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PSoC based haemoglobin measurement system

Meera N.

97rasika@gmail.com

SRM Institute of Science and
Technology, Chennai, Tamil Nadu

Akilandeswari S.

smakila98@gmail.com

SRM Institute of Science and
Technology, Chennai, Tamil Nadu

Revanth S.

chotu.rev@gmail.com

SRM Institute of Science and
Technology, Chennai, Tamil Nadu

Venkata Vivek

vivekwuppukonduru@gmail.com

SRM Institute of Science and
Technology, Chennai, Tamil Nadu

Veera Amudhan

rvamudhan@gmail.com

SRM Institute of Science and
Technology, Chennai, Tamil Nadu

ABSTRACT

5 A hemoglobin test appraises the proportion of hemoglobin in the blood. Hemoglobin is a protein in the red platelets that passes on oxygen to the body's organs and tissues and transports carbon dioxide from the organs and tissues back to the lungs. In the event that a hemoglobin test uncovers that the hemoglobin level is lower than normal, it deduces that the individual has a low (Red Blood Cell) RBC check (iron deficiency). If a hemoglobin test exhibits a higher than run of the mill measurement, it infers that the individual has a high RBC check (polycythemia). Hemoglobin estimation is finished with the assistance of heartbeat oximetry. The beat oximeter utilizes (Light Emitting Diodes) LEDs to emanate light at various wavelengths. This model is structured utilizing (Programmable System on Chip) PSoC, a microcontroller created by Cypress Semiconductor. This aide in diminishing the utilization of outer parts. The computerized qualities that are gotten from the model are interfaced with the SIM 300 GSM module. On the off chance that the information got is anomalous, a message is sent to the number that is given on the product program.

Keywords— Haemoglobin, PSoC, LED

1. INTRODUCTION

The air took in from nature contains oxygen. As the air is taken in, it gets worked up with hemoglobin with the help of a layer. The oxygenated circulatory systems to the heart from where it is passed on to the whole body. From the tissues, the carbon dioxide is expelled out from the lungs. This method of taking in oxygen and breathing out carbon dioxide is called breath. The technique of oximetry implies the spectrophotometric estimation of the dimension of oxygen submersion (SPO₂). This is the general proportion of oxygen in the blood. This sensor gadget is resolved to an unstable piece of the patient's body, by and large, a fingertip or ear tendon, or by the prudence of a newborn child, over a foot. The gadget passes two wavelengths of light through the body part to a photodetector. It checks the changing

absorbance at all of the wavelengths, enabling it to pick the absorbances. The blood oxygen screen shows the component of blood that is stacked with oxygen. Considerably more explicitly it assesses what measurement of haemoglobin, the protein in blood that passes on oxygen, is stacked. Palatable ordinary degrees for patients without pneumonic pathology are 95 to 99 percent. For a patient breathing room air at or near ocean level, a measure vein pO₂ can be conveyed using the "blood-oxygen screen" submersion of outskirts oxygen" (SpO₂).

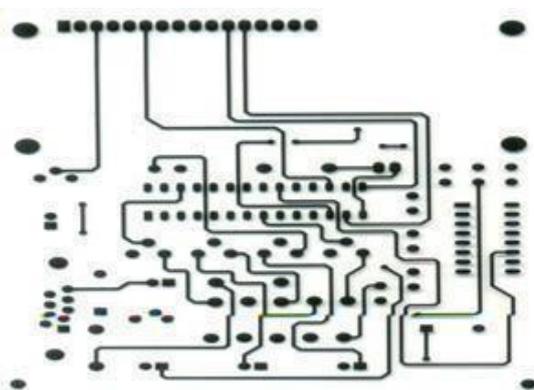


Fig. 1: PCB design of pulse oximeter circuit

Figure 1 represents the complete PCB design layout of the Pulse oximeter.

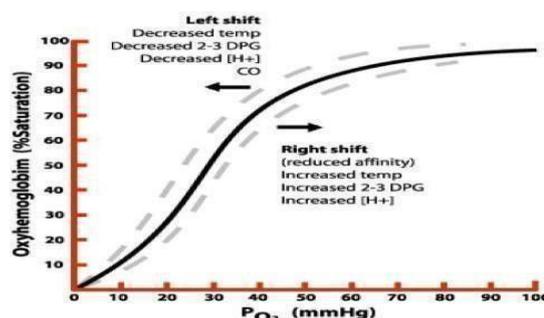


Fig. 2: Oxygen-hemoglobin dissociation curve

2. PRINCIPLE OF OPERATION

The blood on getting oxidized in the tissue ought to be checked for the submersion of oxygen. An ordinary beat oximeter uses an electronic processor and a few minimal lights exuding diodes, going up against a photodiode through a for all intents and purposes a translucent bit of the patient's body, like ear ligament or fingertip. One LED is infrared, with a wavelength of 940 nm, and the other is red with a wavelength of 660 nm. Retention of light at these wavelengths separates fundamentally between blood stacked with oxygen and blood lacking oxygen. Oxygenated hemoglobin holds powerfully infrared light and engages continuously red light to involvement. Deoxygenated hemoglobin enables dynamically infrared light to involvement and acclimatizes constantly red light.

The LEDs succession through their cycle of one on, at that point the other, at that point both off around thirty times each second which permits the photodiode to respond to the red and infrared light independently and besides change for the including light standard. The measure of light that is transmitted is assessed, and separate institutionalized signs are created for every wavelength.

These signs influence in time in light of the way that the extent of vein blood that is open enlarges (truly throbs) with every heartbeat. By subtracting the base transmitted light from the peak transmitted light in every wavelength, the impacts of different tissues are adjusted for. The extent of the red-light estimation to the infrared light estimation is then controlled by the processor (which addresses the extent of oxygenated hemoglobin to deoxygenated hemoglobin), and this extent is then changed over to SpO2 subject to the Beer-Lambert law.

2.1 Beer-Lambert Law

The hemoglobin estimation framework chips away at the guideline of Beer-Lambert Law. The lessening of the light going through a uniform medium happens because of the nearness of engrossing substance. Brew's law depends on the whole of transmitted and retained light property that measures up to the episode light.

Heartbeat oximeter is a medicinal gadget that in a roundabout way screens the oxygen immersion of a patient's blood (rather than estimating oxygen immersion specifically through a blood test) and changes in blood volume in the skin, conveying a photoplethysmogram. The beat oximeter may be combined into a multi-parameter understanding screen. Most screens additionally show the beat rate.

Helpful, battery-worked beat oximeters are in like manner available for porting or home blood-oxygen watching.

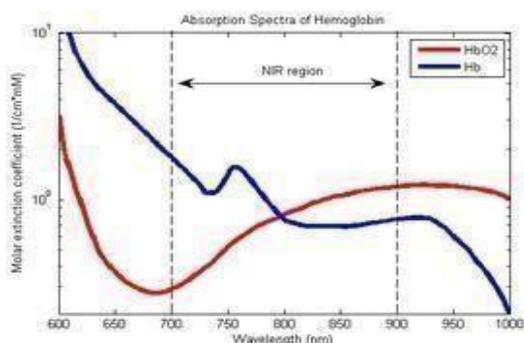


Fig. 3: Absorption spectra of Hb and HbO₂

Figure 3 represents the absorption spectra of Hb i.e. deoxyhemoglobin and HbO₂ that is oxyhemoglobin.

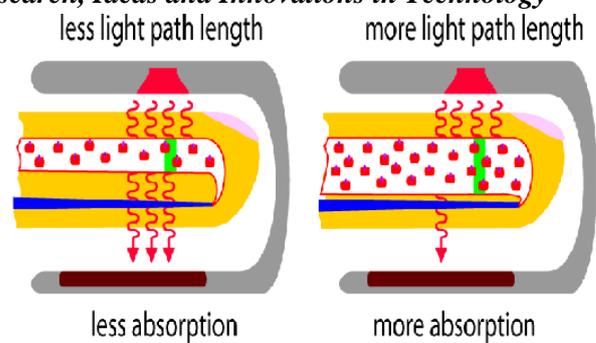


Fig. 4: Absorption differentiation

Figure 4 unmistakably shows the distinction between the low fixation and the high centralization of the hemoglobin particles in the blood. At the point when the hemoglobin atoms are of fewer particles, the light way length is less and the consumed measure of light is little. Though, when thick hemoglobin particles are available, the light way length expands and a measure of light ingested increments.

Beer - Lambert's law may be expressed as follows,

$$-dI / dt \propto I$$

$$-dI / dt = KI \tag{1}$$

Where

I = intensity of incident light,
t = thickness of the medium,
K= proportionality constant

By integrating equation (1), and putting I=I₀,

When t=0,

$$I_0 / I_t = kt \text{ or } I_t = I_0 e^{-kt}$$

Where,

I₀ = intensity of the incident light

I_t = intensity of the transmitted light

k = constant which depends upon wavelength and the absorbing medium used.

By changing the above equation from the natural log, we get,

$$I_t = I_0 e^{-Kt}$$

Where K = k/ 2.303

So,

$$I_t = I_0 e^{-0.4343 kt}$$

$$I_t = I_0 10^{-Kt}$$

2.2 Prototype Design

The model planned here comprises of an equipment circuit that incorporates a microcontroller called Programmable System on Chip (PSoC).

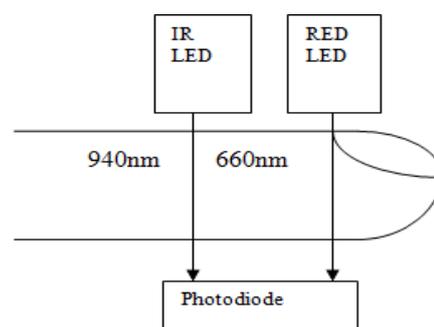


Fig. 5: Transmission type of sensor

Figure 5 demonstrates the transmission type sensor that comprises of LED's of various wavelength and a photodiode. The measure of hemoglobin which is oxygenated can be found by figuring the assimilation at various wavelengths.

2.3 Block Diagram

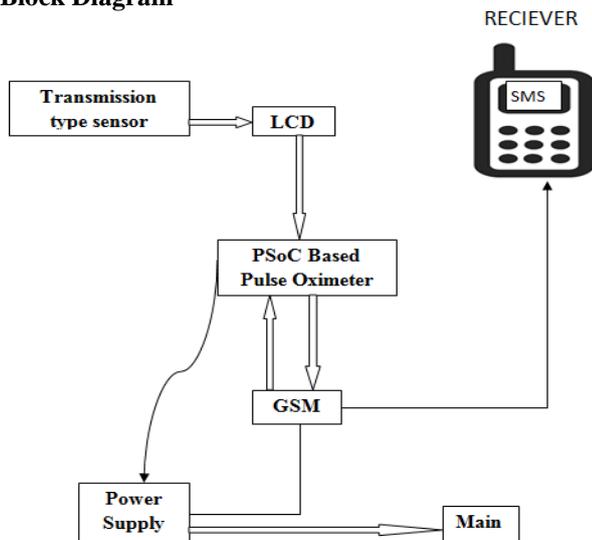


Fig. 6: Block diagram of the design

The square chart of the model plan has appeared in figure 6. The PPG motion from the transmission type sensor is transmitted to PSoC oximeter. The deliberate estimation of hemoglobin is shown on the LCD show and the message is sent to the specialist through GSM that is connected to the PSoC board in the event of anomalous estimations of hemoglobin.

3. PSoC ARCHITECTURE

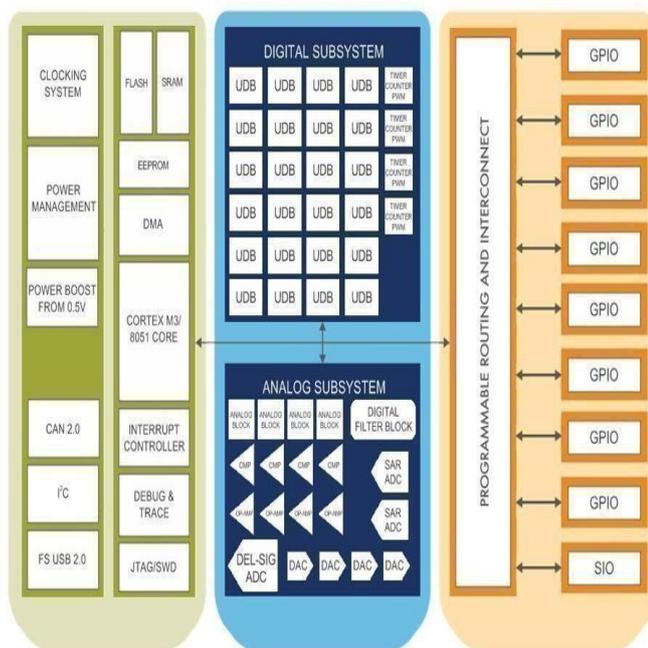


Fig. 7: PSoC creator architecture

Figure 7 portrays the engineering of PSoC Creator. The highlights of PSoC are:

- (a) 8051 focal handling unit (CPU) with a settled vectored intrude on the controller and an elite DMA controller.
- (b) Several sorts of memory component including SRAM, blaze and EEPROM.
- (c) System coordinating highlights, for example, timing, a component rich influence framework and flexibly programmable sources of info and yields.

- (d) The digital framework that incorporates configurable all inclusive computerized squares and explicit capacity peripherals.
- (e) The analog framework that incorporates configurable exchanged capacitors and nonstop time squares.

4. OPERATION OF GSM

Worldwide framework for versatile correspondence (GSM) is a design utilized for portable correspondence in the vast majority of the nations. The GSM modem utilizes both FDMA (Frequency Division Multiple Access) and TDMA (Time Division Multiple Access) in the transmission and gathering of data. The bearer recurrence band of GSM modem is around 900 MHz or 1800 MHz.

The GSM modem utilizes information bundles at the explicit time and points of interest recurrence and is associated with the power supply with the assistance of a DC jack. The DC jack is associated with a power supply of 12 V. The capacity of GSM modem in this model is to make an impression on the specialist on the off chance that the patient's hemoglobin level isn't in the ordinary range.

5. RESULT AND CONCLUSION

The model plan speaks to another degree for implanted framework structure in the field of restorative innovation. The plan of the hemoglobin estimation framework is satisfied by the guideline criteria. The PSoC based microcontroller circuit is expressly intended for the modern market, which is vigorous, practical and conservative.

The PSoC microcontroller assumes an imperative job in structure and advancement of the equipment circuit. The PSoC Creator programming client modules and its capacities help in the decrease of equipment cost. The GSM modem helps in imparting information which decreases the dangers and fatalities and the patient's readings cause' specialists and paramedics to react rapidly in crisis circumstances. In light of the readings acquired, a specialist or the paramedic group can investigate and act as indicated by the patient's wellbeing status and conditions.

6. FUTURE SCOPE AND ENHANCEMENT

The proposed framework keeps running on a controlled power supply and henceforth can be changed to the use of batteries. They can likewise be substituted with battery-powered batteries. Further improvement is to incorporate Glucose, ECG, and Cholesterol sensors to make the framework progressively powerful and flexible. The framework can be made wearable; size can be diminished and can be made convenient.

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