Bioimpedance Analysis Technique To Analyse Body Composition

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ABSTRACT: Bioelectrical impedance analysis (BIA) is simple ,Non invasive, low cost widely used method for estimating body composition .This paper reviews the main concept of bio-impedance measurement technique including frequency based and real time bio-impedance analysis system and measurement of Blood Pressure and Electrocardiography. BIA methods operating at 50kHz (single frequency) 1 to 100kHz (dual frequency) and 5 to 500kHz(multi frequency) were used on human body for estimation of their body composition .By using AD5933 IC we can measure impedance .It allow to use AD5933 IC in two electrode configuration.BIA provides information related to degree of hydration and nutrition in human body. Multi-frequency BIA method give significantly different range of Fat Mass(FM) ,Fat Free Mass(FFM) and Total Body Water(TBW). This paper gives information of principle of electricity needed to comprise in related bio-impedance and body composition.

KEYWORDS: Bioelectrical impedance, fat mass, fat free mass, total body water ,blood pressure, electrocardiography, clinical status monitoring ,disease diagnostics

I. INTRODUCTION

Lots of techniques which are costly and having long time requirement are present to estimate body composition, now a days Bioelectrical impedance analysis [BIA] method is mostly used[1]. Bio-impedance can be measured by applying a small current in mA at set frequency. Then current is injected into body through a pair of electrode and voltage is obtained using same pair of electrode .This voltage is converted into real and imaginary form. By using real and imaginary part bio-impedance is measured with the help of AD5933 IC [Refer fig.1] and measured value is transferred to ARM7 LPC2138 [2].

The human body has a number of electrical properties. One of the property is bioimpedance. This impedance is a measure of how well the body interrupt to electric current flow.

II. METHOD:-

Mainly measurements using AD5933IC are affected by interfacing impedance between the electrode [3]. The bio-impedance (Z) it is a complex quantity which consisting of resistor (R) indicating total body water and reactance (Xc) which is capacitance of the cell[4].Equation (1) indicates the formula to calculate impedance.

$Z=R+jXc$ ……..(1)

The magnitude of impedance can be given as,

$Magnitude= (R^2 + Xc^2)^{½}$ ….....(2)

Impedance=1/(gain factor * magnitude) …….(3)

BIA used for estimating body composition such as FM, FFM and TBW. By using bio-impedance we can calculate body composition parameter such as:

Gain factor =(1/Impedance)/Magnitude …….(4)

TOTAL BODY WATER:

TBW= (0.372 * Height / Impedance) + (3.05 * Sex)

+ (0.142 * Weight) - (0.004 *Age) …..(5)

Where, height is in centimeter

Sex= 1 for sex

Sex= 0 for female

Age is in years

The human body composition refers to proportionality of TBW , FM and FFM in the body. A healthy body composition that includes a lower proportion of fat mass and higher proportion of fat free mass. Total body water that consists of extracellular fluid (ECF) and intracellular fluid(ICF).

FAT FREE MASS:

FFM=TBW/0.732 ……(6)

FAT MASS:

FM=Weight – FFM ……...(7)

BODY FAT IN PERCENTAGE:

Body Fat% = (FM/Weight) * 100 ……..(8)

BIA is a technique for calculating the body fat percentage based on electrical properties of biological tissues. Body weight is percentage consisting of adipose

tissues.FM use to define the existence of overweighting [5]. BIA is used for detection of improper balance in your body composition, due to which current state of health is known.

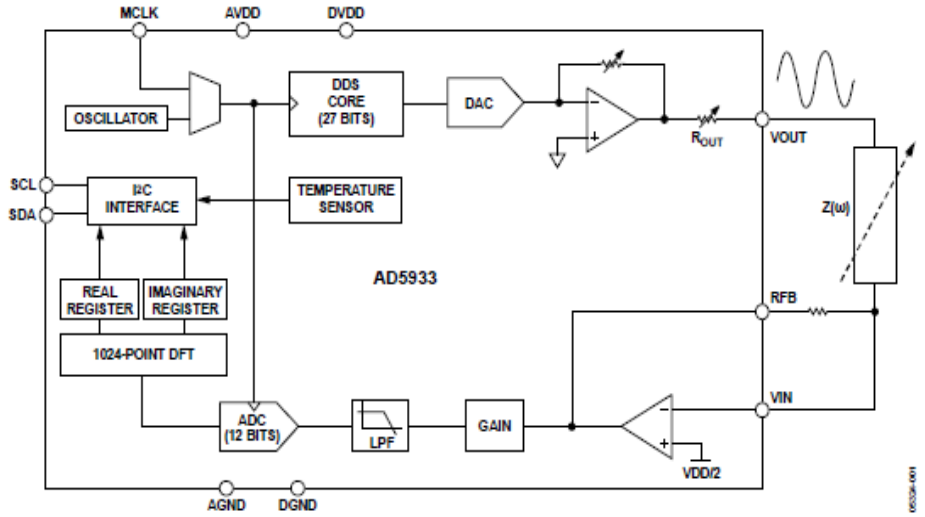

Fig.1 Functional Block Diagram Of AD5933 IC

III. TECHNIQUE:-

The bio-impedance it is a technique for calculating TBW, FM and FFM which is present in human body.

The procedure to calculate impedance is as below :

1.Initialize the hardware.

2.Set frequency (starting) in microcontroller through program code.

3.Then enter a frequency which is set by microcontroller to AD5933.

4.If a frequency is set then convert into current.

5.Else increment frequency and convert it into current.

6.Current signal is passed by using two electrodes connected to the body and voltage is received[Refer fig.2].

7.Then waveform of current and voltage are seen on DSO.

8.AD5933 converts received voltage into impedance in real and imaginary part.

9.By using impedance TBW, FM and FFM is measured.

10.This data is transfered to microcontroller.

11. Microcontroller reads data and then transfer it to PC for preparing database.

12.Visual Basic (VB) software PC is to store the data at a particular time and day. It can store data in the form of GUI.

13.Microcontroller then transfers data to GSM for doctor use[Refer fig.3].

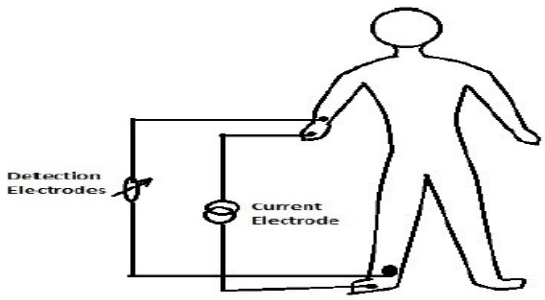

Fig.2 Placements of electrodes

IV. PRINCIPLE OF BP SENSOR :-

The BP sensor receives 5 volt Dc signal from power supply. And such a signal passed to body through electrode. According to voltage blood pumped through muscle by heart causes the arterial walls. When a cuff is placed around upper arm to brachial artery is inflated and then slowly flatten at constant rate, an arterial pressure pressure pulse forms. These pressure pulse pass from heart, through arm and into pressure cuff itself. Passing such pressure(in the form of electrical signal voltage) to microcontroller through electrode[Refer fig.3].

V. PRINCIPLE OF ECG SENSOR :-

ECG Sensor consist of red LED and light detector. The LED needs to be spread maximum light that pass through finger and detected by light detector. When heart pumps a pulse of blood is passes through blood vessels. But our finger are not transparent, so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified through an amplifier which outputs analog voltage between 0 to +5V logic level signal[Refer fig.3].

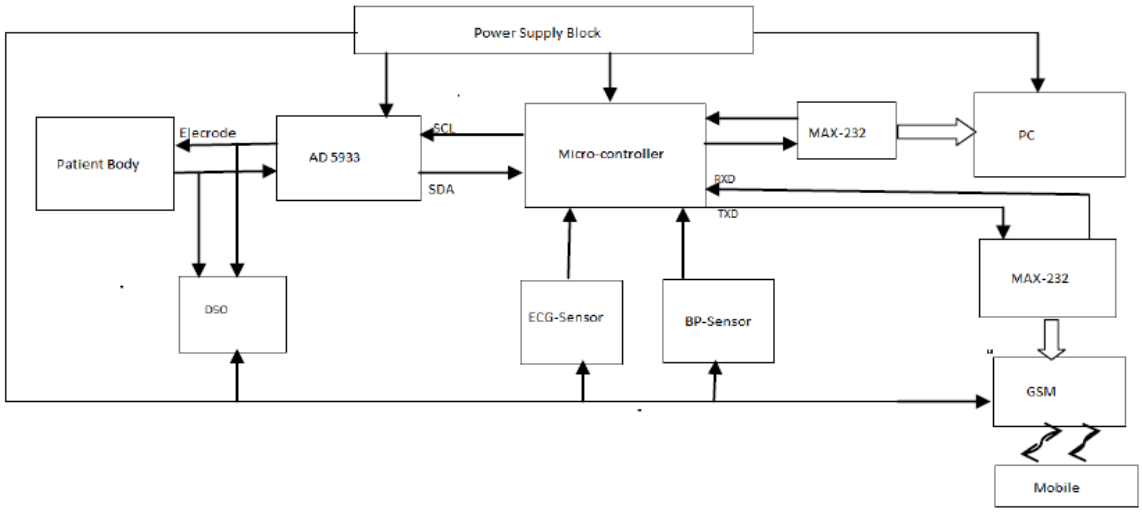

Fig.3 Block Diagram Of Bioimpedance Analysis

VI. CONCLUSION:-

BIA gives presence of water in human being. With the help of BIA measurement of FM, FFM and TBW can be done. By measuring water level in body in percentage the state of body lies in hydrated or dehydrated is known. BIA equipment allows determination of patient .Bioimpedance can be used to detect the diseases like kidney stone, typhoid, cholera etc. BIA is useful technique for body composition analysis in healthy persons. Also we can measure blood pressure and heart rate.

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