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Design an antenna as a sensor for aqueous Glucose Measurement

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Abstract- *The paper presented here is an effort to document the design of microwave ring resonator for non-invasive blood glucose measurement. The sensor was designed on Sonnet lite project editor which is a microwave ring resonator. Sonnet lite project editor® which is freeware for microwave simulation. Robust model of dielectric properties of blood as a function of glucose concentration needs to be investigated taking into consideration all the environmental effects to design a reliable sensor. The simulation results of ring resonator show that there is change in resonant frequency as the concentration of aqueous glucose increases.*

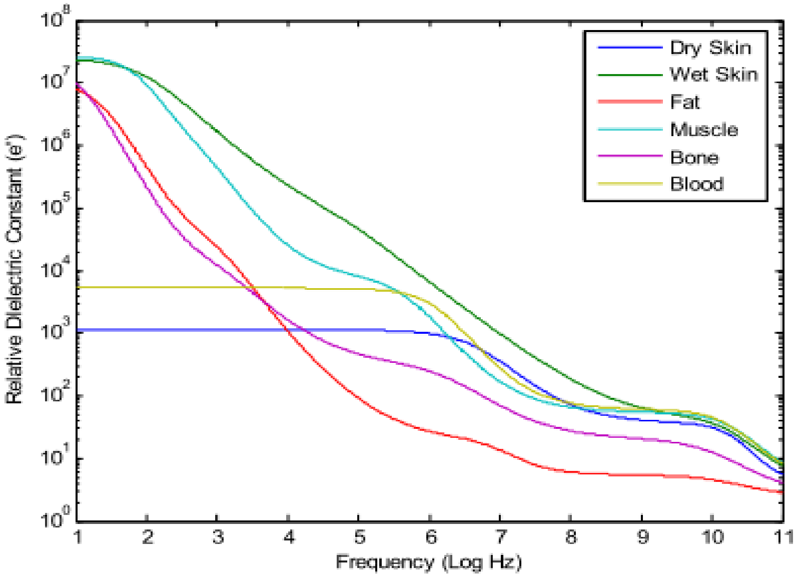
Keywords: *Non-invasive, Glucose measurement, Diabetes, Impedance, Dielectric.*

"I. INTRODUCTION"

In recent years, diabetes is one of the most increasing diseases. According to the International Diabetes Federation (IDF), the number of the diabetics in the world was about 415 million in 2015 it is estimated to grow about 642 million in 2040.The acceptable range of glucose concentration is from 70mg/dL (milligram of glucose in 100 milliliters of blood) to 110 mg/dL .But soon after eating glucose concentration of a person this level may be rise up to 180 mg/dL.[3]
There are 2 techniques for blood glucose measurement such as invasive and non-invasive methods.Measurement of Glucose concentration in the blood of a diabetic patient should be done 1-4 times a day .[1]In invasive method we have to take blood of diabetic person and glucose measurement can be done using certain chemical reaction but this technique is very painful and costly so non -invasive technique come into market.

"II. MICROWAVE PROPERTIES"

Microwaves are form of EM radiation with wavelength from one meter to one millimetre with frequency between 300MHz to 300 GHz. The property monitored by microwave sensor is permittivity. Permittivity is measure how muchelectrical energy a material stores and dissipates when it is in an electric field
In order to understand Microwave it is important to understand to understand dielectric properties of tissue. These tissues include skin, fat, muscle and most importantly blood. The relative dielectric constants of this tissue s have been extensively researched [3].To compute permittivity of different cells over broad frequency range the Cole-Cole model is used.



"Fig.1-Relative dielectric constants of certain tissues in the frequency range of 10 Hz to 100 GHz"

"III. DESIGN OF MICRO STRIP RING RESONATOR"

A microwave resonator was designed using Sonnet Microwave Simulation Studio Suite v 14.53. A standard FR4 substrate with dielectric constant 4.4, PCB material is used in the designing as shown in figure 2.

The design formulas relating the dimension and the resonant
Frequencies are as follows:

$2\pi r = n\lambda_g$ n=1, 2, 3…

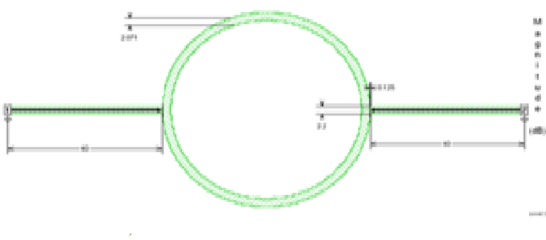
$$f = \frac{c}{\lambda_g \sqrt{\varepsilon_{reff}}}$$

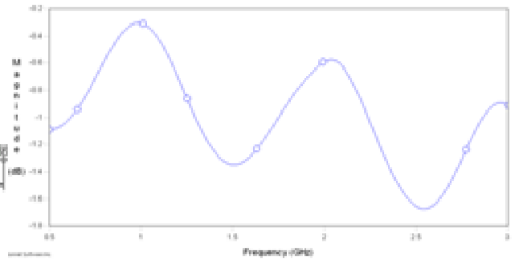
Coupling gap	0.125 mm
Thickness of substrate	1.6 mm
Width of ring	2 mm
Length of feed line	40 mm
Inner radius	22 mm
Outer radius	24mm

"Table 1.Specification of Ring Resonator"

"IV.SIMULATION"

The frequency range was selected from 0.5 GHz to 3GHz.The designed antenna resonates at multiple of 1 GHz frequencies.

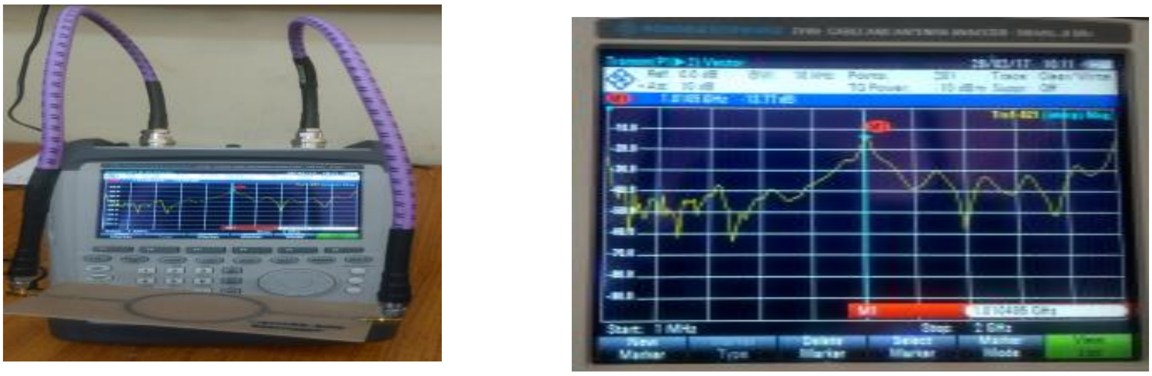




"Fig.2-Ring Resonator""Fig.3-Frequency Response of Ring Resonator"

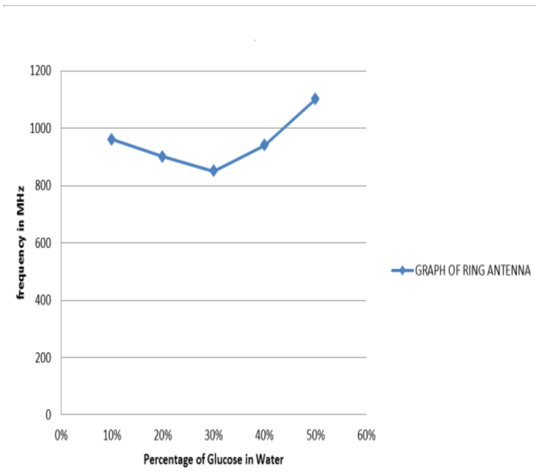
"V.HARDWARE DESIGN"

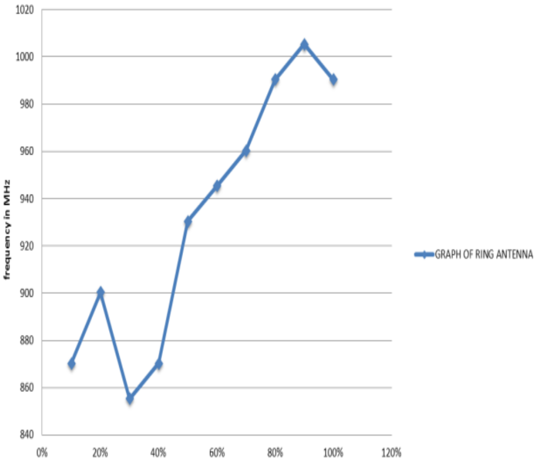
All measurements were taken at room temperature using a ROHDE & SCHWARZ ZVH8 vector network analyzer.VNA is tool which determines the S-parameters of microwave circuit over range of frequencies. VNA Range-100KHz to 8GHz.The frequency range was selected from 0.5 GHz to 3GHz.



“Fig.4-Antenna Simulation with VNA”

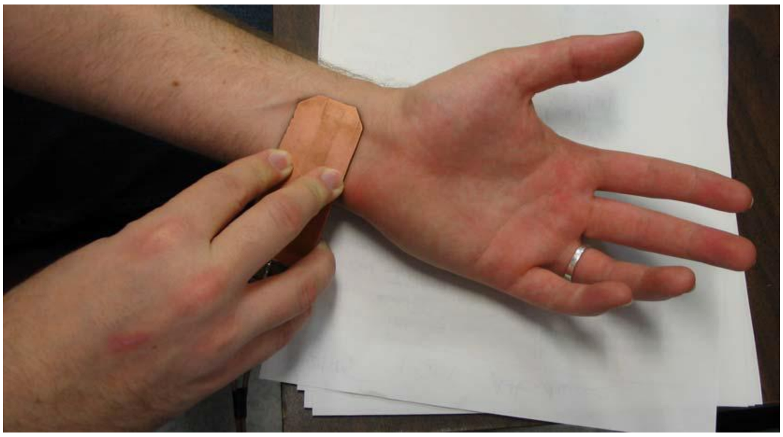
“VI.SIMULATION AND HARDWARE RESULT”





“Fig.5- Simulated Graph of Ring Antenna”“Fig.6- Practical Graph of Ring Antenna”

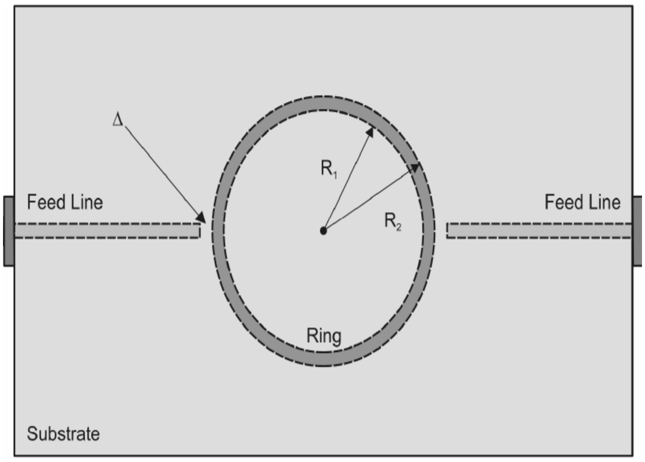
“VII.PLACEMENT OF SENSOR”



“Fig.7- Sensor located at the wrist measuring-site”

Microwave sensor placed on muscle rather than fat.The possible choices for the placement of the sensor are medieval side of bicep and Volar part of Wrist.The antenna was placed on the volar part of the wrist as seen in fig.7.[2]

"VIII. ANTENNA WORKING"



"Fig 8-Functional diagram of antenna"

When a signal enters the ring from coupling gap(Δ) on the left, the energy coupled into the ring splits equally over top and bottom of ring. this produces a standing wave such that when ring is in resonance, the maxima of wave occurs at coupling gaps and nulls are at top and bottom of the ring.

"IX.ACKNOLEDGMENT"

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"X.CONCLUSION AND FUTURE SCOPE"

Simulated and experimented result of circular ring resonator shows that as the concentration of aqueous. Glucose increases there is change in S21 (transmission coefficient) parameter of antenna.It would be non-invasive glucometer that diabetics can use on daily basis[2].

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