# BLOOD GROUP DETECTION USING FIBER OPTICS

**[1]PRAMOD KAKARLA, [2]MURARI YASHWANTH K, [3]SRIKANTH PVNK, [4]RISHI KUMAR R, [5]PRATIBHA N**

Amrita viswa Vidyapeetham, Coimbatore
E-mail: pramod.kakarla92@yahoo.com, murariyashwanth@yahoo.com, srikanth22@rocketmail.com, wrizzhi@gmail.com, n_pratibha@cb.amrita.edu

**Abstract-** Identification of blood group plays a vital role in the medical field for any treatment. Miss-transfusion of blood will lead to many complications. This paper provides an easy and fast means of identification of blood groups. The difference in the amount absorption by each blood group is exploited so as to categorize the blood groups. The light from the pulsating IR LED is passed through the blood sample via an Optical Fiber Cable (OFC) and the transmitted light is then detected, conditioned and is converted into voltage signal. The variations in the intensity of the received signal due to the absorption of blood for different blood groups are translated into corresponding voltage changes, to classify the blood groups.

**Index Terms-** Blood groups, HFBR1415TZ IR LED, Optical fibers, Optical properties, PIN photodiode, Receiver, Transmitter.

## I. INTRODUCTION

In modern electronic communications, fiber optic system plays a prominent role. The principle of fiber optics is used in many modern medical electronic fields like endoscopic devices. The first and foremost thing a doctor does while treating patients met with an accident is to determine patient's blood group. On an average, a doctor takes 10 minutes to find the blood group. In emergency cases, even 10 minutes delay in transfusion of blood may lead to the death of the patient. Hence, determination of blood group of a patient met with an accident, within a very short span of time is a vital factor.

So far, blood grouping is done in laboratories or hospitals either by manual method using slide, or tile method or by semi-automated method using gel technology [1] .Whereas all these processes are laborious and time consuming (takes at least 10 minutes). Hence, there is a need to develop a device which can detect the blood group within seconds. This paper provides the easy and fast semi-automated method to determine the blood group using fiber optics.

Fiber optics is playing prominent role as a biomedical sensor such as blood flow and humidity measurement because of its flexibility and using low light power for sensing purposes [2]. In this work, Optical fiber was used as a medium to transmit pulsating light. This light is then passed through the blood sample and the variation in the intensity of light is measured based on which the blood groups are determined.

The main principle on which this project is based on is that the optical properties like absorption will be different for different blood groups [3].

## II. DESIGN

Figure 1 shows the block diagram of a Blood Group Detection system implemented through fiber optics.

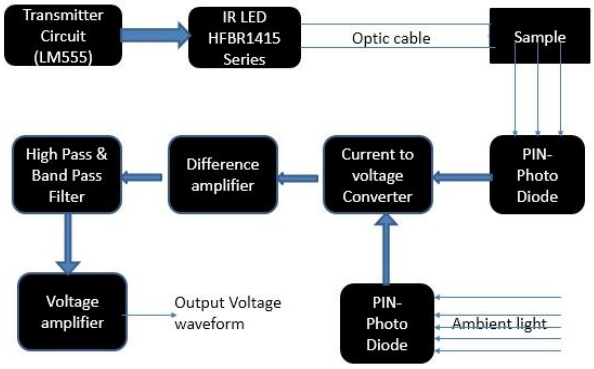



**Figure 1.Block diagram of the Blood group detection system**

### A.Transmitter

The receiver circuit consists of an arrangement to keep the blood sample and to allow light from optical cable to pass through the blood sample the transmitter circuit see( Figure 1)generates the electrical pulses of frequency 3.5kHz which acts as an input to the IR LED.HFBR1415z series IR LED takes the electrical pulses as an input and converts into optical pulses. These optical pulses are then coupled into the multimode fiber optic cable [4] as shown in Figure 2.

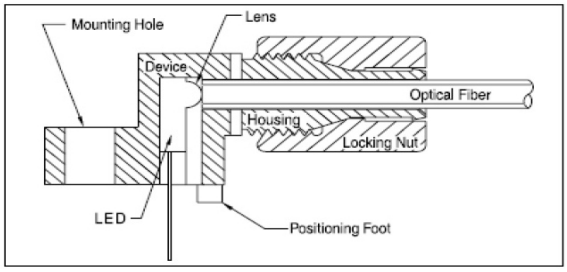



**Figure 2. Coupling of light to optical fiber**

The light received from the other end of the optical cable is then passed through the blood sample. The receiver acquires the transmitted optical light from blood sample, and converts this optical light back into electrical signal and the voltage levels corresponding to different blood groups are measured.

Using LM555 timer [5] in astable configuration (see Figure 3) an electrical pulses of frequency 3.5 kHz is generated. These electrical signals are then converted into optical signals and are fed into the optical fiber.

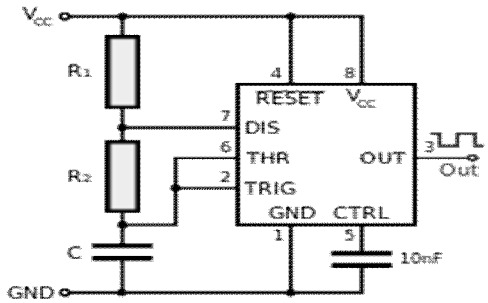



**Figure 3. Transmitter to generate electrical pulses of frequency 3.5 kHz.**

A. Receiver

The receiver circuit consists of an arrangement to keep the blood sample and to allow light from optical cable to pass through the blood sample, instrumentation amplifier to eliminate the ambient light, high pass filter for the removal of DC, band pass filter for obtaining a noise free signal and a voltage amplifier.

1) Black box arrangement

Figure 4 shows the placement of the blood sample. A small amount (few mg) of heparin is added so as to avoid the coagulation of blood. This is done to ensure that the absorption property of blood does not vary during the measurement.

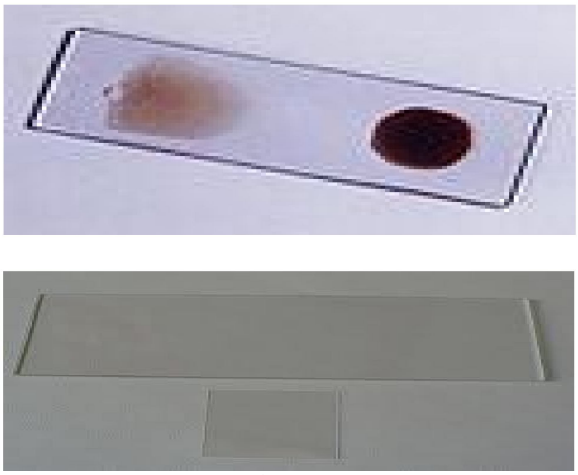


**Figure 4. Showing placement of blood sample in between microscopic glass slide and cover slip.**

This slide is then placed in a specially designed black box or wooden box as shown in Figure 5. This Black Box keeps the white light from falling on the photodiode. The main reason for the introduction of this covering for the IR sensor is to eliminate the change in the absorption of the blood due to the white light and thus helps in avoiding errors in the measurements.

Two photodiodes are placed in either compartments of the black box. The blood sample is placed in the right compartment and light from the optical fiber is passed through the blood sample and the transmitted light is then detected by the photodiode in that compartment. The photodiode in the left compartment detects only the ambient light. The ambient light cancellation is necessary as the photodiode responds to both ambient light and the light transmitted through the blood sample, which in turn introduces an error in the output. Thus, by placing a differential amplifier at the output of this module, ambient light effect on the IR receiver placed in the right compartment is cancelled out.

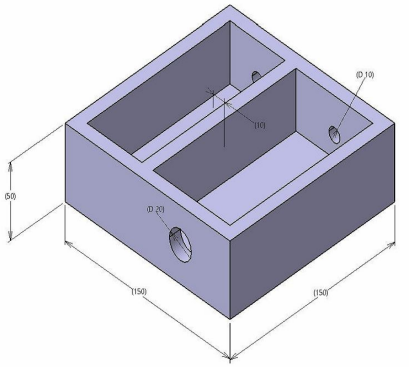



**Figure 5. Wooden box covering designed for IR sensor to remove the effects of ambient light (all dimensions are in mm)**

**2) Instrumentation amplifier**

The photodiode in the right compartment detects both ambient light and the transmitted light from the blood sample whereas the photodiode in the left ompartment detects only the ambient light [5].

Now these two photodiodes converts their respective light into currents and this currents is converted into voltages through I-to-V converter. These are then given as inputs to the instrumentation amplifier as shown in Figure 6 so that the ambient light effect on photodiodes are cancelled out.

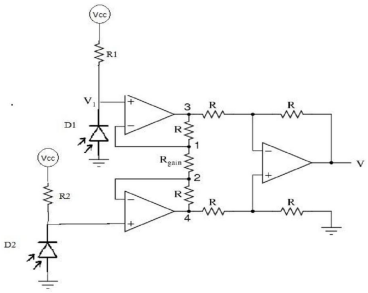



**Figure 6. Instrumentation Amplifier**

3) High pass filter

The voltage from the instrumentation amplifier is then fed to the high pass filter to eliminate any dc signals if present[6].The high pass filter is a second order sallen-key filter of cut-off frequency 72Hz and quality factor of 0.707 and a gain of 1. as shown in Fig 7.

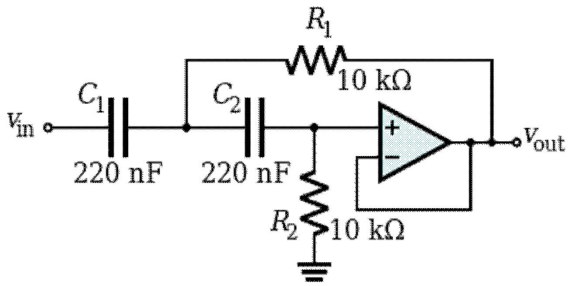



**Figure 7. High pass filter with Fc = 72Hz**

4) Band pass filter

The resultant signal from the high pass filter is then passed through the band pass filter (see Figure 8) with band pass frequency of 3 to 4 kHz, mid band gain = 1 and quality factor is 0.5 and then amplified to remove noises and for improving the accuracy [6]

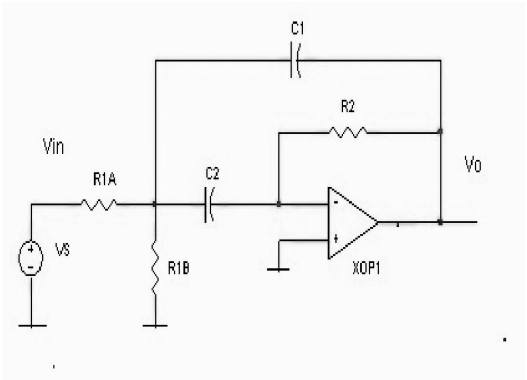



**Figure 8. Band pass filter (Bandpass frequency of 3-4 kHz)**

## II. RESULTS

A. Transmitter

The transmitter circuit is shown in Figure 9 and the electrical pulses generated from the timer circuit are shown in Figure 10 with a peak to peak voltage of 4V and 3.5 kHz frequency.

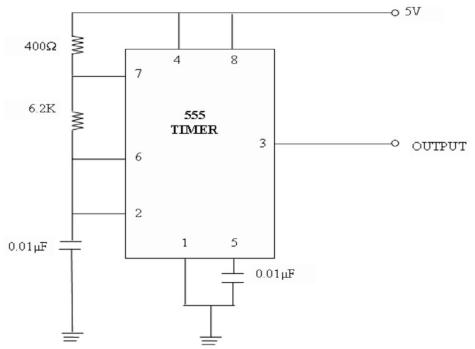



**Figure 9.Transmitter to generate electronic pulses.**

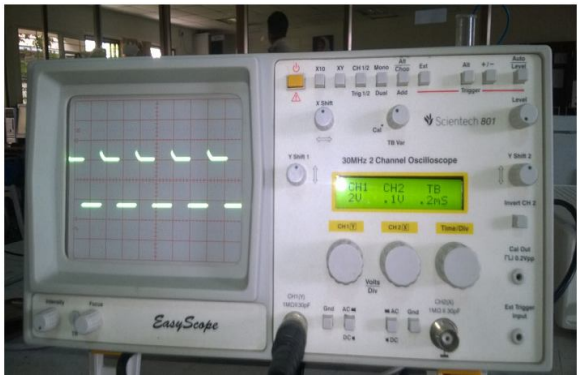



**Figure 10. Output from the transmitter circuit.**

3.2 Receiver

The generated signal from the timer circuit is converted into optical signal and coupled into the optical fiber.

Then the transmitted light from the blood sample is detected by the receiver circuit as shown in Figure 11.

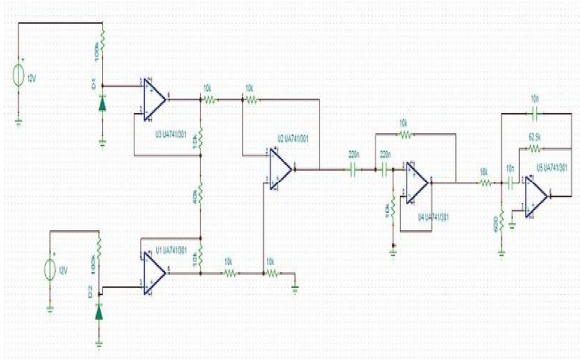


**Figure 11. Receiver circuit containing instrumentation amplifier, high pass filter and band pass filter.**

The obtained voltage signal from receiver is as shown in Fig 12.

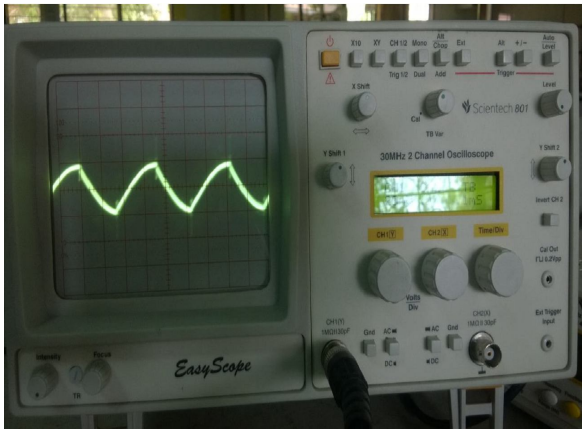



**Figure 12. Output from the receiver circuit.**

C. Characteristics of photodiode

Photodiode has been characterized in photo conductive mode and graph has been plotted for current through LED vs. output voltage of photodiode. Current through IR LED is varied by changing its input voltage and the photodiode detects and converts

the incident light on it into voltage from several distances (see Figure 13).

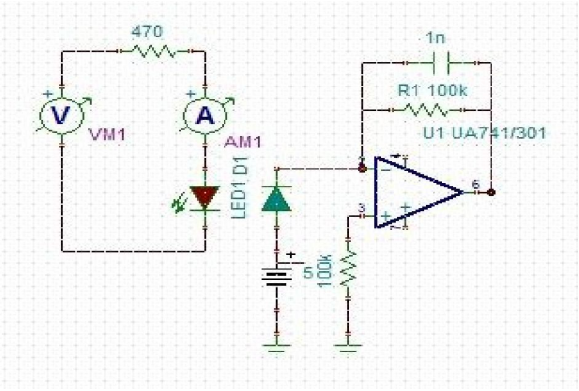



**Figure 13. Circuit to characterize the photodiode.**

The plot of change in current vs. change in voltage for different distances between LED and photodiode is as shown in Figure 14.

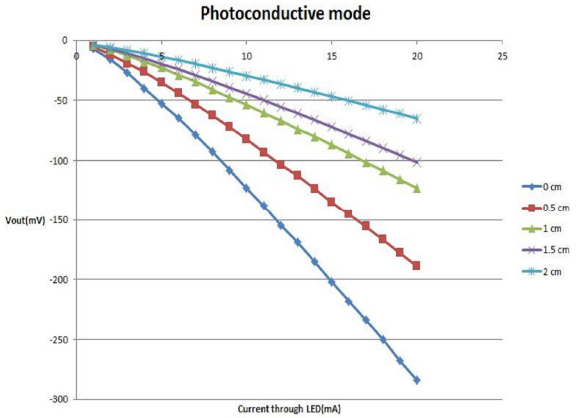



**Figure 14. Characteristics of a photodiode (current through LED vs. $V_{out}$) for different distances.**

## CONCLUSION

After experimenting with several blood samples the following voltage ranges are determined for each blood group.

**Table 1. Classification of Blood Groups based on the voltage levels obtained as output**

| BLOOD GROUP | VOLTAGE LEVELS(V) GAIN=80 |
|---|---|
| A | 2.40-2.48 |
| B | 2.20-2.36 |
| O | 2.12-2.18 |
| AB | 2.02-2.10 |

## FUTURE WORK

In this paper, absorption is the only optical property that is taken into consideration for the detection of blood group. If other optical properties like scattering and reflection are taken into account, then we can also measure the Rh factor of the blood group and hence distinguish positive and negative blood groups.

## ACKNOWLEDGMENTS

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## REFERENCES

[1] Rosenfield, RE, Kochwa, SE, and Kaczera, Z: gel technoogy for the study of human erythrocyte antigen-antibody reactions. Proceedings, Plenary Session, 25th Congress, International Society Blood Transfusion. Paris, 1978.

[2] Mignani A.G, Baldini .F, 'Biomedical sensors using optical fibers', Research institute on Electromagnetic Waves NelloCarrara', Florence, Italy, pp.1-28, 1996

[3] Baranski G V G, 'On the Modeling of Light Interactions with Human Blood', University of Waterloo, Technical Report CS-2011-30, December, 2011.

[4] Jeff Hecht, Understanding fiber optics. New York: McGraw Hill, 1993.

[5] Adel S. Sedra, Kenneth C. Smith, Microelectronic circuits. London: Oxford University Press, 2004.

[6] Ron Mancini, 'Op Amps for Everyone', Design Reference, Chapter 16, August, 2002.

[7] George kalkanis, 'Hands-on Educational Experiment with LEDs, Optical Fibers and Photodiodes, proceedings of the 7th international conference on Hands-on Science, University of Athens, pp. 366-371, 25-31 July 2010.

[8] David A. Johnson, 'Handbook of Optical through the Air Communications', pp.43-58, Chapter 6, 2008

[9] Arthur C. Guyton, 'Textbook of Medical Physiology', pp. 451-455, Eleventh edition, 2005.

[10] Dr. Gerald Farrell, 'Optical Communications Systems', Technical Report, Dublin Institute of Technology, 2002.

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