

A review and visionary design of human tissue blood serum based low pass filter circuit for disease detection

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Abstract—A "Filter" is very common terminology used by electronic circuit design engineer for implementing various circuits and system. General understanding of filter itself indicate that it removes unwanted part of input data. This concept has been developed in analog filter as well as in digital filter. It is also used in designing of medical instrumentation that used for various diseases diagnostic. The medical treatment of patient and working of instruments is combining at the point we can called sensor. Electronics in medicine has a wide range of applications, from diagnostics to therapy, always aiming to provide new tools to improve the well-being of the population. Moreover, some blood taste also working on the concept of filtering. The fundamental electronic component's characteristic has been already observed in human tissues like blood serum, skin etc. By combining filter concept with these human tissue components, we have achieved specific characteristics as a result of our experiments. This article indicates the important behaviour and realisation technique for such bio-electronics filter. It is also helpful to understand biological signal analysis. Additionally comparison of electronic filter and serum filter is represented in result section.

Keyword- Bio-electronics, Liquid State Electronics, Biological signal analysis and low pass filter.

I. INTRODUCTION

In Electronic System, use of filter is very common. The detail functioning, technical parameter and designing of various filter starting from vary simple low pass filter with first order to microwave filter are easily available as well as understandable from engineering references. There are many advanced software which provides the facility of filter designing and analysis of it like GENESYS, WEBENCH, FilterCAD etc. For this experiment all these technical details are not required so just brief about fundamentals of filter explained in next section.

Today medical science has grown up so much with basis of available medicine and treatment methodologies. The Bio-medical engineering and biotechnology are always helpful branches to develop this level till at better position. In addition to this are electronics science and engineering are core stream for this grownup. The latest technology for laparoscopy, sonography, X-Ray, ECG etc has increase the importance of this knowledge. Human body tissue based experiments is also going on in this era. A brief notes for such practical with published result is mentioned in latter section. After that experiment setup for low pass first order filer using sample of human blood serum is presented. For accuracy and precession of readings, result section is given with graph as well as in tabular data form. A short conclusion indicates important of this study with analysis of comparison of ideal electronic filter and human tissue based filter.

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II. FUNDAMENTALS OF FILTER

Basically, an electrical filter is a circuit that can be designed to modify, reshape or reject all unwanted frequencies of an electrical signal and accept or pass only those signals wanted by the circuit designer. In low frequency applications, passive filters are generally constructed using simple Resistor Capacitor (RC) networks, while higher frequency filters are usually made from Resistor-Inductor-Capacitor (RLC) components. The output is always less than the input because filters have no gain or no amplifying components. They are known according to the frequency range of signals that they allow to pass through them, while blocking or attenuating the rest. The most commonly used filters designs are as below:

The Low Pass Filter – the low pass filter only allows low frequency signals from 0Hz to its cut-off frequency to pass while blocking those any higher.

The High Pass Filter – the high pass filter only allows high frequency signals from its cut-off frequency and higher to infinity to pass through while blocking those any lower.

The Band Pass Filter – the band pass filter allows signals falling within a certain frequency band setup between two points to pass through while blocking both the lower and higher frequencies either side of this frequency band.

As the function of any filter is to allow signals of a given band of frequencies to pass unaltered while attenuating or weakening all others those are not wanted, we can define the amplitude response characteristics of an ideal filter by using an ideal frequency response curve of the basic filter types as shown below.

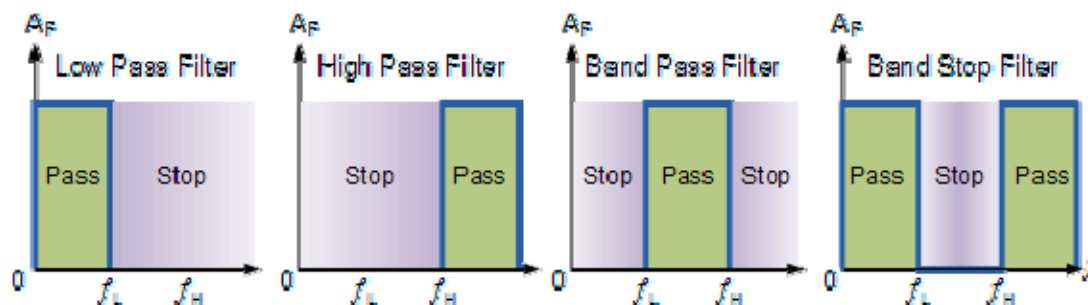


Figure 1: Frequency response of basic filters [13]

Simple first order passive filters can be made by connecting together a single resistor and a single capacitor in series across an input signal with the output of the filter taken from the junction of these two components as indicated in below figure. Depending on which way around we connect the resistor and the capacitor with regards to the output signal determines the type of filter construction resulting in either a Low Pass Filter or a High Pass Filter. In this experiment below circuit is implemented using electronic component as well as serum.

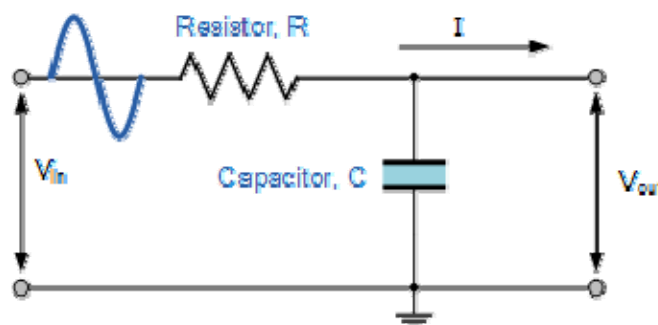


Figure 2: First order low pass RC filter [13]

III.HUMAN TISSUE BASED ELECTRONICS

Today, the Medical Engineering is well known stream for innovation. Since last decade, very fast change occurs in related field known as Bio-Medical Engineering. More or less it's deals with medical instrumentation for diagnostic and analysis for various human's characteristics and behaviour. Recently Bio-Electronics field also become popular to perform the same task with help of combining electronics knowledge in addition with medical engineering. Artificial body parts with sensor, pacemaker, hearing machine etc are well known examples of this. At very deep level human tissue based electronic analysis also done. Such experiments indicated common characteristics of basic electronic components diode and transistor using human body tissues like human blood or skin. It is also experimented tree's leaf and resulted successful experiment in green bio mass also. Few of results and experiment setup is shown in below figures.

The result of this referenced article giving clear cut indication that there will be different characteristics for every different human bodies. Again it is also depend on various parameters like temperature of human body, stress level, health condition, environment of testing place, sensor or probes and many more. The very interesting thing is, after all such dependency according to design circuit human body will provide some specific characteristic. The latest technology and upcoming instruments are based on such results only. This thought results into one more experiment based on Passive Filter based on human body tissue blood serum.

IV. SERUM BASED FILTER

The Liquid State Electronics (LSE) is still subject of research compare to Solid State Electronics (SSE). The represented concept in this article is also opens idea about LSE technique. We have considered resistor and capacitor characteristics can be found in human blood serum with proper arrangements and sensing technique. A resistor and a capacitor is considered in two different test tube as per below figure. Specific and sufficient amount of serum sample is taken into test tubes. The each human body has different characteristics, so instead of taking only one type of serum, sample is form with three different combinations of serum contents (in form of density of serum). The proportionality is indicated in below table. Based on this with different water level 1, 1.2 and 1.5 liters we have taken serum 1 (S1), Serum 1.2 (S1.2) and Serum 1.5 (S1.5).

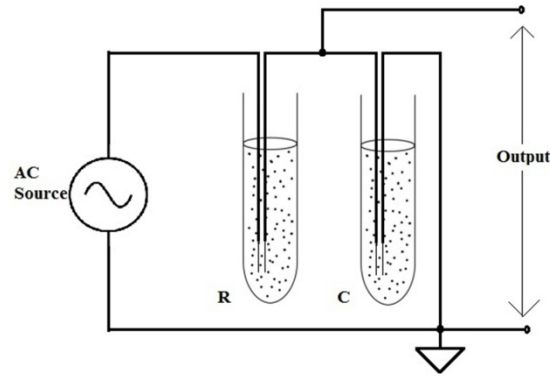


Figure 3: Serum based filter

Table 1: Serum Sample Composition

Serum Sample Content	Molecular Wight (gm/mol)	Proportional level	Effective Molecular weight (gm/mol)
NaCl	58.44	0.1	5.844
KCl	74.55	0.05	3.7275
CaCl ₂	110.98	0.05	5.549
MgSO ₄	120.36	0.05	6.018
NaHCO ₃	84.007	0.05	4.20035
Na ₂ HPO ₄	141.96	0.05	7.098

As indicated in figure simple copper cable is used as connecting medium between serum and electronic circuit. The input ac signal is fix in terms of amplitude that is 10 Vp-p. As per filter concept frequency is vary from 10 Hz to 10 MHz. The output is taken across "C" test tube, where C means considering that tube as capacitor. In same manner "R" indicate Resistor Test tube. The experiment is repeated three times with S1, S1.2 and S1.5. The obtained result is represented in next section using tabular as well as graph form. Few Oscilloscope images are also represented for characteristics learning of input and output signal.

V. RESULTS

Table 2: Serum based filter readings for Hz to KHz frequency range

Sr. no.	Freq.(Hz)	I/P (V)	Serum-1		Serum-1.2		Serum-1.5	
			O/P (V)	Gain	O/P (V)	Gain	O/P (V)	Gain
1	10	10.00	4.72	0.47	4.48	0.45	5.28	0.53
2	20	10.00	4.72	0.47	4.48	0.45	5.28	0.53
3	30	10.00	4.64	0.46	4.48	0.45	5.20	0.52
4	40	10.00	4.56	0.46	4.40	0.44	5.20	0.52
5	50	10.00	4.56	0.46	4.40	0.44	5.20	0.52
6	60	10.00	4.56	0.46	4.80	0.48	5.20	0.52
7	70	10.00	4.48	0.45	4.72	0.47	5.20	0.52
8	80	10.00	4.48	0.45	4.72	0.47	5.12	0.51
9	90	10.00	4.40	0.44	4.72	0.47	5.12	0.51

10	100	10.00	4.40	0.44	4.72	0.47	5.12	0.51
Sr. no.	Freq.(Hz)	I/P V	O/P V	Gain	O/P V	Gain	O/P V	Gain
11	100	10.00	4.40	0.44	4.72	0.47	5.12	0.51
12	200	10.00	4.40	0.44	4.56	0.46	4.96	0.50
13	300	10.00	4.40	0.44	4.48	0.45	4.80	0.48
14	400	10.00	4.32	0.43	4.48	0.45	4.72	0.47
15	500	10.00	4.32	0.43	4.48	0.45	4.64	0.46
16	600	10.00	4.32	0.43	4.48	0.45	4.72	0.47
17	700	10.00	4.32	0.43	4.48	0.45	4.72	0.47
18	800	10.00	4.24	0.42	4.40	0.44	4.64	0.46
19	900	10.00	4.24	0.42	4.40	0.44	4.64	0.46
20	1000	10.00	4.24	0.42	4.40	0.44	4.64	0.46
Sr. no.	Freq.(KHz)	I/P V	O/P V	Gain	O/P V	Gain	O/P V	Gain
21	1	10.00	4.24	0.42	4.40	0.44	4.64	0.46
22	2	10.00	4.16	0.42	4.16	0.42	4.64	0.46
23	3	10.00	4.16	0.42	4.00	0.40	4.56	0.46
24	4	10.00	4.08	0.41	4.16	0.42	4.48	0.45
25	5	10.00	4.08	0.41	4.16	0.42	4.48	0.45
26	6	10.00	4.08	0.41	4.16	0.42	4.40	0.44
27	7	10.00	4.08	0.41	4.08	0.41	4.32	0.43
28	8	10.00	4.08	0.41	4.00	0.40	4.32	0.43
29	9	10.00	4.16	0.42	4.00	0.40	4.32	0.43
30	10	10.00	4.16	0.42	4.00	0.40	4.32	0.43

Table 3: Serum based filter readings for KHz to MHz frequency range

Sr. no.	Freq.(KHz)	I/P V	Serum-1		Serum-1.2		Serum-1.5	
			O/P V	Gain	O/P V	Gain	O/P V	Gain
31	10	10.00	4.16	0.42	4.00	0.40	4.32	0.43
32	20	10.00	4.16	0.42	3.68	0.37	4.08	0.41
33	30	10.00	4.32	0.43	3.68	0.37	3.92	0.39
34	40	10.00	4.32	0.43	3.60	0.36	3.76	0.38
35	50	10.00	4.32	0.43	3.60	0.36	3.76	0.38
36	60	10.00	4.32	0.43	3.60	0.36	3.76	0.38
37	70	10.00	4.40	0.44	3.56	0.36	3.76	0.38
38	80	10.00	4.40	0.44	3.60	0.36	3.76	0.38
39	90	10.00	4.40	0.44	3.60	0.36	3.76	0.38
40	100	10.00	4.40	0.44	3.60	0.36	3.76	0.38
Sr. no.	Freq.(KHz)	I/P V	O/P V	Gain	O/P V	Gain	O/P V	Gain
41	100	10.00	4.40	0.44	3.76	0.38	3.76	0.38
42	200	10.00	4.32	0.43	3.60	0.36	3.68	0.37
43	300	10.00	4.24	0.42	3.76	0.38	3.68	0.37
44	400	10.00	4.16	0.42	3.68	0.37	3.68	0.37
45	500	10.00	4.00	0.40	3.60	0.36	3.40	0.34
46	600	10.00	3.84	0.38	3.60	0.36	3.40	0.34
47	700	10.00	3.76	0.38	3.60	0.36	3.32	0.33
48	800	10.00	3.76	0.38	3.60	0.36	3.44	0.34
49	900	10.00	3.76	0.38	3.60	0.36	3.44	0.34
50	1000	10.00	3.76	0.38	3.60	0.36	3.40	0.34

Sr. no.	Freq.(MHz)	I/P V	O/P V	Gain	O/P V	Gain	O/P V	Gain
51	1	10.00	3.76	0.38	3.52	0.35	3.40	0.34
52	2	10.00	3.68	0.37	3.36	0.34	3.40	0.34
53	3	10.00	3.92	0.39	3.52	0.35	3.44	0.34
54	4	10.00	4.16	0.42	3.52	0.35	3.60	0.36
55	5	10.00	4.40	0.44	3.84	0.38	3.84	0.38
56	6	10.00	4.72	0.47	3.76	0.38	3.84	0.38
57	7	10.00	4.68	0.47	3.76	0.38	3.84	0.38
58	8	10.00	5.44	0.54	3.76	0.38	3.84	0.38
59	9	10.00	6.32	0.63	3.76	0.38	3.84	0.38
60	10	10.00	7.20	0.72	3.76	0.38	3.84	0.38

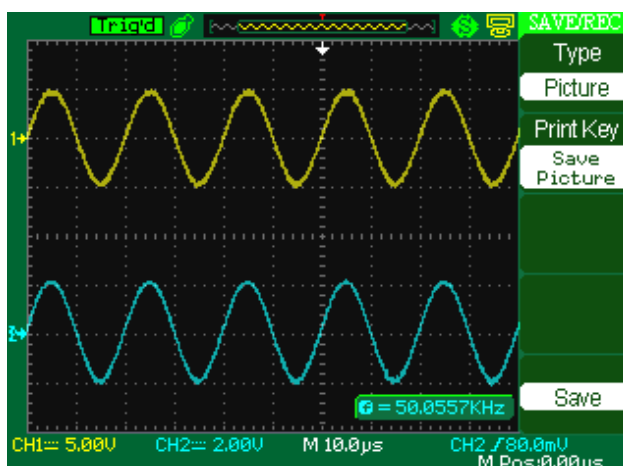


Figure 4: Serum (S1) based filter response-oscilloscope image

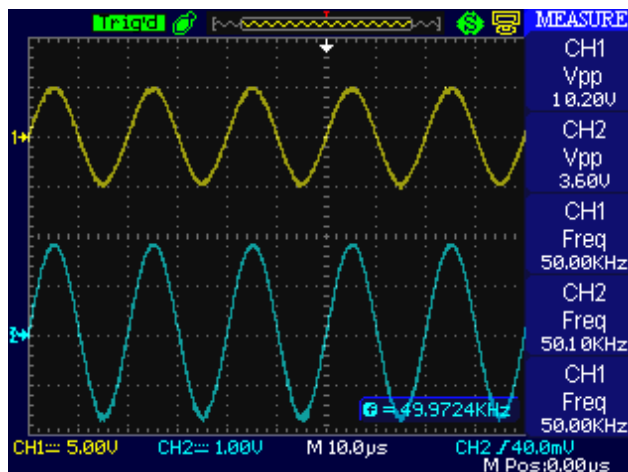


Figure 5: Serum (S1.2) based filter response-oscilloscope image

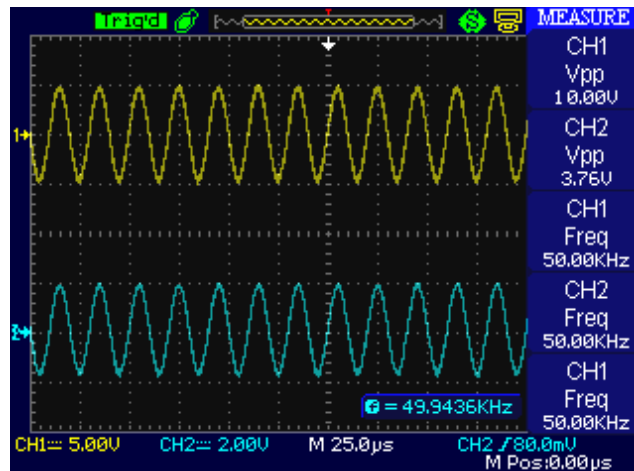


Figure 6: Serum (S1.5) based filter response-oscilloscope image

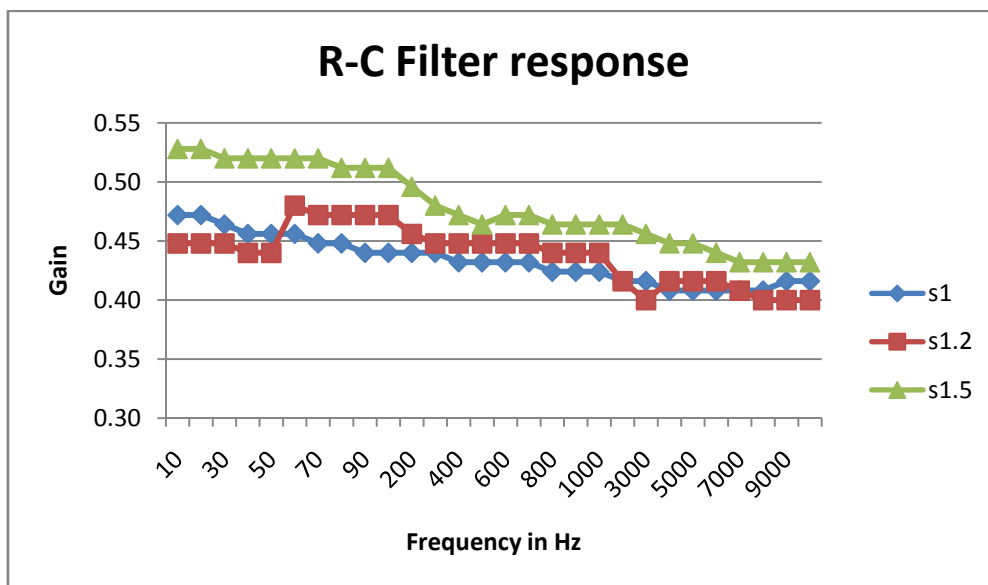


Figure 7: Serum based filter Gain vs Frequency response for Hz to KHz frequency range

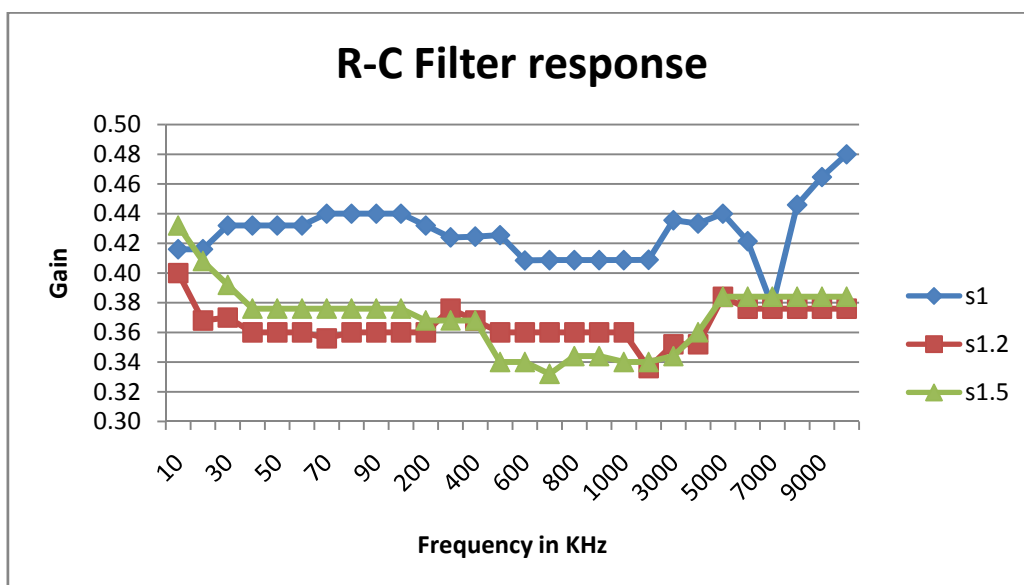


Figure 8: Serum based filter Gain vs Frequency response for KHz to MHz frequency range

VI. CONCLUSION

Experiment's technique and results indicates the new way of electronics as well as alternative therapy for human disease detection and diagnostic. There may be a chance to use this bio-electronics behaviour for disease healing purpose also. An idle filter has many other parameters which are not considered here as like many parameters that control serum construction is not taken care. The response indicates it is very dependent on applied frequency range. The signal shape is very close to its input signal that sounds like electronic filter. In short there will major two point we can conclude. One, an electronics behaviour may be obtained from human tissue itself. Secondly, bio-electronics characteristics may helpful to medical science for understanding and solving human diseases.

ACKNOWLEDGMENT

We are thankful to ECE department and CHARUSAT for providing us valuable recourses. We would like to extent our gratitude to Dr. S. P. Kosta for his motivation.

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