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Indigenous Development of TDR to Investigate Human Blood Group using Waveform Technique

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Abstract

This paper presents a waveform technique using developed TDR for investigation of human blood group. A single drop of blood is put on the sample holder and the digital data is recorded using the computer interfaced with this TDR unit. Approximately 400 blood samples have been tested and their digital data is stored. The graph is plotted for all the recorded data and the change in their lag time at a fixed voltage is analyzed using the interfaced computer. This analysis has shown a satisfactory result for detection of human blood group. The results are explained in this paper using proper waveforms for different blood samples.

Keywords: *Blood Group, Human Blood, Pulse Generator, Sample Holder, TDR.*

1. Introduction

Several biomedical instruments are used to detect the pathological parameters such as blood group and sugar value which are the need of healthy life. Some methods are frequency dependent and some are time dependent. Optical, Resistive and Capacitive parameters behind these techniques are the basic concept for most of the used system in pathology labs. In this presented research work, a time based techniques known as Time Domain Reflectometer (TDR) is used to investigate the blood group of human using the waveform which is obtained through TDR unit for the blood sample. This TDR is developed using the required components like a Pulse generator, Digital Storage Oscilloscope, Connectors, Transmission lines and a sample holder. This developed TDR unit is tested for its some of the parameters like drift, blind spot and impedance matching[1] before starting the experiment. It is found that a warm up time of approximately 30 minutes was needed to remove the drift in waveform. The sufficient transmission line was used and so there was no dilemma of blind spot. Some unwanted reflections in waveform are observed due to some mismatch in impedance of transmission line and load (sample holder). So the waveform obtained was not as smooth as desired. A computer program is used as a solution to get the smooth waveform.

2. Principle of TDR

The basic principle of TDR[2-4] is based on the transmission line theory. In TDR, a pulse is incident and the nature of reflected waveform is observed. If a sample holder of matching impedance is connected at the open end which is empty then the incident pulse will get absorbed at the far end and there will not by any change in reflected waveform. But, if the sample holder holds any sample then a change in nature of reflected wave will be observed depending on the property of the sample.

The basic requirement [5-6] to develop a TDR is a pulse generator of fast rise time, a Digital Storage Oscilloscope (DSO) to display the waveform, some standard quality connectors and good quality of transmission line. A TDR is developed on the basis of these requirements having rise time of 5.6ns. A DSO having 60MHz

sampling rate is used to display the waveform. This TDR consists of best quality of MX connectors and a transmission line having impedance of 75Ω which is connected with the sample holder and DSO.

3. Selection of Designed Sample Holder

Several sample holders[7] have been designed using a piece of copper clad and tested for their sensitivity. Few are shown in figure 1.

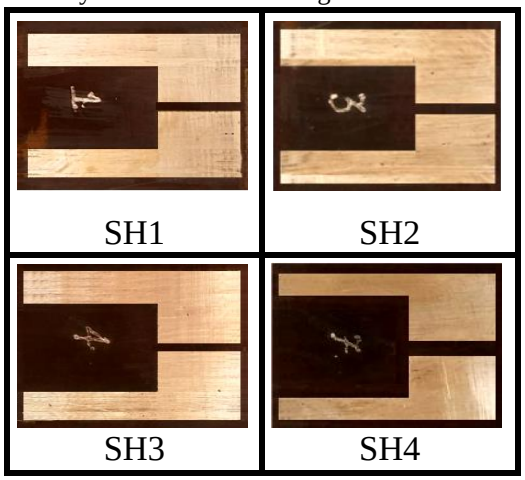

Figure 1: Designed sample holders

Figure 2 shows the nature of waveform when the sample holder is empty.

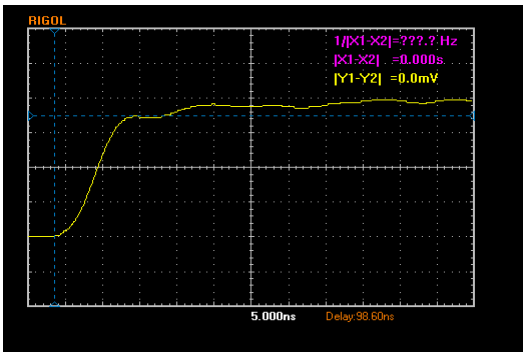

Figure 2: Response of sample holder without sample

Both the cursors are set at the same initial point so that the change in waveform after putting a drop of blood can be detected. All the sample holders are tested and it is concluded that the sensitivity of sample holder SH1 was better than the others. The sample holding section of the selected sample holder SH1 is reduces so that it can hold only one drop at a time. This is done to get better accuracy in result.

Figure 3 shows the sensitivity of this sample holder after putting a drop of blood between the conducting plates. As shown in figure 3, the waveform has shown the change at both the time and voltage axis. This change was very small for all other sample holders and so the other sample holders are ignored for further experiment. The observed change at time axis (lag time) was very small but useful for detection of blood group. The observed lag time was found to be changing for different blood group samples but nearly same for same blood group samples.

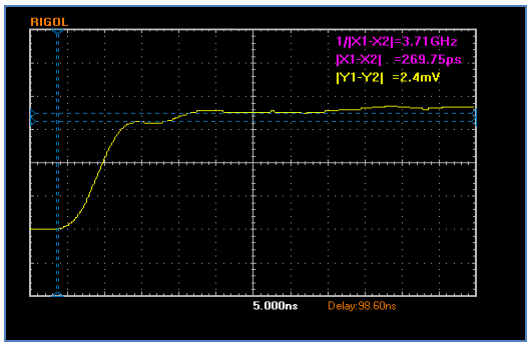

Figure 3: Response of sample holder with sample

4. Used Technique for Blood Group Detection

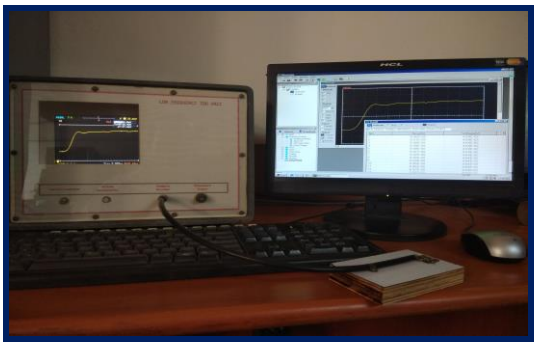

Figure 4: Image of Developed TDR

Figure 4 shows the developed TDR setup used in this research work with sample holder. The digital data is stored using a computer connected with TDR after putting a drop of blood collected from a standard pathology lab with its blood group. This data collection is done for approximately 400 blood samples by collecting on an average of 15 samples per day. The digital data of each sample is recorded for three times to check the reproducibility of TDR. Every time the sample holder is cleaned using distilled water and an electric dryer. It was found that the obtained lag time was either same or with difference of ± 0.02ns. Figure 5 shows the waveforms of some stored digital data.

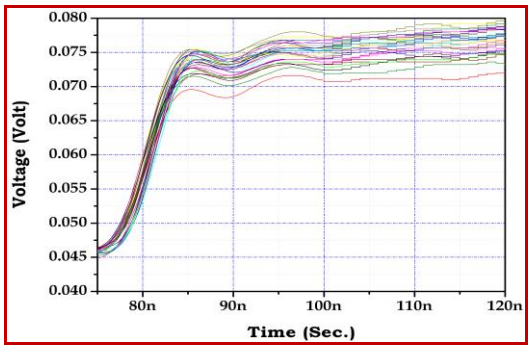

Figure 5: Waveform of some stored digital data

Figure 6 shows the different points of a waveform that are useful to detect some parameters of any sample. These points changes due to different property of blood. So the information like dielectric constant, blood group or sugar content can be determined using deep study of these points.[8,9]

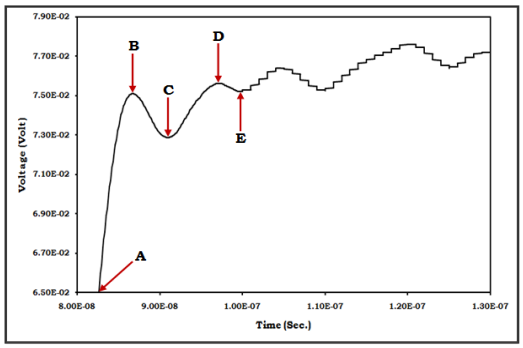

Fig. 6 Points to get information of a sample

After very keen observation at point A, B, C, D and E of figure 6, it is observed that the points C, D and E were useless as they were changing every time with same samples. Out off remaining points A and B, the point A was found to be useful as it was showing a fixed time value for same group of blood sample and changing with different blood group. So the waveform is set at the 65mV and the required part of waveform is expanded as shown in figure 7.

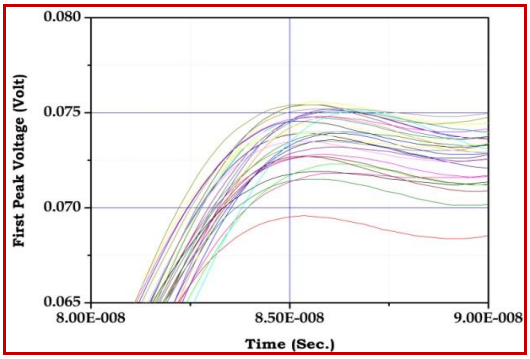

Figure 7: Lag time at 65mV

5. Result and discussion

The table 1 shows the lag time at 65mV for different blood samples with their blood group obtained from pathology lab. Approximately 15% of the samples have been ignored as they have not shown the satisfactory result. The reason behind this may be the delay in recording the data due to technical problem like unavailability of electricity after bringing the sample. This table includes some of the best satisfying sample values.

Table 1: Lag Time and Blood Groups

Sample Name	Lag Time (ns)	Blood Group
BL2131X	82.2	B+
BL2132X	82.2	B+
BL2151X	81	A-
BL2152X	81.2	A-
BL2171X	82.2	B+
BL2201X	81.4	O-
BL2221X	81.9	A+
BL2222X	82	A+

Sample Name	Lag Time (ns)	Blood Group
BL2271X	81.9	A+
BL2281X	81.8	AB+
BL2441X	81.6	AB-
BL2442X	81.6	AB-
BL2491X	81.5	B-
BL2511X	81.6	AB-
BL2521X	82.3	B+
BL2561X	81.6	AB-
BL2562X	81.6	AB-
BL2591X	81.3	O-
BL2611X	81.8	AB+
BL2651X	82	A+
BL2721X	82.3	B+
BL2741X	81.3	O-
BL2761X	82.1	O+
BL2891X	81.7	AB+
BL2941X	81.8	AB+
BL2942X	81.7	AB+
BL2961X	81.6	AB-
BL3081X	81.3	O-
BL3092X	82.3	B+
BL3162X	81.9	A+
BL3191X	81.9	A+
BL3201X	81	A-
BL3311X	81.5	B-
BL3391X	81.5	B-
BL3392X	81.5	B-
BL3401X	81.1	A-
BL3421X	82.2	O+
BL3461X	82.4	B+
BL3581X	81.3	O-
BL3671X	82.4	B+
BL3781X	82.4	B+
BL3821X	81.7	AB+
BL3941X	81.5	O-
BL3981X	82.2	O+
BL4011X	82.4	B+
BL4031X	81.2	A-
BL4061X	82.6	B+

Sample Name	Lag Time (ns)	Blood Group
BL4081X	81.7	AB+
BL4092X	81.9	A+
BL4111X	81.7	AB+
BL4112X	81.8	AB+
BL4161X	81.5	B-
BL4231X	81.9	A+
BL4232X	81.9	A+
BL4271X	81.6	AB-
BL4311X	81.4	O-
BL4321X	82.1	O+
BL4431X	81.5	B-
BL4521X	81.3	O-
BL4591X	82.2	O+
BL4781X	82.4	B+
BL4831X	82.2	O+
BL4871X	82	A+
BL4962X	82.3	B+
BL5021X	81.7	AB+
BL5061X	81.6	AB-
BL5111X	82.3	B+
BL5121X	81.8	AB+
BL5132X	82.2	O+
BL5161X	81.2	A-
BL5201X	81.9	A+
BL5221X	81.1	A-
BL5291X	81.9	A+
BL5331X	82.2	O+
BL5721X	81.5	B-
BL5771X	81.3	O-
BL5811X	81.3	O-
BL5862X	82	A+
BL5901X	82.2	O+
BL5971X	82.1	O+
BL6001X	81.6	AB-
BL6021X	81.6	AB-
BL6032X	82.5	B+
BL6042X	82	A+
BL6071X	81.1	A-
BL6091X	82.2	O+

Sample Name	Lag Time (ns)	Blood Group
BL6101X	81.9	A+
BL6141X	81.6	AB-
BL6161X	81.7	AB+
BL6191X	81.9	A+
BL6192X	81.9	A+
BL6221X	81.7	AB+
BL6241X	81.6	AB-
BL6281X	81.3	O-
BL6321X	81.4	O-
BL6371X	81.5	B-
BL6401X	81.7	AB+
BL6511X	82.1	O+
BL6561X	82.1	O+
BL6671X	82.1	O+

After analyzing each waveform for different samples at point A of figure 7 with the help of stored digital data, it was found that there was variation in intersection at time axis for different blood groups and repetition for same blood group. The result is summarized in table 2.

Table 2: Lag Time for Blood Groups

Blood Groups	Lag Time (in ns)
A-	81.0 – 81.2
O-	81.3 – 81.4
B-	81.5
AB-	81.6
AB+	81.7 – 81.8
A+	81.9 – 82.0
O+	82.1 – 82.2
B+	82.3 – 82.6

Figure 8 to 15 shows the lag time which is summarized in table 2 for different samples but same blood group. The development of a computer program can make this work easy to detect the blood group within few seconds after storing the digital data for the sample.

Figure 8 shows the waveform for different samples of blood group A-.

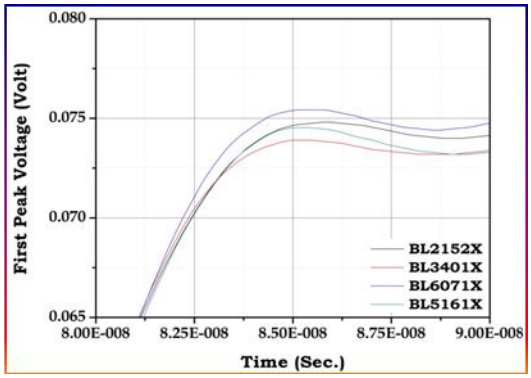

Figure 8: Waveform of blood group A-

Figure 9 shows the waveform for different samples of blood group O-.

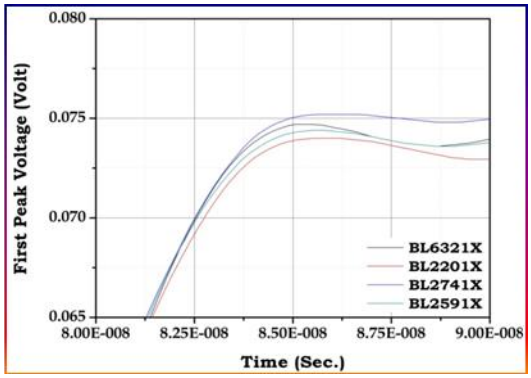

Figure 9: Waveform of blood group O-

Figure 10 shows the waveform for different samples of blood group B-.

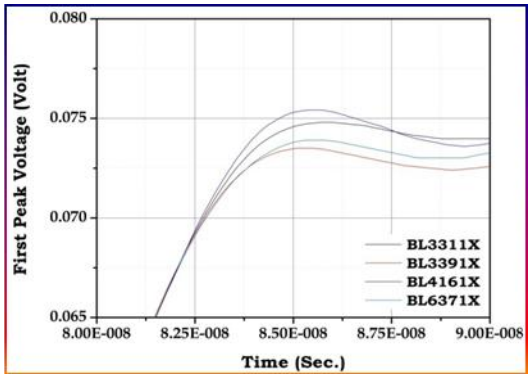

Figure 10: Waveform of blood group B-

Figure 11 shows the waveform for different samples of blood group AB-.

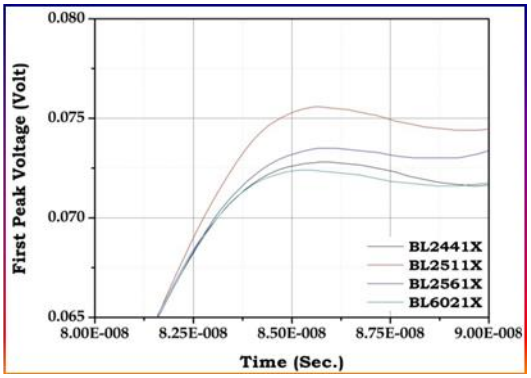

Figure 11: Waveform of blood group AB-

Figure 12 shows the waveform for different samples of blood group AB+.

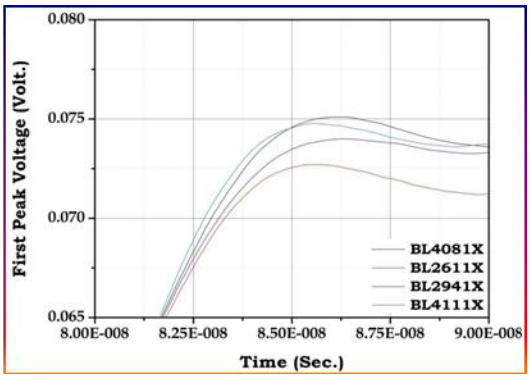

Figure 12: Waveform of blood group AB+

Figure 13 shows the waveform for different samples of blood group A+.

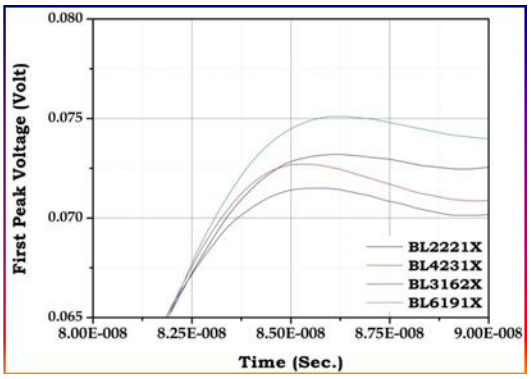

Figure 13: Waveform of blood group A+

Figure 14 shows the waveform for different samples of blood group O+.

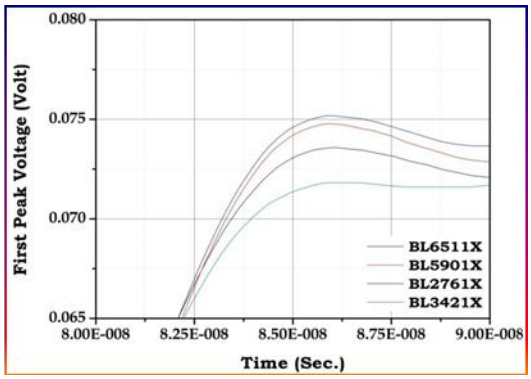

Figure 14: Waveform of blood group O+

Figure 15 shows the waveform for different samples of blood group B+.

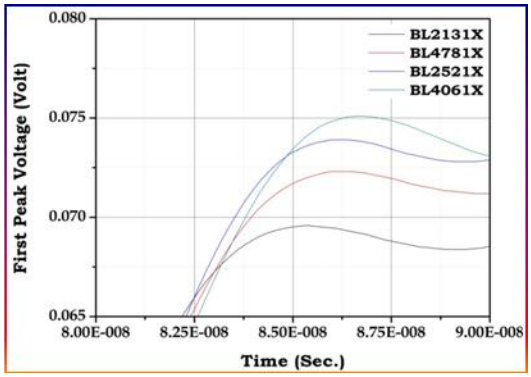

Figure 15: Waveform of blood group B+

6. Conclusions

As shown in table 2, all the blood groups are having different lag time. The blood group B+ has shown the wide range of lag time as compared to all others. But approximately 340 samples out off 400 have shown good reproducibility. So it is concluded that the developed TDR can be used as a part of pathology lab for detection of human blood group.

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