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SELECTION AND DESIGNING APPROACH INTRODUCED TO MICRO CONTROLLER BASED ECG MEASURING BIO-MEDICAL INSTRUMENTS

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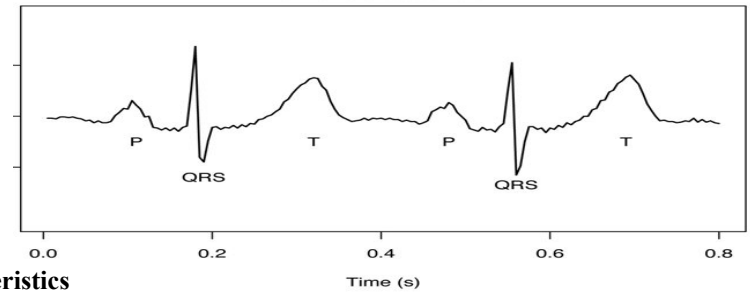
ABSTRACT
The paper presented here provides the solution of the problems that arise duringthe designing of a microcontroller based ECG monitoring instrument. The model encompasses of instrumentation amplifier and filter circuits etc, which are used for signal conditioning of the pulse input from the patient's body and displays on LCD as the ECG waveform. The paper is helpful to choose right microcontroller among the other available microcontrollers. It is also useful to understand the reduction of errors in the output using minimum circuitry

Keywords- *ECGsignals,Instrumentationamplifier,PIC16F877microcontroller, Operational amplifier*

1. INTRODUCTION
This paper presents the basics of ECG signal and problem arise during design and implementation of a compact microcontroller-based portable system used for control of heart rate on real time. Diagnosis of heart disease using ECG signals. I have tried to make this paper easier that it become easy to understand for both medical and technical student; As medical students use this device regularly. This device principle is difficult to analyze it in electronics section. I focused more in electronics devices. After reading so many papers, I realized that other discipline students get confuse with question like why we use in amplifier as a three OPAMP based amplifier and why not use transistor and OPAMP as a amplifier. And also I realize that they confuse with question that why we used LM7805 regulator, and most important question of this project why we used PIC16F877/16F876/16F874 microcontroller in place of other traditional microcontroller like 8051, 8052, 8031(MCS51) family and what happen when we used this microcontroller. In this paper I have tried to solve these questions as easier way.

2. ECG BASICS
ECG(Electro cardio graph) is a word derived from Greek electro because it is related to electrical activity, Kardio Greek word for heart and graphs agreek word means to write.An electrocardiogram (ECG) signal describes the electrical activity of the heart. The electrical activity related to the impulses that travel to the heart. It provides information about the heart rate, rhythm and morphology. It provides information about the structure and function of the heart. Normally ECG is recorded by attaching a set of electrodes on the body surface such as chest, neck, arms and legs. A typical ECG wave of a normal heartbeat consist of a P wave, a QRS complex and T wave. Fig.(a) depicts the basic shape of healthy ECG heart beat signals.



Ecg Waveform Characteristics

Waveform usually contain three distinct segment

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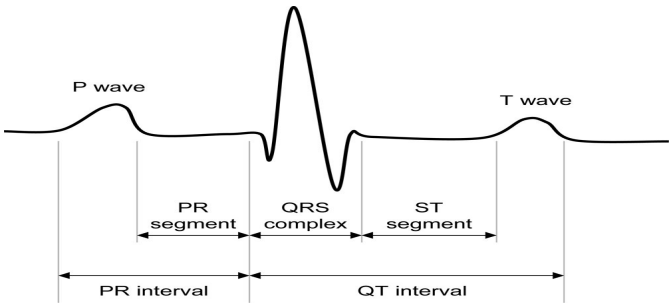


Figure 1QRS Complex

Clinical Importance Of Ecg

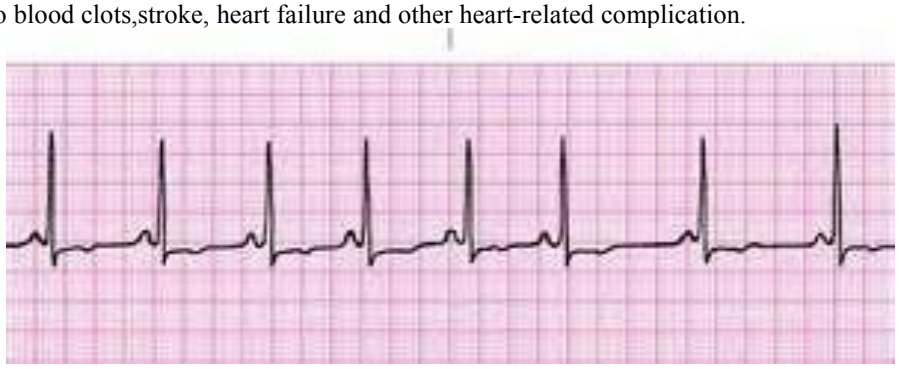
It can provide critical insights on potential abnormalities in the subjects heart functioning. It commonly used as monitoring of cardiac problem. We describe below some heart dieses and their graph.

ECG arrhythmia-It describes heart rhythm disorder. Technically it is known as arrhythmia. It arises due to a periodic waveform of ECG. During this disorder the heart beat may be too fast, too slow or may be irregular.

ECG arrhythmia

Arterial fibrillation

It is also called Afib or AF.In this illness there is missing P waves due to asynchronized excitation of arterial cardiac cell. It can be lead to blood clots,stroke, heart failure and other heart-related complication.



Premature ventricular contraction

In this illness there is sudden broad changes in the QRS complex shape.PVC can be sign of decreased oxygenation to the heart muscle .It characterized bizarrely shaped QRS complexes.

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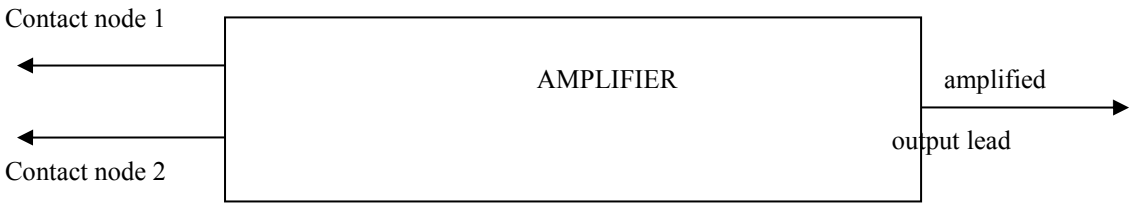
Basic Principal Of Egc Measurement:-
General approach is to place different electrodes at multiple places on the body surface. It measures the potential difference across a lead (that is a pair of electrons). Commonly we use electrodes in the shape of metal disk surrounded by an adhesive form pad.

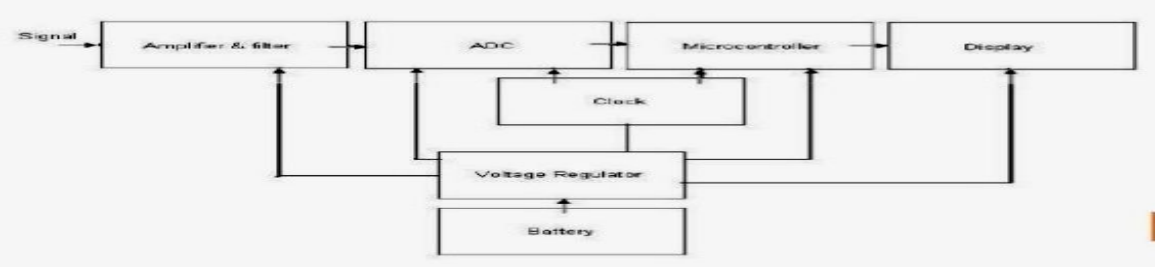
Challenges of ECG signal measurement
ECG signals often lower in amplitude, and distorted by noise sources. Its magnitude is lies between 0.1 to 5 mili volt. Also it is mingle with muscles contraction and power line radiation. There is tough task to measure low level signals and remove noise level maskout useful clinical information.

Sollution
Amplifier circuit
Amplifiers are those circuits which increases the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with the larger magnitude.



To enhance the grow ECG signal level without boosting the noise at the same time we have to amplify only the potential difference across two contact point. Also there is point we have a signal are in AC nature. To amplify these week AC signal we uses OP-AMP with very high CMRR , High PSRR, very low drift, negligible offset characteristics are used. It is best suited that we used three OP-AMP based instrumentation amplifier to initial stage of amplification. To fulfill the requirement of high CMRR and high gain, High PSRR, very low drift, negligible offset characteristics.

Block Diagram Of Heart Rate Monitoring System Using Microcontroller



3. DESIGN REQUIREMENT

Amplification Stage
First stage of block diagram is amplification stage we use instrumentation amplifier and filter. An instrumentation amplifier is usually the very first stage in an instrumentation system. This is because of the very small voltages usually

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received from the probes need to be amplified significantly to be proceeding stages. An instrumentation amplifier (IA) is a difference amplifier where the difference between the two input terminal is amplified and the common signals between the inputs are rejected(Common Mode Rejection Ratio) The latter function is the device characteristics termed the common mode rejection ratio(CMRR) An instrumentation amplifier consist of three op-amps. And for filter we commonly use a low pass filter. It passes low frequency wave to output and block high frequency wave. We use generally Butterworth low pass filter in design of ECG amplifier.

Instrumentation amplifier

We have to use that circuit that would only amplify the differential voltage and common mode voltage level (i.e. error) remains unchanged. There are mainly two functions of an instrumentation amplifier:-

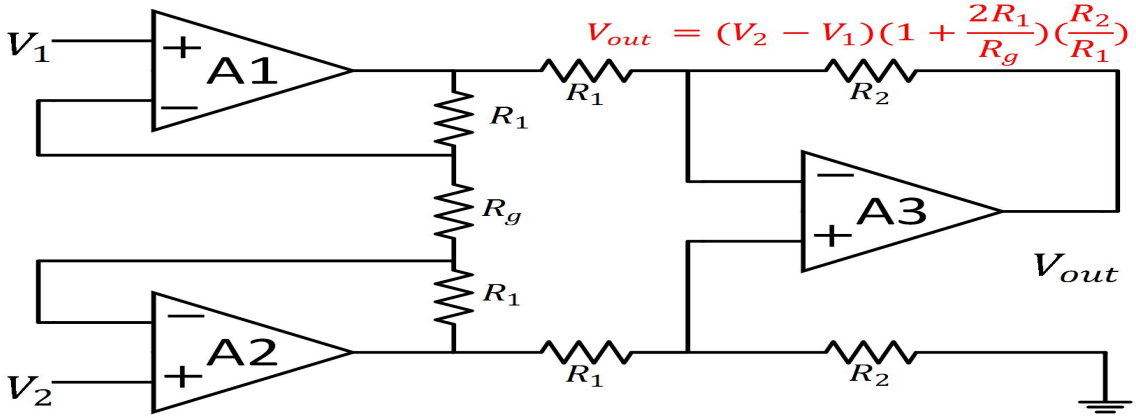
i) It amplifies weak ECG signals(in between **0.1 to 5** milivolt range).
ii) It reduces power line interference and also unwanted high frequency noise.
iii) Instrumentation amplifier is high quality differential amplifier, it has infinite value of CMRR, PSRR, and gain and negligible offset error. That is why generally we use threeOP-AMP configuration of instrumentation amplifier.

The characteristics of a good instrumentation amplifier are:-

i) It should have finite accurate stable gain in the range of 1- 1000.
ii) It should have differential inputs.
iii) It should have high CMRR and high input Impedance.
iv) Low output impedance.
v) Easily adjustable gain.

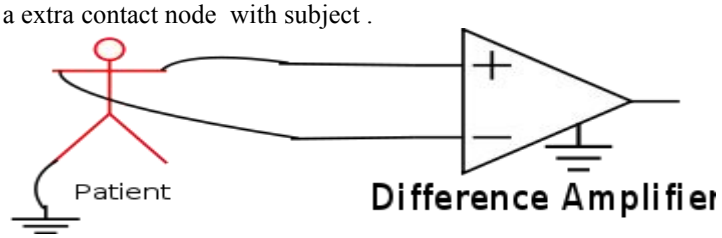
Block Diagram of a three stageInstrumentation Amplifier

The Op-Amp in contrast can be used to builda wide variety of circuit but not make a good as differential amplifier as compared to an instrumentation amplifier. Three OP-AMP based instrumentation amplifier. Because it fulfill high gain requirement with very high CMRR.



Power line noise interference :-

It reduces common mode voltage via shunting the displacement current to ground.
It is implemented by adding a extra contact node with subject .



This is simple diagram it shows how interference is reduces by ground.

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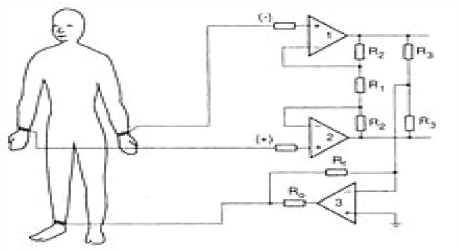


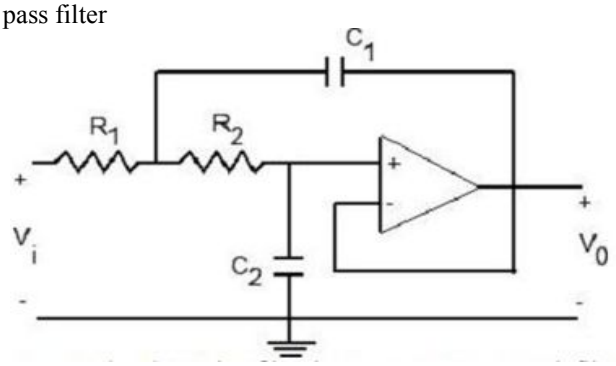
This is modified diagram using instrumentation amplifier.
It reduces almost all common mode voltage and displacement current.
All unwanted current and radiation is passed in ground by the way of differential amplifier.

Filter

We use active filter to reduce noise and interferences. An OP-AMP(active device) is a main component used in the filter that is why it isnamed as active filter. It is frequency selective element.

The amplifier mentioned here uses an active low pass filter.As ECG signals are low frequency signal, these filters are used to bypass low frequency signal and to block high frequency (noise,radiation,interference). Most of the time we use Butterworth second order filter, Because of its efficiency; it uses two frequency selective network of RC. Hence it becomes more efficient compare to normal low pass filter.

Butterworth second order low pass filter

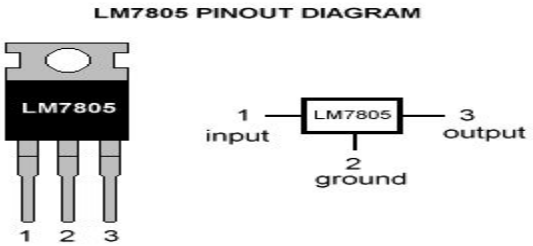


Power-

To power the circuit, the system is divided into two sections. The system is powered through a 9 V battery. Also Section two requires 5V. The conversion of 9 V to 5 V is achieved by a voltage regulatorLM7805. For the amplifier stage the op-amps require dual polarity rails to operate. To generate negative voltage form a single 9 V battery, virtual grounding is to be created.

Regulator

A regulator LM7805 IChas been used in the circuit. It comes from 78xx family. As we required 5V Voltage, the voltage regulator regulates the voltage and provides the desired output. One of the characteristic of this voltage regulator is it does not change with fluctuation of input voltage.



4. MICROCONTROLLER

A microcontroller is a small low-cost computer-on-a chip which usually includes8 bit microprocessor(CPU), RAM, Programmable ROM, parallel and serial input/output port, timer and ADC. It is used to run dedicated code that control one or more tasks in the operation of device or a system.

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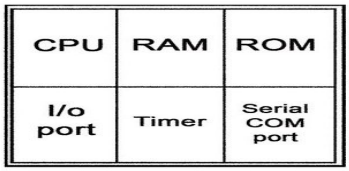
Microcontroller is very essential part for automatic measurement of ECG. We use different commercial microcontroller like MCS-51, PIC, ARM, ATMEGA, PHILIPS etc but for making it on minimum circuitry and facilitate additional feature we depend on PIC Microcontroller. PIC microcontroller has a inbuilt ADC features. We use PIC16F874/16F876/16F877 types microcontroller. But In frequently used microcontroller is PIC 16F877 Microcontroller.

MICROCONTROLLER



(Single chip)

Reason behind using PIC 16F877Microcontroller

Generally in designing of heart beat monitoring system, we use PIC 16F877/PIC 16F876/PIC16F874 Microcontroller, but the question is that.

- Why do we select PIC microcontroller instead of traditional MCS-51 microcontroller?
- Why do we choose PIC 16F877 among various microcontroller in PIC?

Solution of the problems

Comparison between PIC and MCS -51 microcontroller

Peripheral interface controller(PIC) is a family of microcontroller by microchip technology. PIC microcontroller is RISC processors and use Harvard architecture. This is different than Intel 8051 and most of the general purpose that use CISC processor and Von- Neumann architecture. Harvard architecture is a newer concept and comes out of the requirement to speed up the processor. Harvard architecture makes use of separate program and data memory. Function supported by PIC devices include analog to digital converter (ADC) Function built in power on reset and brown-out-reset features. Brown-out-reset means that when the power supply drops below certain range (4v in case of PIC) It causes PIC to reset. In case of MCS-51 there is no inbuilt ADC and brown-out-reset features.

The data memory of PIC is 8 bit wide. Whereas the PIC Program memory is 12, 14 and 16 bit wide but most of the time we used program memory 14 bit wide. But in case of MCS-51 data memory and program memory both is 8 bit wide.

There are only 35 PIC instructions which are easier for programmer to remember by practice. PIC Execute most of the instruction within 0.2 micro second when operated at its maximum clock rate. But in case of MCS-51 There is 111 instruction with clock speed 12MHZ.

PIC machine cycle consists of a 4 clock pulses in contrast with the 12 clock pulses per machine cycle in INTEL 8051.

Almost all PIC instructions have the same format. It means that all PIC register and addressing modes can be used interchangeably.

The oscillator frequency determining component of PIC can be a low cost RC circuit or a quartz crystal or a ceramic resonator. But in case of MCS-51 quartz crystal is required to make external connection of oscillator.

PIC supports a power saving sleep mode. The clock may be frozen with all the data preserved in the processor memory. A software command allows entering into this mode. It will be in sleep mode till PIC is reset again. Thisfeature is not available in MCS-51.

PIC has a watchdog timer with on-chip RC oscillator. A watchdog timer prevents the processor from endless loop hanging condition. In faulty condition watchdog timer reset the processors. It increases the system reliability.

Maximum 12 independent interrupt sources are supported by PIC. The operating voltage range typically is 3-6.0 V Power consumption is very low.

In above listed difference we easily conclude that why we used PIC microcontroller. But in our project we use Microcontroller 16F877 now we describe why we depend on PIC 16F877/PIC16F876/PIC16F874.

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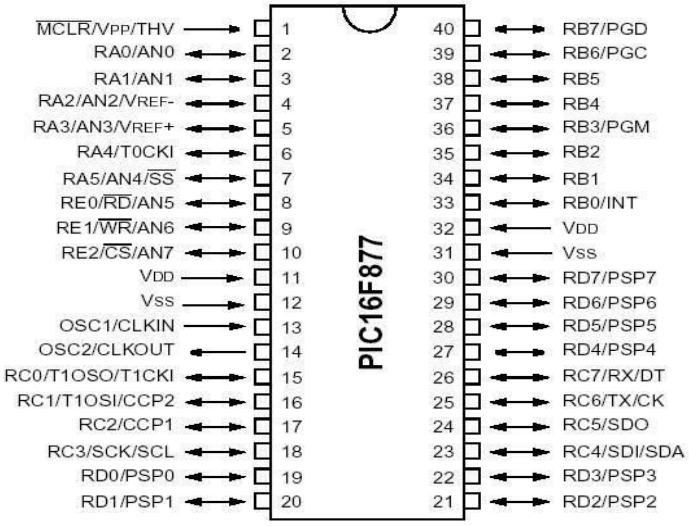
Pin diagram of pic 16f877- this pin diagram is compatible for 16f874 and 16f876 also.



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5. COMPARISON AND EXPLATION OF DIFFERENT 16F8XX MICRO- CONTROLLERS.

PIC part	ProgramMemory	No. of instructions	Data Memory	Timers	Input-output	Additional features
16F877	8K X 14 words flash	35 instructions	368 X 8 bytes of RAM and 256 X 8 bytes of EEPROM data memory	3 + Watch Dog Timer	PORTS A,B,C,D,E	• 8-channel 10 bit ADC • Brown-out-reset • Two capture/PWM module • Two serial port and a parallel slave port. • 14 interrupt sources
16F876	8K X 14 words flash	35 instructions	368 X 8 bytes of RAM and 256 X 8 bytes of EEPROM data memory	3 + Watch Dog Timer	PORTS A,B,C	• 5-channel 10 bit ADC • Brown-out-reset • Two capture/PWM module • Two serial port and a parallel slave port. 14 interrupt sources
16F874	4K X 14 words flash	35 instructions	256 X 8 bytes of RAM and 128 X 8 bytes of EEPROM data	3 + Watch Dog Timer	PORTS A,B,C,D,E	• 8-channel 10 bit ADC • Brown-out-reset • Two capture/PWM module • Two serial port and a parallel slave port. • 14 interrupt sources
16F873	4K X 14 words flash	35 instructions	128 X 8 bytes of RAM and 256 X 8 bytes of EEPROM data memory	3 + Watch Dog Timer	PORTS A,B,C	• 5-channel 10 bit ADC • Brown-out-reset • Two capture/PWM module • Two serial port and a parallel slave port. • 13 interrupt

The above comparison gives us a way to determine the type of micro-controllerthat would be used in ECG amplifie

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6. CONCLUSION

This paper presented here emphasizes the practical importance of bio potential circuit and its uses in ECG measurement. The paper presents the implementation of an ECG Monitoring system involving low cost amplifier, filter components and microcontroller. We can enhance the features of the project by enabling the transmission of ECG signals through mobiles, signal transmitters or internet.

REFERENCES

1) *Enderle j, Introduction to Biomedical Engineering, Academic Press, USA, 2000*
2) *Lee H., Park S, and Woo E., "Remote Patient Monitoring Through the Word-Wide Web", in Proceeding of the 19th International conference of IEEE, Chicago, IL, USA, pp 928-931, 1997*
3) *J.B. Gupta, Electronics devices and circuit;*
4) *Ajay deshmukh, Microcontroller theory and application*
5) *Microchip Manual, PC16F87X Data sheet 28/40-Pin 8 bit FLASH*
6) *Microcontrollers,Microchip Technology Inc., 2001*
7) *Abenstein J. and Tompking W., "A New DataReduction Algorithm for Real Time ECG Analysis," IEEE Transactions Biomedical Engineering, vol. 29, no. 1, pp. 43-47, 1982*
8) *Muhammad Ali Mazidi, PIC microcontroller Mohamed Fezari, Mounir Bousbia-Salah, and Mouldi Bedda Department of electronics,*
9) *University of Badji Mokhtar, Annaba*