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ECG Signal Conditioning

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Abstract
This paper presents the designing of real time ECG signal conditioning circuit. For designing the real time ECG signal conditioning circuit need to understand the physiology of heart. For analysis the heart activity a instrument is used, called as Electrocardiogram(ECG). It is widely used for diagnosis of heart diseases. ECG recorded in 12 lead configuration using 10 electrode placed on the human body. This recordings are often corrupted by motion artifacts, power-line interferences and other noises. The corrupted signal leads to misinterpretation of data, which in turn causes very serious consequences as it leads to misdiagnoses of dangerous disease. Hence the artifacts need to be suppressed by using the appropriate methods and a conditioned signal is obtained. In this paper proposed a designed and tested circuit on hardware and software to extract the real time ECG signal from the subject, This circuit also suppressed the artifacts present in the ECG signal.
Keywords—*ECG, heart, noise, artifacts etc.*

Introduction

In recent trend due to unhealthy life style human health affected commonly. In this scenario more common factor observe is ECG to know the person wellness. The heart is vital organ of the body which supply the blood to whole body so the monitoring of heart activity is very important. For that ECG monitor were design, ECG is the medical instrument that can measure the heart activity, and convert into the analog signal and present the data on ECG chart paper. ECG signal will get from the body to place the electrode at appropriate location of body or in limb lead configuration[1], ECG machine can measure the abnormal rhythms caused by damage to the conductive tissue or electrolyte imbalances [2].or it can also identify damaged heart muscle in specific areas,

The ECG instrument cannot used to know volume of blood pump from heart to whole body, for this ultrasound-based (electrocardiography) or nuclear medicine tests are used. It is possible to be in cardiac arrest with a normal ECG signal (a condition known as pulse less electrical activity). Electro-cardiogram (ECG) is [4] one of frequently used and accurate methods for measuring the heart rate. ECG is a very expensive machine which is used for the measurement of the heart rate. A Low-cost devices also available in the form of wrist watch or wrist band as well as in the mobile application also providing this feature[5][6] to

instantaneous measurement of the heart rate. These kind of devices can give accurate measurements but their cost is usually in excess of several hundred dollars, making them uneconomical. Most hospitals and clinics in the UK use integrated devices designed to measure the heart rate, blood pressure, and temperature of the subject. Although such devices are useful, their cost is usually high and beyond the reach of individuals. This paper describes the design of an low cost ECG monitoring system which monitors ECG in 12 lead configuration and it can also be used to measure .the heart rate of the subject by further implementation using micro-controller.

ECG signal is a very sensitive and weak electrical bio-signal in the frequency range of 0.05 to 100 Hz and amplitude of 20 to 40 mV.[9]. Real time ECG signal is impure and distorted with various internal and external interferences. The internal interference mainly due to other moving organ in the body like lungs, kidney and liver. The external interference due to power line and other hight frequency signal present besides the circuitry. Hence to enable us to use this signal for diagnosis, further signal processing is essential during which the artifacts are removed. ECG is the very important diagnoses of heart activity because heart is the vital organ of body which is responsible to whole body working if heart pumping will stop the person can died. The figure 1 is the standard ECG waveform which will give the information of heart chamber activity. If the standard ECG waveform amplitude and frequency will change means person having the heart problem. So the conditioning of ECG signal is must to analysis the heart activity. Therefore we designed ECG signal conditioning circuit using a low cost IC.

II Block Diagram

The block diagram of ECG signal conditioning mentioned in figure 2 is consists of the following component viz buffer amplifier, instrumentation amplifier, filter and main amplifier. Each block having there own importance. First the signal collect from the subject via shielded cable by placing the electrode in standard lead configuration on subject. then it will pass to the buffer amplifier, it is used to couple the output of the electrode to the input of the instrumentation amplifier circuit to avoid loading. The input signal in the amplitude range of mill volts is fed to the Instrumentation amplifier of gain 210.It amplifies the difference between the inputs to the first stage of instrumentation amplifier. The reason behind using the difference amplifier is the common mode noise cancellation. Here we have fed a fraction of input to the upper stage as input to the lower stage, but in actual ECG amplifier, these two points will be connected to two different points on the body of the patient. The amplified signal is fed to the low pass filter of frequency range 0.5 Hz - 100 Hz. It removes the high frequency noise. The output of the low pass filter is then fed to the high pass filter of frequency range 0.5 Hz. It removes the low frequency noise. The signal obtained from the high pass filter is fed to the main amplifier. The gain of the overall amplifier is 16. After amplification from the main amplifier get the rectified ECG signal without noise.

III Circuit diagram

The complete circuit diagram of the ECG signal conditioning circuit is shown in figure 3, with the help of two TL084 op-amp IC", as its core component. The TL084 is the low cost IC has the the quad op-amp and high CMRR. It is used for designing the Buffer amplifier (B1, B2), instrumentation amplifier (B3, B4 and B5), Low pass filter(B6), high pass filter and main amplifier designated as B7 , B8 respectively and also the right leg drive circuit B9 to protect the human body.

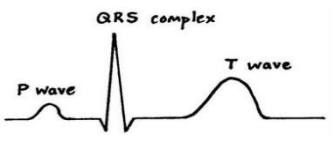

Fig. 1: Standard ECG waveform

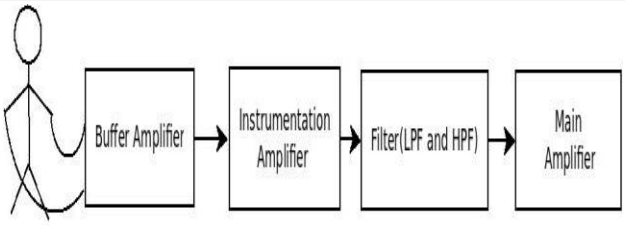

Fig. 2. Block diagram of ECG signal conditioning

IV RESULTS

The result of instrumentation amplifier and filter observed on DSO is mentioned in figure 4 and 5 respectively. The figure 4 shows the ouptput of instrumenation amplifier with noise in lead 1st configuaration and figure 5 shows the filter ouput of the same subject in lead 1 configuartion.

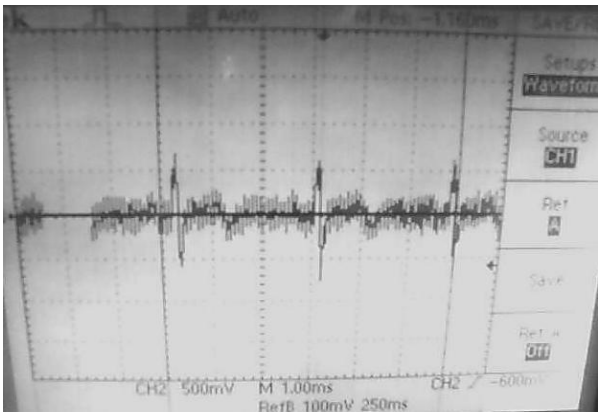

Fig. 4 Unconditioned ECG signal from the Instrumentation amplifier

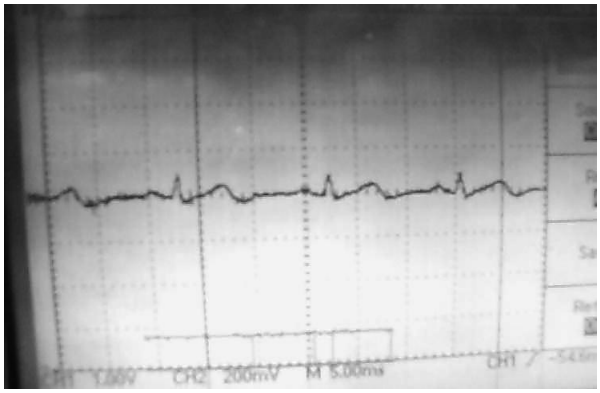

Fig. 5 Filtered ECG signal in limb lead 1st configuration

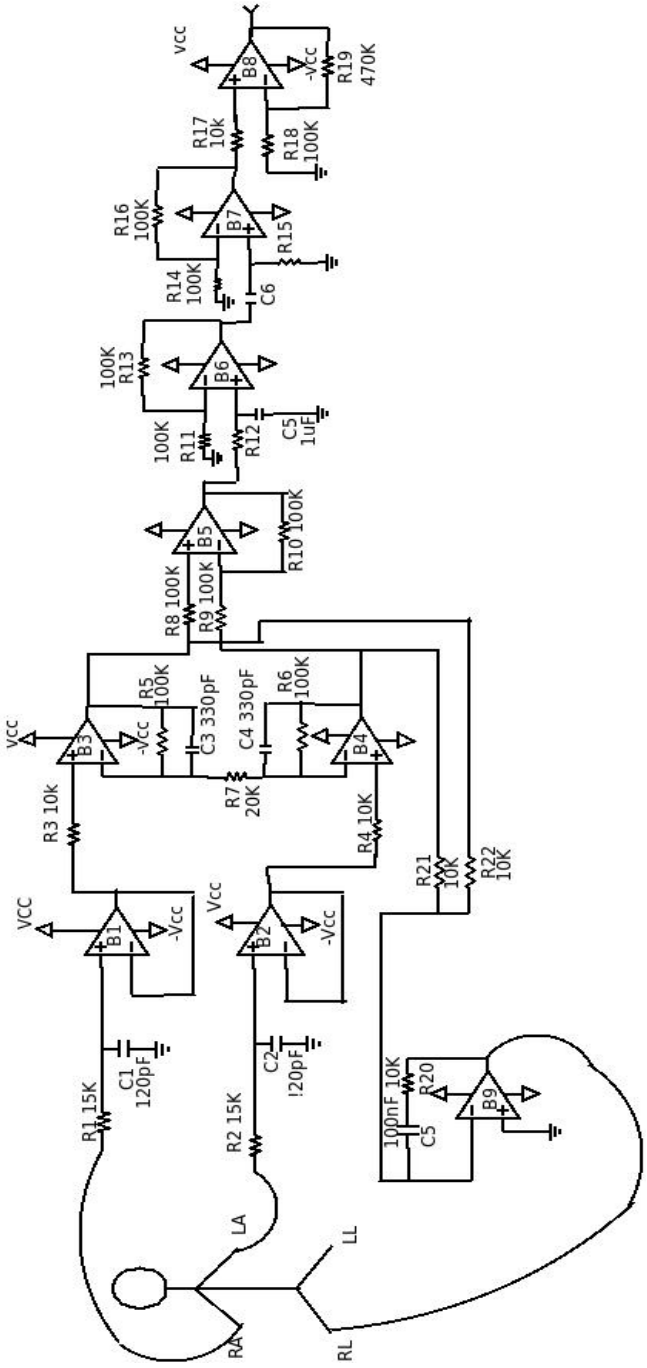

Fig. 3 ECG signal conditioning circuit in limb lead 1t configuration

V Conclusion

We successfully designed the ECG signal conditioning circuit at low cost for Lead 1, II and III AvR, AvL, and Avf configuration. This circuit will help to further designing of any heart beat monitor and also able to record the electric heart activity in 12 lead configuration at low cost. For further getting the better result without noise we need to encapsulate the whole circuitry in box. And also use

shielded cable to carry denoising signal from the body to the circuit.

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Author Profile

Ms. Pushpa Gothwal currently working as an Assistant Professor in Amity University, Rajasthan, from ASET(ECE Department) Since 2012. In past she worked as an Assistant professor in Medicaps Institute of Science & Technology , Indore(Madhya Pradesh) for 2011 to 2012. She received her B.E. degree in biomedical engineering from Shree Govindram Seksaria Institute of Technology and Science, Indore (Madhya Pradesh) in 2008. She worked as a Biomedical Engineer at Scientech Technologies Pvt. Ltd., Indore during June 2008 to July 2009. she completed her M. Tech. degree in Electrical Engineering at the Indian Institute of Technology Bombay(IITB). Her research interests include embedded system design, biomedical instrumentation. and Diagnostic instrument design.