# ECG HEALTH MONITORING SYSTEM

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## ABSTRACT

Designing ECG System with low-power consumption and portable system. 3-electrode ECG sensor will be used in the proposed system, patient's parameter such as ECG, Temperature and Heart Beats will be continuously transmitted and monitored through wireless technology. The need for better support of cordiac case prompted the extension of system to include the continuous acquisition of 3-lead ECGs and real-time ECG transmission to the MATLAB. The 3-lead ECG module has been developed and integrated in the existing system with attention to the provision of and easy user interface so that the extra work required to the ambulance is negligible. This system does not require the patient to be confined to his bed and allow him to move freely in his room within a specific distance from the doctor's monitor.

**Keyword :** - Temperature Sensor, ECG Sensor, GSM, LCD Display, PL2303, Microcontroller, MATLAB (PC),Power Supply.

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## *1.* Introduction

In this article we propose a patient monitoring system, facilitating early detection of disease. We take patient location tracking, and the location information can then be recorded in a local database. With knowledge of the movement patterns of a patient, a medical practitioner is more likely to be able to determine whether a target patient is developing disease. The proposed patient monitoring system would be beneficial for medical practitioners for proper and better treatment; also it would be useful for health care provider to improve disease management. The patient is monitored from ICU and the data send to the Computer is wired. Recent work includes using

GSM technology report signs to PDAs held by the patient or his doctor. Monitoring based on ultra wideband-based personal area network was reported in monitoring. Compared to Bluetooth, ZigBee, GSM provides higher network flexibility and a greater number of nodes, and a better transmission range with low power consumption. Recently, GSM-based wireless networks were tested in various applications. In the proposed system, patient's parameters such as ECG, Temperature and Heart Beats will be continuously transmitted and monitored through wireless technology GSM. These systems do not require the patient to be confined to his bed and allows patient to move freely in his room within a specific distance from the doctor's monitor

## 2. Block Diagram

Heart of the system is ATmega 16, to which all the peripheral have to interface. ATmega 16 is low power CMOS 8 bit microcontroller based on AVR enhanced RISC architecture.

In this system LM35 temperature sensor is used .LM35 is the series precision integrated circuit temperature device with an output voltages linearly proportional to the centigrade temperature.

Temperature sensor sense the temperature of patient’s body and then displays on LCD display and also MATLAB.

ECG sensor gives the ECG value in digital count to the MATLAB also to the LCD display. Through this digital count patient’s condition is messaged through GSM to doctor and patients family member.One more input is used, is the stoared ECG on database. Through this database we conclude the condition of patient.

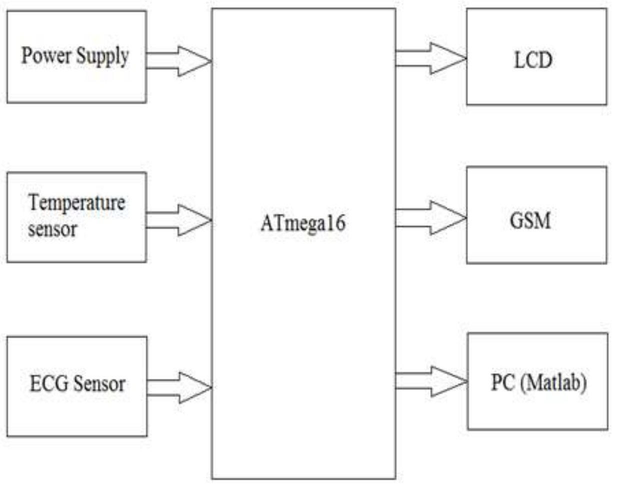


**Fig1:Block Diagram**

**2.1 Temperature Sensor (LM 35):**

The LM35 series are precision integrated circuits temperature devices with an output voltage linearly proportional to the centigrade temperature. The LM35 device has advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient in centigrade scaling.

**Features:**

- Calibrated directly in Celsius.
- Suitable for remote applications.
- Operates from 4V to 30V.
- Low cost due to Wafer-Level Trimming

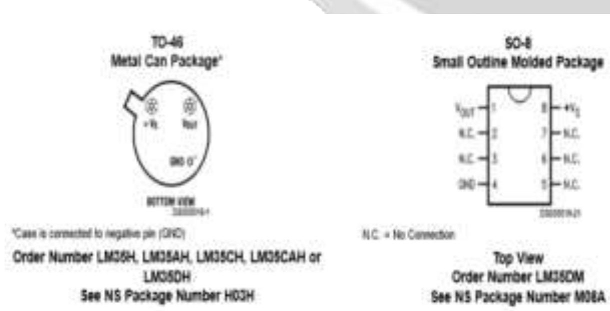


Fig. LM35

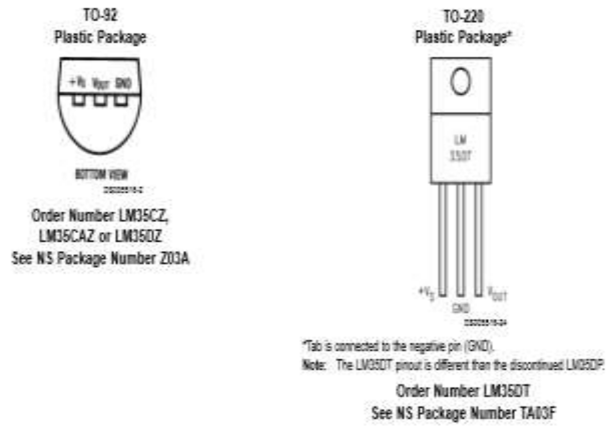


Fig (b) LM35

## 2.2 ECG Sensor:

Heartbeats are triggered by bioelectrical signals of very low amplitude generated by special set of heart (the SA node).Electrocardiography (ECG) enables the translation of this electrical signal into numerical values. Enabling them to be used in the wide array of application . Our sensor allow data acquisition not only at the chest ("off-the-person"), and works both with pre-gelled and most type of dry electrodes. The bipolar configuration is ideal for low noise.

**Features:**

- Bipolar differential measurement.
- Pre-conditioned analog output.
- High signal-to-noise ratio.
- Small form factor.
- Easy to use.
- "on –the-person "and "off-the-person"

**Specification:**

- Gain:1100
- Range:+1.5mV
- Bandwidth:0.5-40Hz
- Consumption:~4mA
- CMRR:110dB
- Electrodes:2 or 3
- Input Impedance:100 GOhm

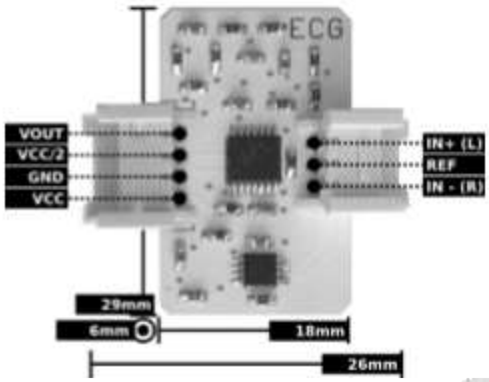


Fig.(a) pin-out and physical dimensions

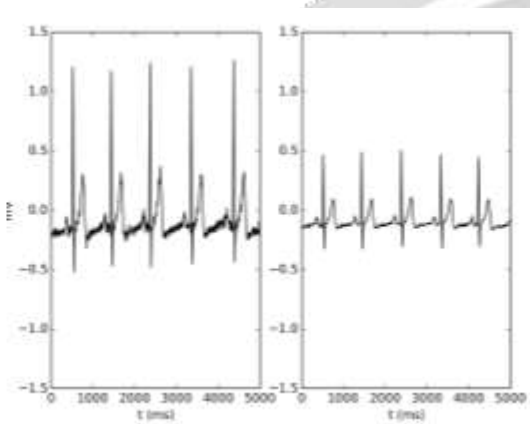


Fig.(b) Typical raw ECG data (acquired with BITalino)

Using 2 electrodes at the hands (Left)

Using 3electrodes at the chest (right).

Fig. (c) Example of a 2 electrode placement at the

Hands (Left) and a 3 electrode placement

At the chest (right).

**WORKING OF ECG SENSOR:**

The circuit consist an instrumentation amplifier (the AD620) to take the voltage difference between two spot on the body. A 2nd amplifier (the CA3140) amplifies this differential signal. A potentiometer is used to siphon off current from the negative input of the 2nd amplifier, and tuned to remove the DC offset resulting from the inevitable and unpredictable static voltage difference between any two spot on the body: unless removed, the DC offset causes the 2nd amplifier to saturate its output at power or ground. Because we power the amplifier using only the +5V and ground levels from micro-controller board we need to split the supplies for the amplifiers, which require for a positive and a negative supply line. To do so, we use a voltage divider circuit to define a virtual ground at 5V/2 = 2.5V, and then use +5V and microcontroller ground as the -ve and +ve supply lines, respectively. An electrode held at ground electrode is also placed on the body at a third location. Both Low and high pass filtering are performed in-between amplification steps and during the 2nd amplification step, and then a bank of three low-pass filters follows after amplification to remove extra 60 Hz noise. Those interested in understanding the accurate frequency response of the system should do a full calculation (e.g., using the Op Amp golden rules and the rules for frequency dependent impedance of resistors and capacitors) or a Spice simulation, because the filters going through the 2nd amplification stage cannot be treated simply as individual high and low pass filters in series. According to the data sheet: Gain = (49.9 kilo Ohm / R_G) + 1 where R_G is the gain resistor. Therefore a 49.4 * (10^3)/22 = 2.2 kOhm R_G resistor leads to a gain in the first stage of amplification of around 23. The 2nd amplifier should give an additional factor of around 1 megaOhm/(2.2 kOhm) = 455. The filtering may remove some frequency components. So the total gain is over 1e4, theoretically. In the below, we are usually measuring signals of around 1V, which is about 1000x higher than the millivolt-range signals characteristic of ECG, even after filtering, and even using the fabric

### 2.1 GSM:

The GSM (Global System For Mobile Communication) system is the most widely used cellular technology in use in the world today. It has been particularly successful cellular phone technology for variety of regions including the ability to rom world wild with the sertainty of being able to be operate on GSM network in exactly the same way - provide billing agreements in place. The GSM system is designed as a second generation cellular phone technology. one of the basic aims was to provide a system that would able greater capacity to be achieved than the previous first generation analogue system.GSM achieved this by using a digital TDMA(Time Division Multiple Access).

**GSM Basics**

The GSM cellular technology had a no. of design aims when the development started:

- It should offer better subjective speech quality.
- It should have a low phone or terminal cost.
- Terminal should be able to handle.
- The system should support international roaming.
- It should offer good spectral efficiency.

### 2.3 ATmega16

The ATmega16 is low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By to carry out powerful instructions in a single clock cycle. The ATmega16 throughputs approaching 1MIPS pre MHz allowing the system designed to optimize power usage versus processing speed. The ATmega16 provides the following features like: 16K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1K byte SRAM, 32 general purpose Input Output lines, 32 general purpose working register, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer or Counters with compare modes, Internal and External Interrupts, serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-

channel, 10-bit ADC with optional differential I/P stage with programmable gain a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, ADC, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to sustain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all Input Output modules except Asynchronous Timer, ADC to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows fast start-up combined with low-power consumption. In Extended Standby mode, the main Oscillator and the Asynchronous Timer continue to run.


Fig.Pin Diagram

In order to maximize performance and parallelism, the AVR uses Harvard architecture – with separate memories & buses for program and data. Instructions in the program memory are executed with a single level pipelining. While one instruction is being execute, the next instruction is pre-fetched from the program memory. This concept enables instructions to be executed in every clock cycle. The program memory is In-System Reprogrammable Flash memory. Fast-access Register File contains 32 x 8-bit general purpose working registers with a single clock cycle access time. This allows single-cycle Arithmetic Logic Unit (ALU) operation. In a typical ALU operation, there are two operands are output from the Register File, the operation is executed, and the result is stored back in the Register File in one clock cycle. 6 of the 32 registers can be trite as three 16-bit address register pointers for Data Space addressing – enabling efficient address calculations. One of the these address pointers can also be used as address pointer for look up tables in Flash Program memory. These added function registers are the 16-bit X-, Y-, and Z-register, described later in this section.The ALU supports arithmetic, logic operations between registers or and a constant register. Single register operations can also be executed in the ALU. After an arithmetic operation the Status Register is updated to reflect information about the operation. Program flow is provided by conditional and unconditional jump and call instructions able to directly address the whole address space. Most AVR instructions have a single Sixteen-bit word format. Very program memory address contains a 16- or 32-bit instruction.Program Flash memory space is divided in 2 sections, the Boot program and the Application Program section. These both sections have dedicated Lock bits for write and read or write protection. The SPM instruction that writes in the Application of the Flash memory section must reside in the Boot Program section. During interrupts calls and subroutine calls, the return address Program Counter (PC) is stored on the Stack. The Stack is effectively allocated in the general data Static RAM, and consequently the Stack size is only limited by the total SRAM size and the usage of the SRAM. All user programs must initialize the SP in the reset routine. The SP is read/write accessible in the Input Output space. The data Static RAM can easily be accessed through the 5 different addressing modes supported in the AVR architecture. The memory spaces in the AVR architecture are linear and regular memory maps. A flexible interrupt module has its control registers in the Input Output space with an additional global interrupt enable bit in the Status Register. All interrupts have a different interrupt vector in the interrupt vector table. The interrupts have priority in accordingly with their interrupt vector position. The lower the interrupt vector address, the higher the priority. The Input Output memory space contains 64 addresses for CPU peripheral functions as Control Registers, SPI, and other Input Output functions.

## 2.4 LCD Display:

LCD (Liquid Crystal Display) screen is an electronic display module and search a wide range of applications. A 16x2 LCD display is very basic module and is very broadly used in various devices and circuits. These modules are preferred over 7 segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; no limitation of displaying special & even custom characters (unlike in 7 segments), animations and so on A 16x2 LCD means it can be display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has 2 registers, namely, Command and Data. The command register store the command instruction gives to the LCD. A command is instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data for display on the LCD. The data is the ASCII an value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD

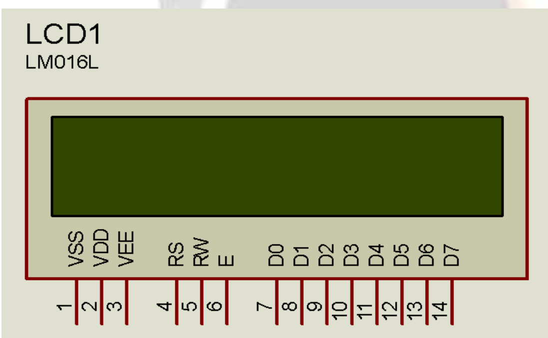


Fig.LCD Display

**Features of LCD**

- Type: Character
- Display format: 16 x 2 characters
- Built-in controller: ST 7066 (or equivalent)
- Duty cycle: 1/16
- 5 x 8 dots includes cursor
- power supply: + 5 V
- Optional: Smaller character

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## 6. REFERENCES

[1] Author- F.Chiarugi, D.Trypakis, P. j. Lees. "Continuous ECG Monitoring in Management of Pre-Hospital Health Emergencies." Published in-2003. IEEE.

[2] Author-Prima Puneet Singh, "Zigbee and GSM Based Patient Health Monitoring System",

Published in- 2014. IEEE.

[3]Publisher- The American Journal of Psychiatry, **"**Physical Health Monitoring of Patients With Schizophrenia", Year- August 01, 2004.

[4] Author-R.Suji Pramila, Shajin Nargunam, "A Survey on Effective in-Home Health Monitoring System", Year- April 2013.

[5]Author- wolfgang. leister, habtamu,arne-kristian.groven.,"Threat Assessment of Wireless Patient Monitoring Systems", Published in- 23 May 2008 .,**Publisher-** IEEE.

[6] Author –Cardiology. "eHealth in cardiovascular medicine: A clinical update *European Journal of Preventive", Publish in* -October 1, 2016 .

[7]Author-Leisch E, Orphanoudakis. HECTOR solution.1st "International Conference on Health Emergency Telematics Seville",Spain,1999.

[8]Author-Leisch E,Orphanoudakis HECTOR Pilot System of crete as part of a Regional Health Telematics Network 1st "International Conference on Health Emergency Telematics Seville",Published-Spain,1999.

[9] Author-Giovas P,Papadoyannis D,Thomakos D,soulis D,Stamateopoulos C,Mavrogeni S, Kapsilambros N,Papazachos G,Rallidis M. "Transmission of Electocardiograms from a moving ambulance journal of Telemedicine and Telecare",Published -1998.

[10]Author-Chiarugi F,Spanakis M,Lees PJ,Chronaki CE,Tsiknakis M,Praganitis A,Orphanoudakis SC."Real – Time Cardiac Monitoring over a Regional Health Network"

[11] Author-R. Fensli; E. Gunnarson; T. Gundersen, "A wearable ecg-recording system for continuous arrhythmia monitoring in a wireless tele-home-care situation."

[12]Author- Daniel Lucani; Giancarlos Cataldo; Julio Cruz; Guillermo Villegas; Sara Wong;" A portable ecg monitoring device with bluetooth and holter capabilities for telemedicine applications".Published- 30 Aug.-3 Sept. 2006