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AT89C51 Microcontroller based Medical Two Channel ECG Module and Body Temperature Measurement with Graphics LCD

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Abstract— ***Human heart produce an electrical activity at every beat. The instrument that uses to record the electrical activity of the heart is called Electrocardiograph and recording of that activity is called Electrocardiogram (ECG). In this paper we describe a new model of ECG module with two channel input and body temperature measurement of human body based on AT89C51 microcontroller. This electronic system have analog circuit, ADC circuit, microcontroller unit, a Graphical LCD and an analog circuit to measure temperature. The system takes the physical pulse input using sticking electrodes stuck to the arms and right leg of the patient under observation. The model encompasses of instrumentation amplifier and filter circuits etc.***

Keywords— ***Graphic LCD, Electrocardiograph, IC-LM35, AD620 Instrumentation Amplifier, High pass and Low Pass Filter,***

I. INTRODUCTION

The electrocardiogram (ECG) is a diagnostic tool that is routinely used to monitor the electrical and muscular functions of the heart. A typical single cardiac waveform of a normal Heart beat as it appears on electro-cardiograph charts the voltages produced represent pressures exerted by the heart muscles in one pumping cycle. Is shown in Figure 1. The heart is a two stage electrical pump and the heart's electrical activity can be measured by electrodes placed on the skin. The electrocardiogram can measure the rate and rhythm of the heartbeat, as well as provide indirect evidence of blood flow to the heart muscle. The ECG signal strip is a graphic tracing of the electrical activity of the heart. It measures the length of time taken for the initial impulse to fire at the Sinus Node and then ends in the contracting of the Ventricles. The first upward pulse of the EKG signal, the P wave, is formed when the atria (the two upper chambers of the heart) contract to pump blood into the ventricles. When the two lower chamber of the heart (ventricles) are contracting to pump out blood the next spike pulse the QRS is formed more cell depolarization cause a stronger signal QRS. The next section the ST segment, measures the end of the contraction of the ventricles to the beginning of the rest period before the ventricles begin to contract for the next beat. The next slight rising section, the T wave, measures the resting period of the ventricles. It is one of the life signs monitored in many medical and intensive care procedures. Any deviation from the norm in a particular electrocardiogram is indicative of a possible heart disorder. Instrumentation is provided to alert medical staff member to any changes detected in the cardiac function. Information that can be obtained from an electrocardiogram includes whether the heart is enlarged and where the enlargement occurs, whether the heart action is irregular.

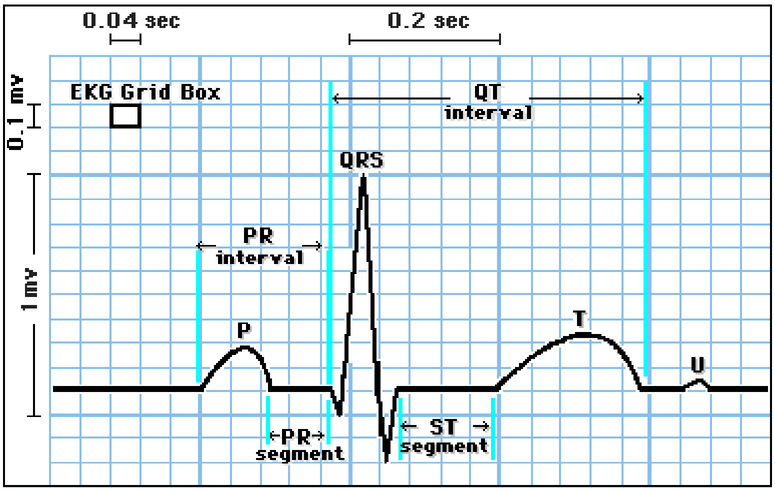

Fig. 1. Example of an ECG Signal

II. OVERVIEW OF THE TECHNOLOGY

1) 128x24 Graphic LCD

The Graphic Liquid Crystal Display (GLCD) use an electronic visual display technology. Graphic LCD used as an information output sources and different gadgets, mostly in display screens of many electronic devices. This technology employs manipulating tiny crystals of a contained liquid crystal solution through precise electronic signals to perform graphic display.

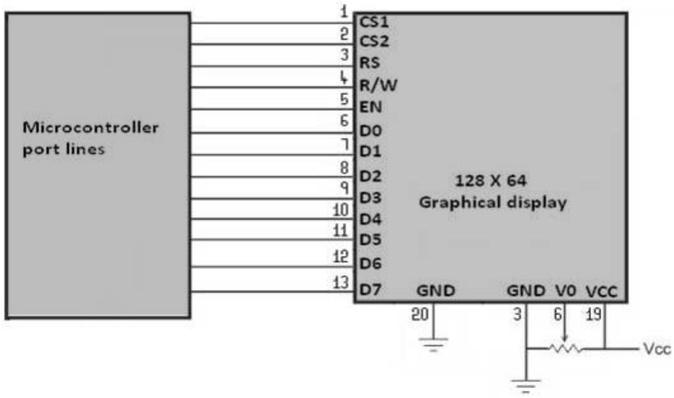

Fig. 2. Interfacing of Graphic LCD with AT89351

We can interface Graphic LCD module with microcontroller AT89C51 in two ways 8-bit interfacing and 4-bit interfacing, the 8-bit interfacing is two time more fast then 4-bit Interfacing here we are using 8-bit interfacing method. Figure 2. Shows how to interface the GLCD to microcontroller. The GLCD needed to use 8-bit interface, 8 data bits, address bit, read/write bit, three control lines and control signal to adjust contrast by trim pot. The initialisation process is always done at the beginning of the software program before we start displaying anything on the screen. It is done by sending a series of commands through data lines from the microcontroller AT89C51 to the Graphic LCD module. Some commands can be need more data therefore should be sent with corresponding data bytes. The C/D pin of the LCD module must be pulled high when sending the command, and pulled low when sending the data.

2) AD620 Instrumentation Amplifier

To set the gain of 1 to 10000 we need only one single external resistor in AD620 IC. Furthermore It is also have high accuracy, the AD620 features 8-lead SOIC and DIP packaging that is smaller than discrete designs and offers lower power (only 1.3 mA max supply current), making it a good fit for battery-powered, portable (or remote) applications. The AD620, with its high accuracy of 40 ppm maximum nonlinearity, low offset voltage of 50 μV max, and offset drift of 0.6 μV/°C max, is ideal for use in precision data acquisition systems, such as weigh scales and transducer interfaces. Furthermore, the low noise, low input bias current, and low power of the AD620 make it well suited for medical applications, such as ECG and blood pressure monitors. The AD620 works well as a pre amplifier due to its low input voltage noise of 9 nV/√Hz at 1 kHz, 0.28 μV p-p in the 0.1 Hz to 10 Hz band, and 0.1 pA/√Hz input current noise.

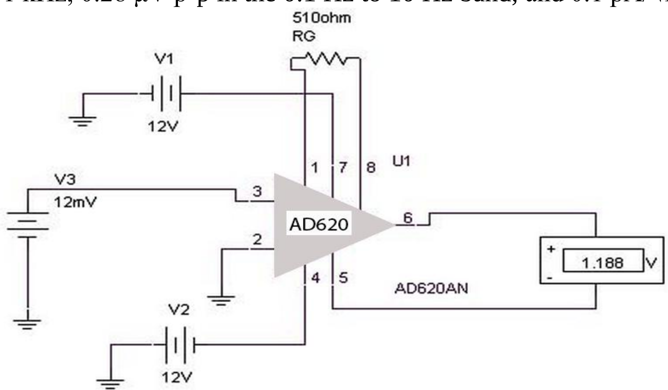

Fig. 3. Instrumentation Amplifier

Also, the AD620 is well suited for multiplexed applications with its settling time of 15 μS to 0.01%, and its cost is low enough to enable designs with one in-amp per channel. The Instrumentation Amplifier most used amplifier in the medical instrumentation especially in ECG. It is high accuracy instrumentation amplifier that requires only one external resistor to set gains of 1 to 1000 according to the following equation:

$$G = (49.9\ k\_/RG) + 1$$

The 12mV positive pin is connected to the Non inverting input, Pin 2 is connected to the inverting input and for proper isolation for the patient the IA is powered from the isolation module provide an isolated ground to the patient that is connected to the Right Leg of patient. The output from the IA is the picked up ECG amplified ten times as we use RG=5.1*k*

3) ADC and AT89C51 microcontroller

The ADC0808, data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bitA/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256Rvoltage divider with analog switch tree and a successive approximation register. The 8-channelmultiplexer can directly access any of 8-single-ended analog signals. The design of the ADC0808 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The ADC0808, offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. The device contains an 8-channel single-ended analog signal multiplexer. A particular input channel is selected by using the address decoder. Fig. 3. Shows the input states for the address lines to select any channel. The address is latched into the decoder on the low-to-high transition of the address latch enable signal.

SELECTED ANALOG CHANNEL	ADDRESS LINE		
	C	B	A
IN0	L	L	L
IN1	L	L	H
IN2	L	H	L
IN3	L	H	H
IN4	H	L	L
IN5	H	L	H
IN6	H	H	L
IN7	H	H	H [RB1]

Fig. 4. Address lines to select channels

The 8-bit A/D converter uses successive approximation as the conversion technique. The device eliminates the need for external zero and full-scale adjustments. The non-isolated ECG is connected to channel number 0. The 8051 collect the data from ADC upon a programmable timer interrupt. The data collected by the 8051 is displayed on a 240x128 graphics LCD. Figure 5 shows the designed ADC with 8051 controller.

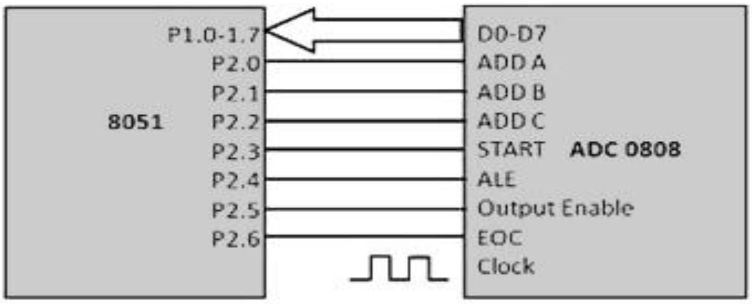

Fig. 5. Interfacing of ADC0808 with AT89351

In the ADC0808, $V_{ref}(+)$ and $V_{ref}(-)$ set the reference voltage. If $V_{ref}(-)$ = Gnd and $V_{ref}(+)$ = 5V, the step size is 5V/256 = 19.53mV. Therefore, to get a 10mV step size we need to set $V_{ref}(+)$ = 2.56V and $V_{ref}(-)$ = Gnd. From figure given below of ADC0808, notice the ALE pins. We use A, B, and C addresses to select IN0 – IN7, and activate ALE to latch in the address. SC is for the start conversion. SC is same as the WR pin in other ADC chips. EOC is for end-of-conversion, and OE is for output enable (READ). The EOC and OE are the same as the INTR and RD pins respectively.

4) High pass, low pass filters

Each electrogram collected is passed through a series of filters that are each designed to remove specific type of information. The filtering used on each electrogram will have a significant impact on what information is removed, and thus what information is displayed, on each electrogram visualized. The most common filter is the noise filter. A noise filter is designed to remove specific high and mid-range frequency signals while allowing other lower frequencies to pass. This design works to eliminate electronic source noise or power line noise from most signals. Electronic source noise is produced internally by circuits within the system during operation. Band pass filter which uses a combination of high pass and low pass filters to remove unwanted information from the recorded electrogram. A high pass filter blocks low frequency signals and allows the higher frequencies to pass. This type of filter is designed to remove physiologic waveforms such as the low frequency myopotential emitted by the diaphragm or the slow far field signals from cardiac chambers outside the chamber we are mapping. The low pass filter allows lower frequencies to pass and helps to remove high frequency environmental noise that comes from outside the recording system.

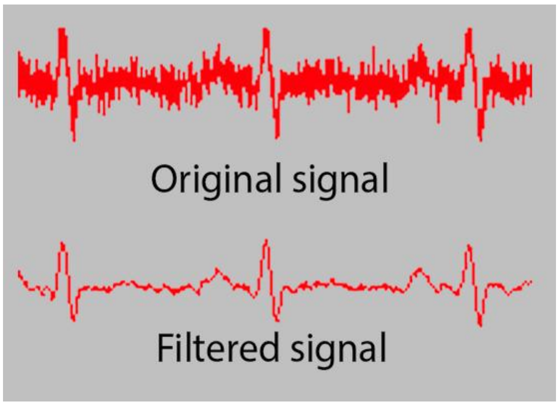

Fig. 6. Original signal and Filtered signal

A filter should remove noise without affecting the signal we are interested in. Unfortunately, this is rarely possible. One reason is that the signal and noise may share the same frequencies. Mains noise (50/60Hz), muscle noise and drift in dc offsets due to patient movement all fall in the same frequency range as a typical ECG. Another problem is that practical filters normally don't have a sharp edge between the "pass" band and the "cut" band. Rather there is usually a slow transition in the filters response, so if the wanted and unwanted signals are close we may not be able to remove the noise without removing some of the desired signal.

5) ICLM35 and AT89C51 microcontroller

LM35 IC is a temperature Sensor IC. It sense the temperature and covert it equivalent voltage label. The LM35 circuit simply consists of selecting a load resistor between the output pin and ground. The value of this resistor is determined by the supply voltage which is about 5V. When supplying 5 volt VCC on LM35 then it convert o.o1v per 1° of voltage change. The output of ADC then directly feed to channel 0 of IC ADC0808. And this IC convert the input voltage in 8-bit binary number. For voltage 0.01v the output will be generated 00000001 in 8-bit position. When the ambient temperature is sensed by LM35 temperature sensor which produces an output voltage proportional to the temperature at a rate of 10mV per degree Celsius. This analog voltage is fed to the analog to digital converter which is an 8 bit converter working on the principle of successive approximation conversion. The analog to digital converter is controlled by a microcontroller. As per the program, the input line is first selected by sending output signals from the microcontroller to the address pins of the ADC. A high logic signal is then given to the ALE pin of the ADC to latch the address. A high logic signal is also given to the Start pin of ADC to start the successive approximation register. After sometimes a low logic signal is given to both ALE and Start pins to start the conversion. After some time when the EOC pin of ADC goes low, microcontroller receives an interrupt. This indicates end of conversion. The OE pin is then given a high logic signal to receive the digital output from ADC. After sometime OE is given low logic signal to store the converted value to the register. The microcontroller then processes the digital output in hexadecimal form to get the value in decimal form. This value is then displayed on the left corner of The Graphic LCD screen. The IC-LM35 and ECG Unit using same ADC0808 but in different time allocation.

III. FRAME WORK OF THE SYSTEM

1) Block Diagram

The block diagram of the designed AT89C51 Microcontroller based Medical Two Channel ECG Module and Body Temperature Measurement with Graphics LCD shown in Figure 2 consists of an instrumentation amplifier (AD620) and filters, k-grade isolation module, AT86C51 Microcontroller, band pass filter (high pass the low pass) for selecting the appreciate contents of ECG Signal. After that the TX family IC-ADC0808 collect the analog signal and convert it to digital 8-bit form and send it to AT86C51 Microcontroller that fetch the data and display it in to Graphic LCD,

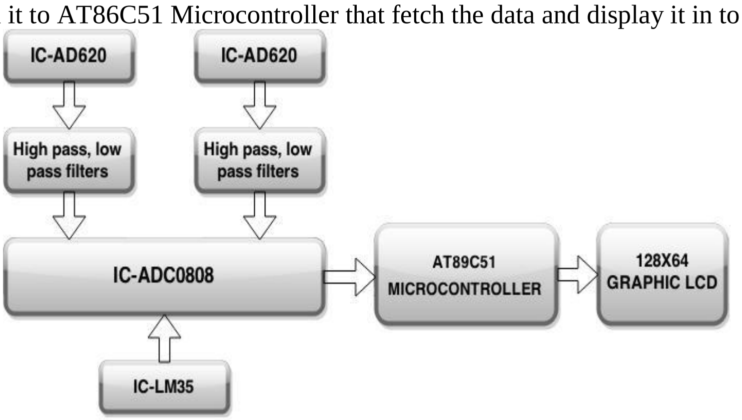

Fig. 7. Block Diagram

Most important task is to program microcontroller to take input and display it on the graphic LCD. Basic c language programming have been done in a fashion compatible with graphic LCD so that it could display both cardio graph and temperature in Fahrenheit scale and have red alert display if cardio graph is different from normal functioning cardio graph.

2) Implementation of the system

There are 3 leads in this ECG the AHA calls these leads RA, LA and, LL. Next, clean the electrode skin site to remove excess oils that could screw up the hearts electrical signal. If the patient has excess chest hair, use a shaver to remove the hair. Failure to obey these rules will cause artefact on the ECG monitor, there are two types of ways to place the electrode. In Way one (chest electrode ECG) The 3 electrode can be placed on the chest it is shown in the fig no-8, In way two The electrode can be put on the arms and the left leg shown in figure no-9, the limb electrode shouldn't be positioned too low on the limb since you won't receive a very strong signal that is putting the electrodes on the fingers and toes.

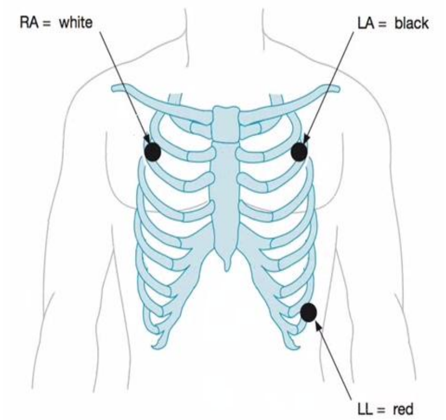

Fig. 8. Placing the electrode way 1

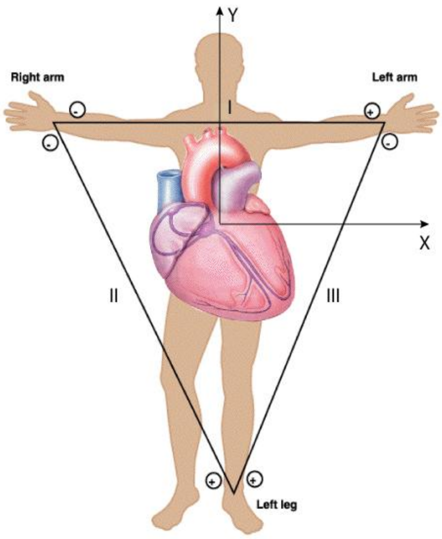

Fig. 9. Placing the electrode way 2

IV. CONCLUSION

We have completed hardware part and required programming for graphic LCD to display the output. The results have been remarkably close to the prediction or actual value. It is practical application and very feasible to implement as a low budget ECG plus body temperature measurement as a household application

REFERENCES

[1] Braunwald E. (Editor), Heart Disease: A Textbook of Cardiovascular Medicine, Fifth Edition, p. 108, Philadelphia, W.B. Saunders Co., 1997. ISBN 0-7216-5666-8.

[2] J. G. Webster, "Medical Instrumentation, Application and Design". 3rd Edn., 2010, Wiley.. ISBN : 978-0-471-67600-3.

[3] J. Tomcsanyi and Beezeg P, "Home ECG Monitoring of High Risk Post-Myocardial Infraction Patients, Orv. Hetil 2009, 150(21): 985-988

[4] A. Rosado, Batallet, M., Guerrero J. F. Calpe J. Frances JV, and Magdalena JR., " High Performance Hardware Correlation Coefficient Assessment Using Programmable Logic for ECG Signals, Microprocessors and Microsystems, 2003, 33:19-27

[5] "2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care - Part 8: Stabilization of the Patient With Acute Coronary Syndromes." Circulation 2005; 112: IV-89-IV-110

[6] C. Aleksander Zoric, Sinisa S.llic, " PC Based Electrocardiography & Data Acquistion", TELSIKS, IEEE, ,September 28-30-2005.,619-622

[7] G.M.Patil, K.Subbarao, V.D.Mytri, A.D. Rajkumar, D.N.Reddy and K. "Embedded Microcontroller based Digital Telemonitoring System for ECG", J. Instrum.Soc. India 37(2) 134-149.

[8] A. Karilainen, T. Finnberg et. Al... Mobile Patient Monitoring Based on Impedance-Loaded SAW-Sensors. IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control. Vol. 51. No. 11. Pp 1464 – 1469.2004.

[9] Jose J.Segura, David Cuesta-Frau, Luis Samblas-Pena Mateo Aboy. "A Microcontroller Based Portable Electro-cardiograph Recorder". IEEE Transaction on biomedical Engineering, 2004:51(9), 1686-1690.

[10] R.L. Lux, C.R. Smith, R.F. Wyatt, and J.A. Abildskov.," Limited lead selection for estimation of body surface potential Maps in electrocardiography". IEEE Transaction Biomedical Eng., 25:270–276, 1978.

[11] J. Adam and R. J. Rak, " Effective Simulation of Signals for Testing ECG Analyzer" , IEEE Transactions on Instrumentation and Measurement, vol 54, No. 3, June 2005.

[12] S. Korsakes et. al, 2006, " The Mobile ECG and Motion Activity Monitoring System for Home Care Patient" ,Computers in Cardiology, 2006, 33:833-836.

[13] A. AlMejrad , "Design of intelligent system for speech monitoring and treatment of low and excessive vocal intensity", Journal of Artificial Life and Robotics, 2010, Vol.15:320-324, DOI: 10.1007/s10015-010-0816-5.

[14] S. Kara Sadik, Kemalogu and S. Kirbas, " Low Cost Compact ECG with Graphic LCD and Phonocardiogram System Design", J. Med. Sys. , 2006, 30:205-209.