performance or Range. Apparently, measure Resonance frequency and Quality factor(Q-factor) rather than sensing system. Display the specific resonance frequency in which the extensible system will execute this is significant throughout the manufacturing development to the function of communication and gauging the High-Quality factor(Q-factor) for robust system procedure. Further how to expand RFID Distance Read Range and a major task to integrate RFID into biosensors for construction of wireless biosensors. In the market different types of battery-free wireless biosensors (like magnetoelastic biosensors, acoustic wave-based biosensors, self-powered biosensors, and potentiostat biosensors) are available but our emphasis is on RFID-based biosensors because it is cost-effective and companionable with mass production and probable with variant configuration in the upcoming time.**

Keywords:- *Wireless-Technology, Biological Sensors, Signal, Active or Passive RFID Tag, RFID Reader.*

➢ *List of Symbols and Abbreviations*

The following is the list of abbreviations that are used in this.

- RFID Radio frequency identification
- IoT Internet of things
- MUT Material under test
- DUT Device under test
- LF Low frequency
- HF High frequency
- UHF Ultra-high frequency
- FET Field effect transistor
- EMR Electromagnetic radiation
- ASIC Application of integrated circuit chip
- IPT Inductive power transfer
- F0 Resonance frequency
- BW Bandwidth
- Q-factor Quality factor
- Zin Input impedances
- PT Transmitted Power
- PR Received Power
- GT & GR Transmitted Gain and Received Gain

I. INTRODUCTION

The back end of the line of wireless biosensors is a futuristic technology based on communication devices in hand use electromagnetic energy of radio frequency to transmit data from transponder to receiver. In some abrupt exclusive cases, RFID transponders use ferrite cores (magnetic cores made of ferrite) use for high magnetic permeability coupled in the presence of low electrical conductivity. In the meantime, ensure that the RFID transponder operates with enough energy, The rate of recurrence of the reading coil should be well-tuned with the resonance frequency of the transponder, it's mandatory for the attached low bandwidth, however more than a few things that require a low Q-factor rather than high Q-factor. On the other hand, the High Q-factor is beneficial for extreme voltage by the side of resonance.

➢ *According to the Literature, RFID Technology is Separated into the following Categories*

- Chipless RFID tech
- Radio-frequency energy gathering efficiency
- Integration of RFID and sensing tech
- RFID sensor network tech

In the early 1990s Hertz and Tesla proposed wireless energy harvesting, the fundamental of RFID, Energy harvesting is divided into two portions backscattering and inductive coupling. in addition, the chip-less RFID uses shift resonant frequency, When chip less tag is integrated with MUT (Material under test) the resonant circuit evolves to frequency and different resonant amplitude, and the resonant frequency flow in the direction of data change of the sensor, the major limitation is that we do use it in some specific region only because the data storage capacity of the chip less RFID is far less than the chipped unities. In general, there are various types of techniques for the integration of RFID and biosensors, One of the most popular silver enhancement-based techniques to the measurement of humidity detection and IgG detection.

Although we measure the parameter but frequently cannot be evaluated directly that same thing put on the resonance frequency and Q-Factor of different Passive RFID (UHF RFID, HF RFID, LF RFID), several methods exist for measurement.

II. WORKING AND OPERATION

➢ *Working of HF & LF RFID: -*

Radio frequency identification is used for **the** Transition of data (information) from the transponder to the receiver wirelessly, uniform Each RFID tag has a unique code to categorize the object or various applications. Regarding RFID that uses inductive coupling based on a common magnetic field shown in fig-1,

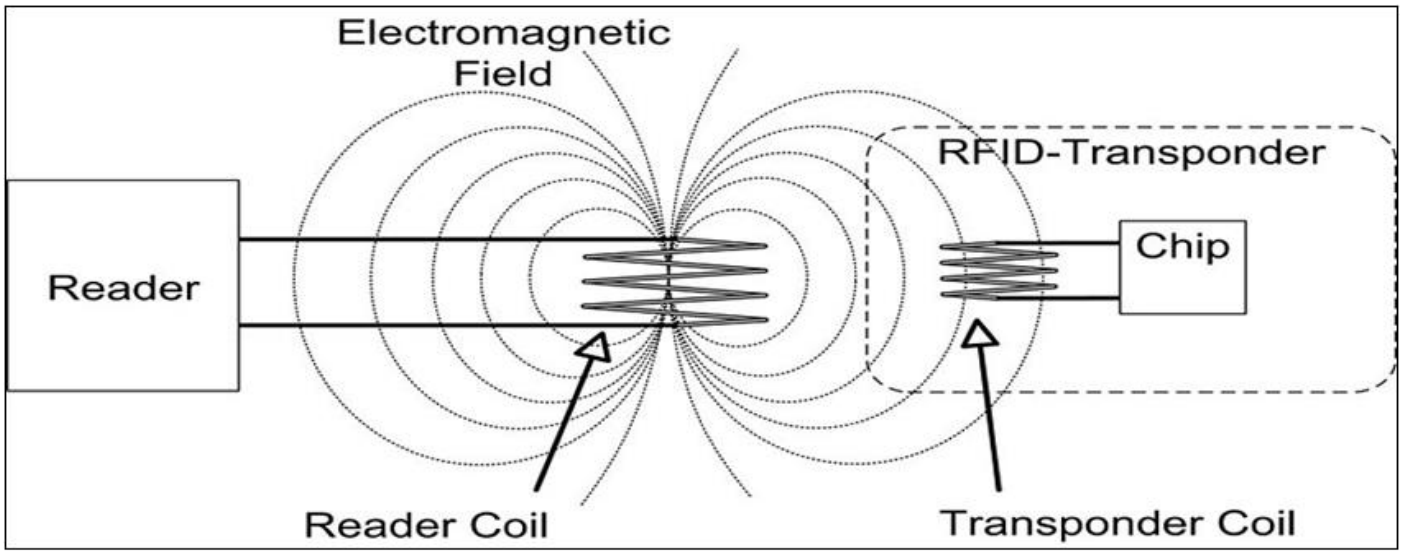

Fig 1 Inductive Coupling of RFID

From the fig-1 when the flow of current (I1) through the reader coil, reinforces magnetic flux Φ1 in the read coil. Φ12 is a fragment of this magnetic flux Φ1 which goes through a second single winding loop of the transponder coil, It is needed for inductive coupling they have to necessity a mutual magnetic flux, rendering to inductive law, causing a voltage (t) in the second winding which primes to the current I2 and the equivalence is valid if the same magnetic flux Φ goes through all windings

$$(t) = -N\ (d\Phi \backslash dt)$$

The overall magnetic flux Φ1 will be

$$\Phi 1 = \Phi 10 + \Phi 12 = \Phi 1 *(1 - k1) + \Phi 1 * k1$$

Φ10 = a magnetic flux those are not inductively coupled with secondary winding also called stray flux
K = coupling factor

However, that will work as well if an irregular current in the transponder coil (in the second winding) would cause a magnetic flux Φ2 and Φ21 = k2 * Φ2 and a current I1 in the reader coil (winding one).

➢ *Equivalent Circuit Diagram: -*

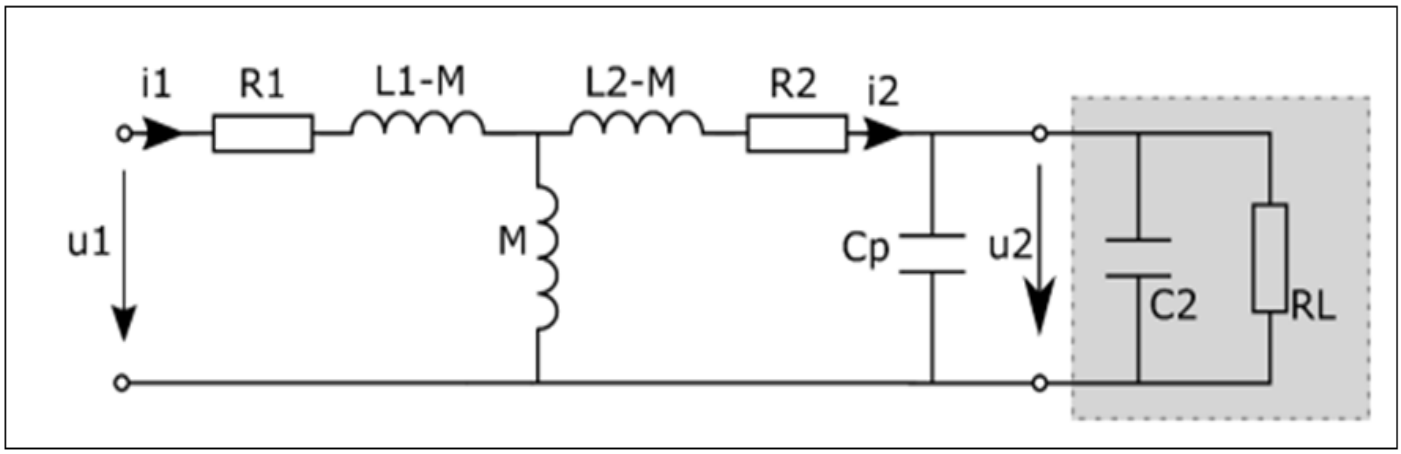

Fig 2 ECD of Magnetic Coupled RFID Reader Coil and Transponder Coil

If considering the ECD of the magnetic coupled RFID Reader coil and Transponder coil then from fig-2 the left side of the ECD is the reader portion and the right portion is the TAG portion in which the transponder coil is associated with the memory microchip so this ECD mechanism is called chipped based RFID [combination of RL(Load Resistance) and capacitor(C2)] and the parasitic capacitor (Cp) are parallelly connected to C2 because at different voltage level exhibit, the two close conducting element form an unwanted capacitor called parasitic capacitance. and grouping that ensures the circuit has in specific resonance frequency, that frequency depends on which type of passive RFID (HF, LF) is used.

➢ *Working of UHF-RFID: -*

ITs different forms HF and LF RFID, UHF RFID is based on a backscattering process called radar backscattering. Shown in fig-3

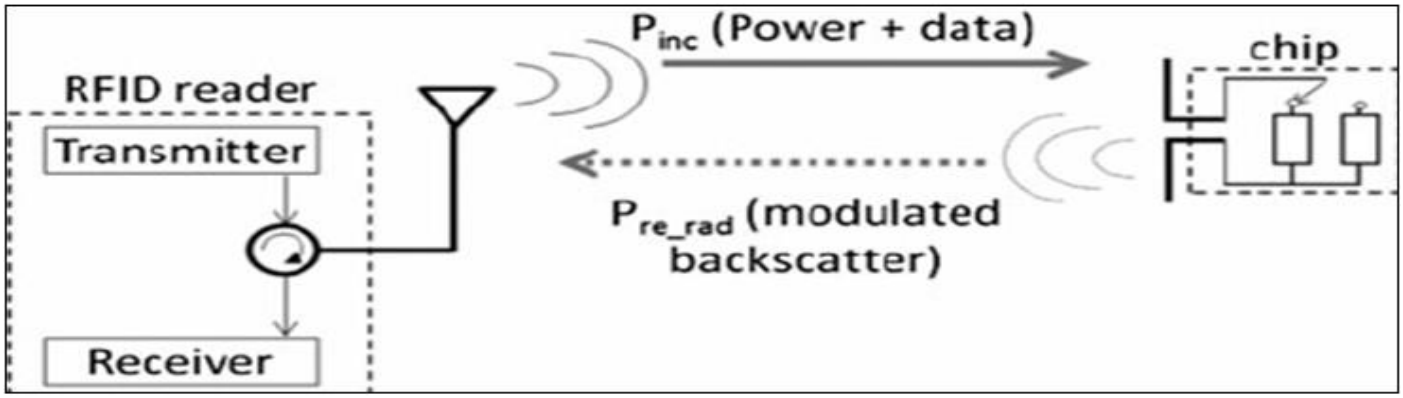

Fig 3 UHF -RFID

According to the Fig -3 When electromagnetic field travels from the interrogation (RFID Reader) transmitter Antenna with timing information and power and bumps into the TAG RFID Receiver antenna, the transmitted signal is converted behalf into a backscatter electromagnetic field with information and response, and transmitted by TAG Antenna to receive Antenna. The range of UHF RFID is 20m or more but there is one typical limitation the size varies greatly as compared to HF & LF – RFID, We use it as a tracking or identification to objects because of the frequency range of around 860-960 MHz.

➢ *Mathematical Relationship: -*

- *For RF Power Transmission: -*

$$P_{\text{Tag}} = S \cdot A_E = P_T \left(\frac{\lambda}{4\pi R}\right)^2 G_T G_{\text{Tag}}$$

- *For Power Reflection: -*

$$P_R = S_{\text{Back}} A_w = \frac{P_T G_T G_R \lambda^2 \sigma}{(4\pi)^3 R^4}$$

$$\text{Loss Term} = \left[\frac{4\pi d}{\lambda}\right]^2$$

III. OPTIMIZE THE READ RANGE OF RFID

➢ *Antenna Gain: -*

The ratio of transmit and receive power must be in the precise angle or direction of an isotropic antenna, receive power could be high or around 9dbi with the use of a high gain antenna. but the one thing that matter here, a high gain antenna is not sufficient for all type of application because TAG is nearly with the antenna so that we can measure a vicinity scan

So, for the boost amount of RFID signal or read range must be ensured to use a high gain antenna simultaneously for low read range use a low gain antenna.

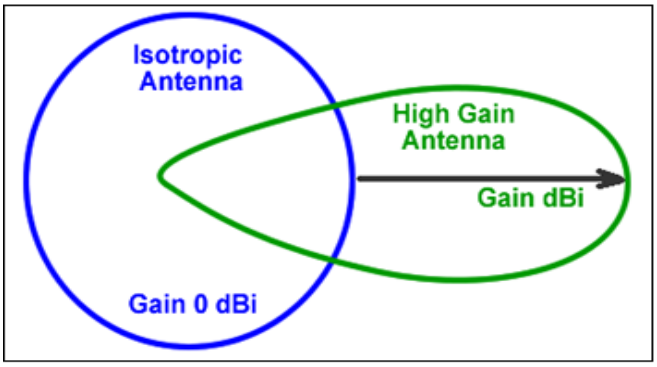

Fig 4 Antenna Gain

➢ *Antenna Polarization: -*

In this, we consist of two polarizations one is linear polarization and the other is circular polarization, Although circular polarization refers to near-field communication (shorter read range), due to two separate planes the radiated power will dispersed and lost around 3db, behalf of linear polarization in which only one axis will exist so that power is not split across more than one axis and that follows to far-field (longer read range).

➢ *Relay Resonator: -*

A relay resonator is a device that is used for range extension of transmission frequency or information from RFID Reader to chip and vice versa to achieve high efficiency with additional variation with distance orientation.

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IV. INTEGRATION OF RFID TO BIOSENSOR

To construct tiny RFID-based Biosensors, which can be implanted in the human body for different medical diagnostic applications (to check glucose levels, cancer diseases, bacteria etc.). Some RFID-based biosensors are shown in FIG-4 and FIG-5.

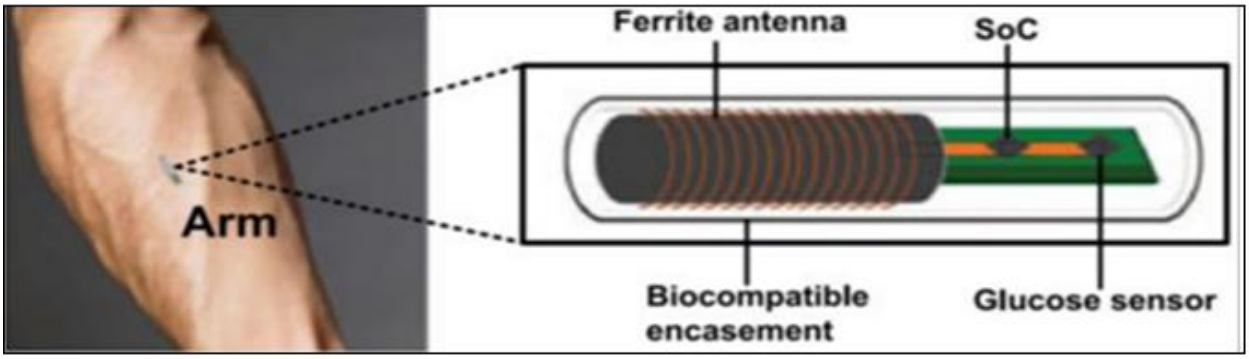

Fig 5 Implanted Glucose Detection Model [1]

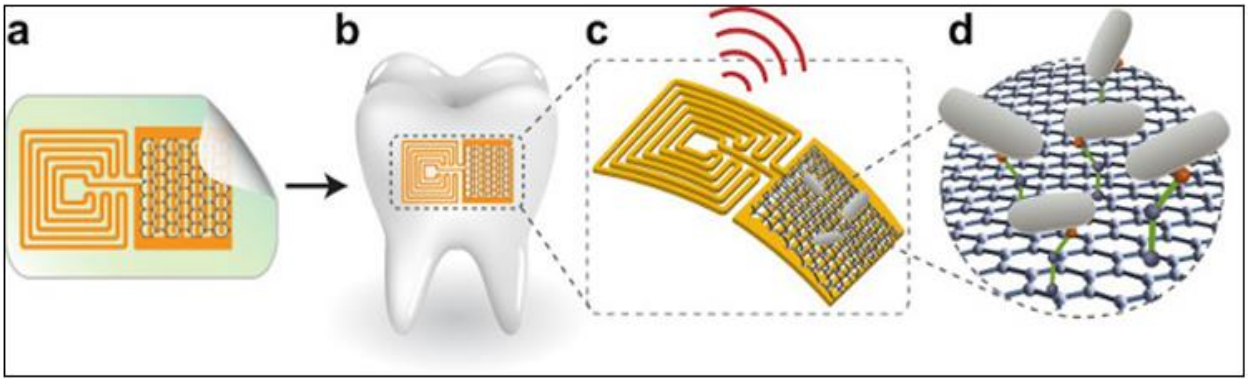

Fig 6 Tooth Sensor [2]

Freeze DC power from power sources for better transmission transitivity and data reception in the Radio frequency identification chip (RFID) and sensing module, RF power must be converted to DC to provide a power supply. Usually, a multistage rectifier is for gain O/p voltage and RF energy harvesting, The various types of rectifiers (half wave, full wave, bridge) are designed for the conversion of the power signal and to improve their efficiency.

However, if the RF power is too weak, then using a highly sensitive CMOS (0.13 or 0.18micro m CMOS process) rectifier with threshold voltage devices is proposed by many kinds of literature. And leakage current can be reduced without affecting the sensitivity and power can be gained wirelessly at different distances This significance can be used in a UHF RFID application.

The RFID technique is the combination of RF power and data communication interface, It's easy to use and integrate, and different processes containing inkjet printing, PCB, flexible etc Inkjet printing is the phenomenon of electronic and printing technology and is used for printing technology in the direction of electronic assemblage and on to a line of technique, the consistency work of flexible RFID used to fabricate chip free RFID and chip-based RFID, in which print nanoparticle like copper, graphene, silver, CNT, gold etc.

Apart from this medium RFID ICs (integrating chip) is important for sensor progress, many RFID ICs produced as RFID transponder which can be used in RFID application, they have many capabilities like Furthermost ICs integrate RF energy collecting circuit, read and write capability for exterior MCU in consecutively inform the sensor data, ADC are contained within the RFID ICs used for interfacing with sensor circuit component some ICs model such as MLX90129 and SL13A.

V. MEASURING AND ANALYSIS

The resonance frequency does depend on the peak value of the impedance (real part) and must sure the impedance be purely resistive, at the side of the resonance frequency without communicating the device under test (DUT) can measure the Q-factor of the RFID transponder

- *Resonance Frequency:* -

The highest peak voltage across the RFID chip(tag) element can be described mathematically. Which using a Kirch-off voltage law measures the voltage at the side of the RFID chip or TAG. according to the ECD, current flow in RFID leads to the voltage across the TAG coil with a constant root mean square (RMS) value of current, meanwhile, the absolute value of the voltage at the side of the tag coil (RFID chip) concerning angular frequency, that

will get the circular frequency to obtain the communication performance of the circuit.

Along with the physical method, with the help of an analyser to detect the resonance frequency. Calculate the impedance without contacting the transponder from a read coil, those avert magnetic coupling, backscatter coupling, and mutual inductance, this measurement applies to a real part of the impedance. Simultaneously under this at different signal levels measure the impedance to place an RFID TAG in a contacting field of RFID READER. Due to the Reference, the resonance frequency is dependent on the signal level (power), which means the larger the amount of signal power the more RFID try to influence the result.

- *Q-Factor: -*

Usually the Q-factor can be categorized with two factorized terms, the Frequency and Bandwidth ratio (-3db bandwidth as well as resonance frequency required to obtain Q-factor) or the other is the energy ratio (maximum energy deposited in the resonant circuit and energy dissipation per cycle) and the limitation is both are dissimilar to each other but get almost correspondent for high Q-factor.

Behalf of the systematic methodology sampling ratio of frequency and bandwidth, the literature claims the two significant measurement methods to exhibit the bandwidth concluded the part of the impedance in the occurrence of resonance frequency, in which the absolute value of the impedance is according to time at a particular point, where the lower and upper frequency exists at a same point.

On the other hand, to measure the bandwidth with the help of the real part of the impedance, the upper and lower frequency of the bandwidth gain in that point where the real part of the impedance is a semi-of maximum value. the energy ratio method, the emphasis of conception is the same as the preceding way but this method generally focuses on the uncoupled transponder circuit which demonstrates imaginary frequency can easily be considered at zero-crossing of imaginary impedance. Mathematically expression is given below.

- *Features: -*

Autonomous, mass manufacture, easy to use, cost-effective, Multiplexing capabilities, quick response time etc.

VI. CONCLUSION

In this demonstration, the application of multiple properties and robust systems has been achieved, thereby achieving maximum efficiency at the imaginary resonance frequency and Q-factor of communication devices. While studying all the sensor technologies used in detection as per the application, which is one of the important parts of the system, the pros and cons of each sensor can be analyzed. Half of this, in the implementation of a scene-based system, has some disadvantages and advantages in an application or in the measurement of resonance frequency and Q-factor. However, the advantages outweigh the disadvantages during detection. The purpose of this article is to adopt and improve some modernizations (to draw your attention to the upcoming technology). In this article, the communication and system performance of exquisite RFID-based biosensors are achieved and high integration with various technologies is shown. Which we can use in various areas of application, like. - Neural dust sensor wireless biosensor was first introduced by the University of California in 2011, It is suitable for monitoring and controlling muscles and nerves. This device comes under the category of BCI (Brain-Computer Interface). Also, old and integration with upcoming new technologies and processes that can improve performance, such as graphene dipole antenna on paper substrate UHF RFID, and inert gas sensor integration such as carbon nanotube and some processes such as CMOS process, 3D printing, etc. Introduction to Integration. RFID sensor technology. It has seen a wide range of capabilities while ensuring use or practicality without RFID IoT (Internet of Things) applications or technologies such as smart agriculture, vehicles, smart pollution and home etc. and with different environmental characteristics such as high pressure, humidity, temperature etc. For this, the RFID sensor should not be exposed to the RF wave (information) transmitted through the RFID sensor like a metal building block or near water. Due to the close environment of the DUT (the device under test), there is no need for high electrical conductivity and high permittivity of the material, as the minimum space at that location is in an empty and reliable magnetic field. At the end of the observation, errors will arise with simplification, but usually, it depends on the very high magnetic field strength accessible to the RFID chip.

- *Reference of Consequence: -*

Emphasise hypothetical resonant frequency, which is the frequency that can be used to execute a system in a low amount of magnetic field. By using this frequency, we can achieve an extreme amount of energy to distance ratio.

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