

## Implementation of GSM Based Heart Rate and Temperature Monitoring System

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Available online at: [www.isca.in](http://www.isca.in)

Received 25<sup>th</sup> February 2013, revised 25<sup>th</sup> March 2013, accepted 15<sup>th</sup> April 2013

### Abstract

There is a vast growth of VLSI technology and GSM communication in these days. This project deals about the implementation of GSM technology in Medical applications. This wireless communications would not only provide them with safe and accurate monitoring but also the freedom of movement. In this, heart beat and temperature of patient are measured by using sensors as analog data, later it is converted into digital data using ADC which is suitable for wireless transmission using paging messages through GSM modem. AT89S52 micro controller device is used for temporary storage of the data used for transmission.

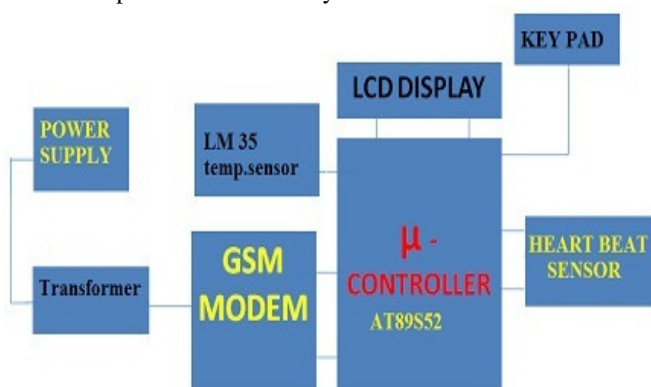
**Keywords:** Heart Beat Sensor, LM35, GSM module, AT89S52 Microcontroller.

### Introduction

This project is useful in medical applications and offers less cost and size than ECG (Electro Cardiogram). In the case of emergency for old people who are suffering with heart diseases continuous monitoring of the patient<sup>1,2</sup> is required which is sometimes not possible in the hospital, or the patient location is far away from the hospital. In such a case this prototype circuit is useful to measure the heart rate<sup>3</sup> as well as temperature of the person<sup>4</sup> and the information is transmitted to the medical advisory for the preliminary precautions so that patient can be under control, prevented from serious situation before reaching to the hospital.

### System Hardware and Working Principle

The system majorly consists of three components like Heart rate sensor circuit<sup>5</sup>, GSM modem and MCU (AT89S52). Let us see the brief explanation of circuitry.



**Figure-1**  
**Block Diagram of Proposed Prototype**

### Heart Rate Sensor and Temperature Unit

It consists of LED (light emitting diode) and LDR (light detection resistor) which are placed parallel to each other. LED emits IR (Infrared) rays so that, when the finger is placed in between LED and LDR so that there exists some systolic pressure<sup>6,7</sup>. LED emits IR rays which are travelled through finger and blood flows with arteriole pressure. Whenever systolic pressure is applied, normal pressure of blood flow is disturbed at finger tip which is high and IR rays penetrate through blood and are received by LDR. The signals are analog which are converted into digital by ADC (Analog-Digital Converter), suitable for the MCU. LM35 temperature sensor<sup>8</sup> is used to measure the temperature and connected to MCU. This sensor unit works under low power DC input of 5V which is controlled by a mini transformer.

### Microcontroller

This system uses AT89S52 MCU<sup>9</sup> featuring ultra low power, small volume and high in performance and it consists of CMOS 8-bit CPU with registers A and B. It has on chip EPROM of 8Kbytes and Internal RAM (Random Access Memory) of 128 bytes. Crystal oscillator generates continuous cycles and can be reset by RST.

ALE/PROG is used to latch the address to during accesses of external ROM (Read Only Memory) and for controlling timing pulses. PSEN is activated while reading data from external memory. XTAL1 and XTAL2 are used as oscillatory input and output for controlling timing signals.

**MAX232:** Since GSM supports digital data transmission, MAX232 is used to convert the digital data in the serial form using parallel-in-serial-out shift registers suitable for wireless

communication. UART IC chip allows the digital data transmission in the form of bits (bits per second) in asynchronous manner (characters transmission). RS232 standards are used for serial communication<sup>9</sup>, which are not TTL (Transistor-Transistor-Logic) compatible.

**GSM:** GSM is abbreviated as Global System for Mobile Communication<sup>10</sup>. GSM modem has a slot for inserting SIM (Subscriber Identity Module). GSM network contains Mobile Station, Base station subsystem and Network subsystem. Mobile station contains IMEI number and SIM has IMSI number. Base station subsystem contains Base Transceiver Station which has antennas for communication and Base Station Controller which controls multiple base stations. Network subsystem contains VLR (Visitor Location Register), HLR (Home Location Register), AuC (Authentication Center) and EIR (Equipment Identity Register). MSC (Mobile Switching Center) is the major part which is the gate way for communication between mobile station and PSTN. HLR stores the information about the subscriber and the current location of subscriber. VLR provides the services to the subscribers of HLR who are visitor users. AUC gives the security of the user and to identify the location of the subscriber. EIR is also for security purpose and to identify the mobile station. MAX232 is connected to GSM modem so that it is useful for serial data transmission. OSS (Operation Support System) is used to control the traffic of users.

**SMS at Commands:** In order to communicate with the GSM modem we have a special set of commands called SMS AT-Commands.

AT+CMGD	Delete SMS Message
AT+CMGF	Select SMS Message Format
AT+CMGL	List SMS Messages
AT+CMGR	Read SMS Message
AT+CMGS	Send SMS Message
AT+CMGW	Write SMS Message To Memory
AT+CMSS	Send SMS Message From Storage
AT+CMGC	Send SMS Command
AT+CNMI	New SMS Message Indication
AT+CPMS	Preferred SMS Message Storage
AT+CRES	Restore SMS Settings
AT+CSAS	Save SMS Settings
AT+CSCB	Select Cell Broadcast SMS Messages
AT+CSDH	Show SMS Text Mode Parameters
AT+CSMP	Set SMS Text Mode Parameters
AT+CSMS	Select Message Service

**LCD:** LCD is a liquid crystal display<sup>9</sup> and there are 14-pin and 16-pin displays. Among them 16-pin display is used which has additional features than 14-pin like background color transition and more than 80 characters are displayed. RS pin resets the display after some delay, 4 data lines are connected to MCU.

**Software:** Initially after switch on the hardware circuit we designed, program variables are initialized, LCD is initialized<sup>9</sup> by using cmd\_lcd( ) and GSM modem is initialized using (AT+CMGF) command. On the LCD we get the message as “CHECK HB/Temp”. After pressing the Reset Switch the Heart beat and Temperature calculation takes place. Heart beat sensor gets the beats count for 10sec and converts it beats per minute value (bpm) by using the formula mentioned below  
Count = 6 \* Count / it is a heartbeat in bpm

In order to get the accurate value of heart beat, we’ve measured three readings and displaying the average value of three readings on the LCD.

Simultaneously the hardware we designed calculates the body temperature of the concerned patient in °C (Celsius)

Finally the measured readings of Heartbeat and Temperature are sent to the concerned medical expert by using AT+CMGS command<sup>10</sup>.

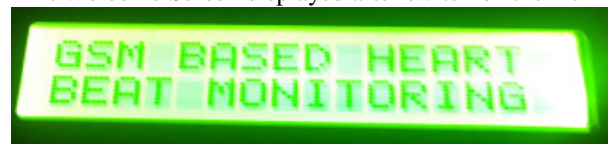
After sending sms, on the LCD we obtain the message as “message sent”.

## Test and Result

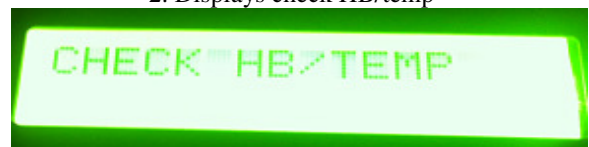
Heart rate sensor and LM35 sensor senses the heart rate and temperature of person by taking the average of ten readings by fixing maximum and minimum values (normal range of heart beat is 60-100bpm and 98.6°F) and the data is transferred to MCU. Crystal oscillator generates 11.0952MHz of signals used for operation and by enable input MUC works, stores the data in EPROM chip which is displayed on LCD. MCU stores the digital data after converting the analog data from sensor unit through ADC, for some delay unit of time and resets the reading in MCU as well as in LCD also. MAX232 receives the digital data and converts into serial form suitable for GSM communication so that data is received by the user (doctor) by verifying the IMEI number. The doctor advises precautions for the temporary observation of the patient from serious condition.

The following are the results we obtained while testing:

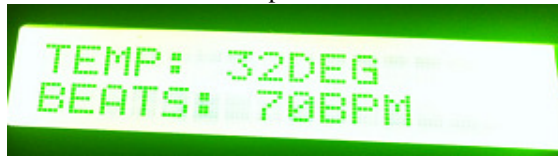
1. Welcome Screen displayed after switch on the kit



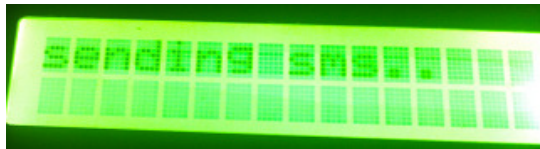
2. Displays check HB/temp



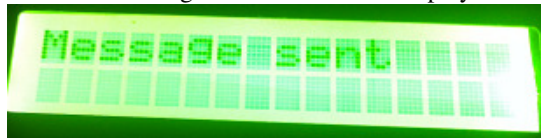
### 3. Heart Beat/Temperature Calculation



4. Then the calculated result will be send as an SMS to the destination number



5. After sending the SMS to the Doctor/a person it will display as 'Message sent' on the LCD display



## Conclusion

By using this prototype circuit containing AT89S52 MCU, GSM Modem, LCD and other hardware circuit so that the page messages can be transferred at fixed time intervals to the corresponding medical expert to give necessary precautions to take care about the patient. This system has the following features: i. AT89S52 MCU consumes low power with suitable devices for interconnection. ii. Auto alarm system is provided which sounds only when the reading exceeds or reduces than the normal level. iii. Continuous monitoring of patients is done which is simple by using GSM network.

**Future Scope:** The device can be improved in certain areas as listed below: i. A graphical LCD can be used to display a graph of the change of heart rate over time. ii. Sound can be added to the device so that a sound is output each time a pulse is received. iii. Serial output can be attached to the device so that the heart rates can be sent to a PC for further online or offline analysis. iv. Warning or abnormalities (such as very high or very low heart rates) can be displayed on the LCD or indicated by an LED or a buzzer. v. The Whole health monitoring system, which we have proposed can be integrated into a small compact unit as small as a cell phone or a wrist watch. This will help the patients to easily carry this device with them wherever they go. The VLSI technologies will greatly come handy in this regard. vi. The project can be implemented as complete patient health monitoring system by measuring B.P, Tumors etc., which can be done by connecting corresponding sensors to the MCU.

## Nomenclature

Abbreviation	Meaning
VLSI	Very Large Scale Integration
GSM	Global System for Mobile Communications
MCU	Micro Controller Unit
EPROM	Erasable Programmable
ALE	Address Latch Enable
PSEN	Program Store Enable
IMEI	International Mobile Equipment Identity
UART	Universal Asynchronous Receive Transmit
PSTN	Public Switched Telephone Network

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