MOBILE HEALTH CARE

Submitted in partial fulfilment of the Degree of

Bachelor of Technology

In

Electronics and Communication Engineering

Under the Supervision of

Dr. D. S. Saini

By

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to

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CERTIFICATE

This is to certify that project report entitled Mobile Health Care", submitted by Saurabh Arora, Anisha Kapoor and Niti Mittal in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Signature of Supervisor

Supervisor's Name : Dr. D. S. Saini

Designation: Associate Professor

Date: 30.05.12

ACKNOWLEDGEMENT

"Nothing In This World Will Take Place Of Persistence. Talent Will Not; Nothing Is Uncommon Then Unsuccessful Man With Talent, Genius Will Not; Unrecorded Genius Is Almost A Proverb, Education Alone Will Not ; The World Is Full Of Derelicts, Persistence And Determination Are Omnipotent"

The zeal to accomplish the task of formulating the project report on "Mobile Health Care" could not have been realized without the support and cooperation of the members of the faculty of ECE Department. We wish to express our gratitude and indebtness to our project guide Dr. D. S. Saini (Associate Professor, Electronics and Communication Department) for his encouragement, guidance and valuable assistance which helped us to complete this project successfully. He helped us develop novel solutions to every problem and helped us emerge with good engineering acumen.

We are at loss of words to express our deep gratitude towards our guide who made us realize the fact that stumbling blocks were in fact stepping stones to success. He motivated us to take this project as a challenge and come out with flying colours.

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SUMMARY

Mobile Health Care offers a flexible, unobtrusive and ubiquitous monitoring of vital body parameters. The system allows health monitoring for various requirements (critical patients, senior citizens, pregnant women, new born babies, sport persons etc). The system, if successful, allows for many other applications to be added to it, making it more efficient in prevention of illness or disease. Such patient monitoring and care system can reduce the risk of infection and other complications, as well as assist in providing for patient comfort. Additionally, it helps improve patient health, thanks to early diagnosis and preventive care.

What we propose is a system consisting of regular checking of body parameters such as temperature, blood pressure, pulse rate etc through body sensors which will connect to a microcontroller. The microcontroller is programmed in such a way that whenever the parameters' values' cross a certain threshold, an alert message is sent to one or more predefined numbers through the GSM modem. The doctor may reply accordingly to take certain corrective measures by the patient himself or a nearby nurse. The doctor can also ask for the current condition of the patient by sending a message, to which a reply is automatically sent.

Project Members

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Supervisor

Dr. D. S. Saini

Date: 30.05.12

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LIST OF ACRONYMS

GPRS- General Packet Radio Service

GPS-Global Positioning System

GSM- Global System for Mobile

RAM-Random Access Memory

ROM-Read Only Memory

ALU-Arithmetic Logical Unit

CPU-Control Processing Unit

MCU-Multipoint Control Unit

DSP-Digital Signal Processor

PCM-Pulse Code Modulator

PIO-Programmed Input Output

I/O-Input/Output

SPI-serial peripheral interface bus

UART-universal asynchronous receiver/transmitter

USB-Universal Serial Bus

SMT-Surface mount technology

AT Command- Attention Command

V

PROJECT PROCESSES

The project idea has evolved over a period of one year and it is important that we discuss the efforts of the team and the process through which the project has evolved

August 11
- Study conducted on the working of temperture sensor LM 35.

Septembe r 11
- Study conducted on the working of Microcontroller AT89252.

Novembe r 11
- Designed a layout for the temperature sensing device section and implemented the hardware part of it.

January 12
- Study conducted on GSM modem and it interfacing with the microcontroller.

March 12
- Interfaced temperature sensors and the 16x2 LCD display with the microcontroller.

April 12
- Interfaced the GSM modem with the microcontroller.

CHAPTER 1

INTRODUCTION

Advancement in health care revolves around more comfort, more effectiveness, prevention rather than treatment, early detection and ubiquity. Large machines in hospitals usually require multiple wires to be attached to a patient's body and often to sensitive areas, making them feel very uncomfortable. Often patients who only need daily monitoring are kept at hospitals which takes away precious time and is a source of worry. These patients can be allowed to be at home if only they could be monitored in their comfortable home environment or anywhere else.

One of the key measures that can be taken to improve health of people is preventive care instead of only treatment after detection. Many such medical devices are being invented nowadays for example home care device, such as an electronic blood pressure or glucose meter. An ambulatory system that allows long-term monitoring of mobile patients is also desirable. The ambulatory electrocardiogram (ECG) Holter device, used since the 1960s, provides a reliable measurement of the wearer's heartbeat but is heavy and cumbersome to wear over an extended period of time. In addition, its substantial power consumption forbids continuous operation using low-capacity batteries. In recent years, lightweight devices have emerged as a viable technology for continuous measurement of vital biomedical parameters. Wearable, biosensors connected to self organizing allows physicians to continuously monitor vital signs, and helps in preventing any critical mishap and also helps physicians to record long-term trends and patterns that provide invaluable information about a patient's ongoing condition.

This system will serve the requirement of portability so that these health monitoring devices can fit or attach easily to a wrist or arm band, ring sensor or other wearable or implantable device. Continuous monitoring requires portable devices and a fast and efficient responsive protocol. All of these elements are now in place and ready to be adapted to numerous biomedical applications. Moreover cardiac patients can be regularly monitored without the physical presence of the doctor.
So a solution is, the Mobile Health Care System, which would accept signals from sensors, beaming that data straight to the Care System to act accordingly and prevent the calamity to occur if the need arises without the actual presence of a doctor. The need for patient monitoring and care is apparent in situations where the patient is: Patients with a suspected life-threatening condition; for example, a patient who has findings indicating an acute myocardial infarction (heart attack). Patients at high risk of developing a life-threatening condition; for example, patients immediately post open-heart surgery, or a premature infant whose heart and lungs are not fully developed, patients in a critical physiological state; for example, patients with multiple trauma or septic shock.

This kind of system could also help monitor athletes and sportspersons and their performance by their trainers during training. Also senior citizens and pregnant women can be monitored for emergencies.

CHAPTER 2

THEORY OF SENSORS

In our project we will be using Temperature Sensor. Temperature sensors come in a wide variety and have one thing in common: they all measure temperature by sensing some change in a physical characteristic.

The seven basic types of temperature sensors to be discussed here are thermocouples, resistive temperature devices (RTDs, thermistors), infrared radiators, bimetallic devices, liquid expansion devices, and molecular change-of-state and silicon diodes.

2.1 Thermocouples Sensor

Thermocouples are voltage devices that indicate temperature by measuring a change in voltage. As temperature goes up, the output voltage of the thermocouple rises – not necessarily linearly. Often the thermocouple is located inside a metal or ceramic shield that protects it from exposure to a variety of environments. Metal-sheathed thermocouples also are available with many types of outer coatings, such as Teflon, for trouble-free use in acids and strong caustic solutions. A variety of thermocouples are available, suitable for different measuring applications (industrial, scientific, food temperature, medical research, etc.).

1. Type K (Chromel (Ni-Cr alloy) / Alumel (Ni-Al alloy)): The "general purpose" thermocouple. It is low cost and, owing to its popularity, it is available in a wide variety of probes. They are available in the −200 °C to +1200 °C range.

2. Type E (Chromel / Constantan (Cu-Ni alloy)): Type E has a high output (68 µV/°C) which makes it well suited to low temperature (cryogenic) use. Another property is that it is non-magnetic.

3. Type J (Iron / Constantan): Limited range (−40 to +750 °C) makes type J less popular than type K. The main application is with old equipment that cannot accept modern thermocouples. J types cannot be used above 760 °C as an abrupt magnetic transformation causes permanent decalibration.

4. Type N (Nicrosil (Ni-Cr-Si alloy) / Nisil (Ni-Si alloy)): High stability and resistance to high temperature oxidation makes type N suitable for high temperature measurements without the cost of platinum (B, R, S) types. They can withstand temperatures above 1200 °C. Thermocouple types B, R, and S are all noble metal thermocouples and exhibit similar characteristics. They are the most stable of all thermocouples, but due to their low sensitivity (approximately 10 µV/°C) they are usually only used for high temperature measurement (>300 °C). Thermocouples are most suitable for measuring over a large temperature range, up to 1800 K. They are less suitable for applications where smaller temperature differences need to be measured with high accuracy, for example the range 0--100 °C with 0.1 °C accuracy. For such applications other sensors are more suitable.

2.2 Resistive Temperature Detector Sensor (RTD)

A basic physical property of a metal is that its electrical resistivity changes with temperature. All RTD's are based on this principle. The heart of the RTD is the resistance element. Several varieties of semi-supported wire-wound fully supported bifilar wound glass, and thin film type elements are shown here.
Some metals have a very predictable change of resistance for a given change of temperature; these are the metals that are most commonly chosen for fabricating an RTD.

A precision resistor is made from one of these metals to a nominal ohmic value at a specified temperature. By measuring its resistance at some unknown temperature and comparing this value to the resistor's nominal value, the change in resistance is determined. As the temperature vs. resistance characteristics are also known, the change in temperature from the point initially specified can be calculated. We now have a practical temperature sensor, which in its bare form (the resistor) is commonly referred to as a resistance element. Through years of experience, the characteristics of various metals and their alloys have been learned, and their temperature vs. resistance relationships is available in look-up tables. For some types of RTD's, there are also equations that give us the temperature from a given resistance. This information has made it possible for instrument manufacturers to provide standard readout and control devices that are compatible with some of the more widely accepted types of RTD's.

Platinum RTD's can measure temperatures from -200°C to 650°C. (IEC says -200°C to 850°C).

2.3 Bimetallic Devices Sensor

The Bimetallic strip is a mechanical temperature sensor element. It converts temperature to a mechanical displacement. This displacement may be coupled to a switch for simple on-off function, to a needle of an indicator, or to a position detector for electronic output. The most common application of the bimetallic strip is as a thermostat switch used for temperature and energy control. A bimetallic strip is simply constructed from two strips of different metals bonded together. Typically a welding process is used for bonding, but rivets, bolts, adhesive and other fasteners can also be used. The operation of the bimetallic strip relies on the different expansions rates of the two metals to temperature change (the different coefficients of thermal expansion of the metals). As a matter of interest, the bimetallic strip can be scaled up or down. On a large scale, it can provide literally tones of force for mechanical control or other purposes. On a smaller scale, it can provide the force and movement for micro machine integrated circuits (MMIs).

Advantages of bimetallic devices are portability and independence from a power supply. However, they are not usually quite as accurate as are electrical devices, and you cannot easily record the temperature value as with electrical devices like thermocouples or RTDs; but portability is a definite advantage for the right application.

2.4 Thermometers

Thermometers are well-known liquid expansion devices. Generally speaking, they come in two main classifications: the mercury type and the organic, usually red, liquid type. The distinction between the two is notable, because mercury devices have certain limitations when it comes to how they can be safely transported or shipped. For example, mercury is considered an environmental contaminant, so breakage can be hazardous. Be sure to check the current restrictions for air transportation of mercury products before shipping.

2.5 Change -of- State Sensors

Change-of-state temperature sensors measure a change in the state of a material brought about by a change in temperature, as in a change from ice to water and then to steam. Commercially available devices of this type are in the form of labels, pellets, crayons, or lacquers. For example, labels may be used on steam traps. When the trap needs adjustment, it becomes hot; then, the white dot on the label will indicate the temperature rise by turning black. The dot remains black, even if the temperature returns to normal. Change-of-state labels indicate temperature in °F and °C. With these types of devices, the white dot turns black when exceeding the temperature shown; and it is a nonreversible sensor which remains black once it changes color. Temperature labels are useful when you need confirmation that temperature did not exceed a certain level, perhaps for engineering or legal reasons during shipment. Because change-of-state devices are nonelectrical like the bimetallic strip, they have an advantage in certain applications. Some forms of this family of sensors (lacquer, crayons) do not change color; the marks made by them simply disappear. The pellet version becomes visually deformed or melts away completely. Limitations include a relatively slow response time. Therefore, if you have a temperature spike going up and then down very quickly, there may be no visible response. Accuracy also is not as high as with most of the other devices more commonly used in industry. However, within their realm of application where you need a non reversing indication that does not require electrical power, they are very practical.

Other labels which are reversible operate on quite a different principle using a liquid crystal display. The display changes from black color to a tint of brown or blue or green, depending on the temperature achieved. For example, a typical label is all black when below the temperatures that are sensed. As the temperature rises, a color will appear at, say, the 33°F spot - first as blue, then green, and finally brown as it passes through the designated temperature. In any particular liquid crystal device, you usually will see two color spots adjacent to each other - the blue one slightly below the temperature indicator, and the brown one slightly above. This lets you estimate the temperature as being, say, between 85° and 90°F. Although it is not perfectly precise, it does have the advantages of being a small, rugged, nonelectrical indicator that continuously updates temperature.

2.6 Silicon Band gap Temperature sensor

Silicon band gap temperature sensor is a very ordinary form of temperature sensor or thermometer used in electronic equipment. The silicon band gap temperature sensor is able to measure temperatures on computer chips with accuracy and speed. What are the advantages of using silicon band gap temperature sensors?

One of the benefits of using the silicon band gap temperature sensor is that the band gap temperature sensor can be included in a silicon integrated circuit at a very low cost. Silicon temperature sensors are fast becoming important transducers in electronic systems because as the electronic systems become more complex, it is even more important to monitor critical temperatures. Silicon sensors are preferred because they are accurate, cheap, linear and can be integrated on the same IC as amplifiers and any other required processing functions. How does a silicon band gap temperature sensor works? The principle of the band gap temperature sensor is that the forward voltage of a silicon diode is dependent on the temperature. An electronic circuit, for example the Brokaw band gap reference, can be used to calculate the temperature of the diode. The results that you obtained will stay valid up to about 200°C to 250°C when leakage currents become strong enough to corrupt the measurement. Once you go above 250°C in temperature, silicon carbide is used to replace silicon.

2.7 Infrared Sensors (IR)

Infrared sensors are non contacting sensors. As an example, if you hold up a typical infrared sensor to the front of your desk without contact, the sensor will tell you the temperature of the desk by virtue of its radiation - probably 68°F at normal room temperature.

In a non contacting measurement of ice water, it will measure slightly under 0°C because of evaporation, which slightly lowers the expected temperature reading. Here in our project we are using LM35 IC which is a digital thermometer. The LM35 measures temperature using a band gap-based temperature sensor because at low temperatures (i.e. body temperature) band gap based temperature sensors work best. In starting of our project we used LM35 temperature sensor IC but it has a drawback that it gives analog output so there is a need for an analog to digital converter (ADC) for converting the output to digital format before feeding it to microcontroller.

Chapter-3

GSM TECHNOLOGY

3.1 History of GSM

During the early 1980s, analog cellular telephone systems were experiencing rapid growth in Europe, particularly in Scandinavia and the United Kingdom, but also in France and Germany. Each country developed its own system, which was incompatible with everyone else's in equipment and operation. This was an undesirable situation, because not only was the mobile equipment limited to operation within national boundaries, which in a unified Europe were increasingly unimportant, but there was also a very limited market for each type of equipment, so economies of scale and the subsequent savings could not be realized.

The Europeans realized this early on, and in 1982 the Conference of European Posts and Telegraphs (CEPT) formed a study group called the Groupe Spécial Mobile (GSM) to study and develop a pan-European public land mobile system. The proposed system had to meet certain criteria:

- Good subjective speech quality
- Low terminal and service cost
- Support for international roaming
- Ability to support handheld terminals
- Support for range of new services and facilities
- Spectral efficiency
- ISDN compatibility

In 1989, GSM responsibility was transferred to the European Telecommunication Standards Institute (ETSI), and phase I of the GSM specifications were published in 1990. Commercial service was started in mid-1991, and by 1993 there were 36 GSM networks in 22 countries. Although standardized in Europe, GSM is not only a European standard. Over 200 GSM networks (including DCS1800 and PCS1900) are operational in 110 countries around the world. In the beginning of 1994, there were 1.3 million subscribers worldwide, which had grown to more than 55 million by October 1997. With North America making a delayed entry into the GSM field with a derivative of GSM called PCS1900, GSM systems exist on every continent, and the acronym GSM now aptly stands for Global System for Mobile communications.

The developers of GSM chose an unproven (at the time) digital system, as opposed to the then-standard analog cellular systems like AMPS in the United States and TACS in the United Kingdom. They had faith that advancements in compression algorithms and digital signal processors would allow the fulfilment of the original criteria and the continual improvement of the system in terms of quality and cost. The over 8000 pages of GSM recommendations try to allow flexibility and competitive innovation among suppliers, but provide enough standardization to guarantee proper interworking between the components of the system. This is done by providing functional and interface descriptions for each of the functional entities defined in the system.

3.2 Services provided by GSM

From the beginning, the planners of GSM wanted ISDN compatibility in terms of the services offered and the control signalling used. However, radio transmission limitations, in terms of bandwidth and cost, do not allow the standard ISDN B-channel bit rate of 64 kbps to be practically achieved.

Using the ITU-T definitions, telecommunication services can be divided into bearer services, teleservices, and supplementary services. The most basic teleservice supported by GSM is telephony. As with all other communications, speech is digitally encoded and transmitted through the GSM network as a digital stream. There is also an emergency service, where the nearest emergency-service provider is notified by dialling three digits (similar to 911).

A variety of data services is offered. GSM users can send and receive data, at rates up to 9600 bps, to users on POTS (Plain Old Telephone Service), ISDN, Packet Switched Public Data Networks, and Circuit Switched Public Data Networks using a variety of access methods and protocols, such as X.25 or X.32. Since GSM is a digital network, a modem is not required between the user and GSM network, although an audio modem is required inside the GSM network to interwork with POTS.

Other data services include Group 3 facsimile, as described in ITU-T recommendation T.30, which is supported by use of an appropriate fax adaptor. A unique feature of GSM, not found in older analog systems, is the Short Message Service (SMS). SMS is a bidirectional service for short alphanumeric (up to 160 bytes) messages. Messages are transported in a store-and-forward fashion. For point-to-point SMS, a message can be sent to another subscriber to the service, and an acknowledgement of receipt is provided to the sender. SMS can also be used in a cell-broadcast mode, for sending messages such as traffic updates or news updates. Messages can also be stored in the SIM card for later retrieval.

Supplementary services are provided on top of teleservices or bearer services. In the current (Phase I) specifications, they include several forms of call forward (such as call forwarding when the mobile subscriber is unreachable by the network), and call barring of outgoing or incoming calls, for example when roaming in another country. Many additional supplementary services will be provided in the Phase 2 specifications, such as caller identification, call waiting, multi-party conversations.

3.3 Architecture of the GSM network

A GSM network is composed of several functional entities, whose functions and interfaces are specified. Figure 1 shows the layout of a generic GSM network. The GSM network can be divided into three broad parts. The Mobile Station is carried by the subscriber. The Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the main part of which is the Mobile services Switching Center (MSC), performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. Not shown is the Operations and Maintenance Center, which oversees the proper operation and setup of the network. The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link. The Base Station Subsystem communicates with the Mobile services Switching Center across the A interface.

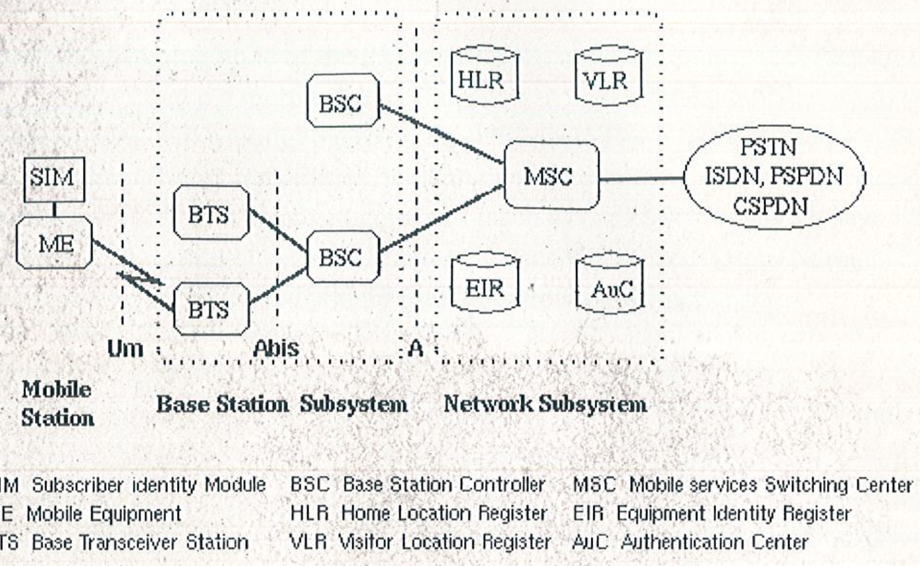


Figure 3.1: GSM Architecture

3.3.1 Mobile Station

The mobile station (MS) consists of the mobile equipment (the terminal) and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services.

The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI) used to identify the subscriber to the system, a secret key for authentication, and other information. The IMEI and the IMSI are independent, thereby allowing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

3.3.2 Base Station Subsystem

The Base Station Subsystem is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). These communicate across the standardized Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers.

The Base Transceiver Station houses the radio transceivers that define a cell and handles the radio-link protocols with the Mobile Station. In a large urban area, there will potentially be a large number of BTSs deployed, thus the requirements for a BTS are ruggedness, reliability, portability, and minimum cost.

The Base Station Controller manages the radio resources for one or more BTSs. It handles radio-channel setup, frequency hopping, and handovers, as described below. The BSC is the connection between the mobile station and the Mobile service Switching Center (MSC).

3.3.3 Network Subsystem

The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the PSTN or ISDN, and additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. These services are provided in conjunction with several functional entities, which together form the Network Subsystem. The MSC provides the connection to the fixed networks (such as the PSTN or ISDN). Signalling between functional entities in the Network Subsystem uses Signalling System Number 7 (SS7), used for trunk signalling in ISDN and widely used in current public networks.

The Home Location Register (HLR) and Visitor Location Register (VLR), together with the MSC, provide the call-routing and roaming capabilities of GSM. The HLR contains all the administrative information of each subscriber registered in the corresponding GSM network, along with the current location of the mobile. The location of the mobile is typically in the form of the signalling address of the VLR associated with the mobile station. The actual routing procedure will be described later. There is logically one HLR per GSM network, although it may be implemented as a distributed database.

The Visitor Location Register (VLR) contains selected administrative information from the HLR, necessary for call control and provision of the subscribed services, for each mobile currently located in the geographical area controlled by the VLR. Although each functional entity can be implemented as an independent unit, all manufacturers of switching equipment to date implement the VLR together with the MSC, so that the geographical area controlled by the MSC corresponds to that controlled by the VLR, thus simplifying the signalling required. Note that the MSC contains no information about particular mobile stations --- this information is stored in the location registers.

The other two registers are used for authentication and security purposes. The Equipment Identity Register (EIR) is a database that contains a list of all valid mobile equipment on the network, where each mobile station is identified by its International Mobile Equipment Identity (IMEI). An IMEI is marked as invalid if it has been reported stolen or is not type approved. The Authentication Center (AuC) is a protected database that stores a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and encryption over the radio channel.

3.4 Radio link aspects

The International Telecommunication Union (ITU), which manages the international allocation of radio spectrum (among many other functions), allocated the bands 890-915 MHz for the uplink (mobile station to base station) and 935-960 MHz for the downlink (base station to mobile station) for mobile networks in Europe. Since this range was already being used in the early 1980s by the analog systems of the day, the CEPT had the foresight to reserve the top 10 MHz of each band for the GSM network that was still being developed. Eventually, GSM will be allocated the entire 2x25 MHz bandwidth.

3.4.1 Multiple access and channel structure

Since radio spectrum is a limited resource shared by all users, a method must be devised to divide up the bandwidth among as many users as possible. The method chosen by GSM is a combination of Time- and Frequency-Division Multiple Access (TDMA/FDMA). The FDMA part involves the division by frequency of the (maximum) 25 MHz bandwidth into 124 carrier frequencies spaced 200 kHz apart. One or more carrier frequencies are assigned to each base station. Each of these carrier frequencies is then divided in time, using a TDMA scheme. The fundamental unit of time in this TDMA scheme is called a*burst period* and it lasts 15/26 ms (or approx. 0.577 ms). Eight burst periods are grouped into a *TDMA frame* (120/26 ms, or approx. 4.615 ms), which forms the basic unit for the definition of logical channels. One physical channel is one burst period per TDMA frame.

Channels are defined by the number and position of their corresponding burst periods. All these definitions are cyclic, and the entire pattern repeats approximately every 3 hours. Channels can be divided into *dedicated channels*, which are allocated to a mobile station, and *common channels*, which are used by mobile stations in idle mode.

3.4.2 Traffic channels

A traffic channel (TCH) is used to carry speech and data traffic. Traffic channels are defined using a 26-frame multiframe, or group of 26 TDMA frames. The length of a 26-frame multiframe is 120 ms, which is how the length of a burst period is defined (120 ms divided by 26 frames divided by 8 burst periods per frame). Out of the 26 frames, 24 are used for traffic, 1 is used for the Slow Associated Control Channel (SACCH) and 1 is currently unused (see Figure 2). TCHs for the uplink and downlink are separated in time by 3 burst periods, so that the mobile station does not have to transmit and receive simultaneously, thus simplifying the electronics.

In addition to these *full-rate* TCHs, there are also *half-rate* TCHs defined, although they are not yet implemented. Half-rate TCHs will effectively double the capacity of a system once half-rate speech coders are specified (i.e., speech coding at around 7 kbps, instead of 13 kbps). Eighth-rate TCHs are also specified, and are used for signalling. In the recommendations, they are called Stand-alone Dedicated Control Channels (SDCCH).

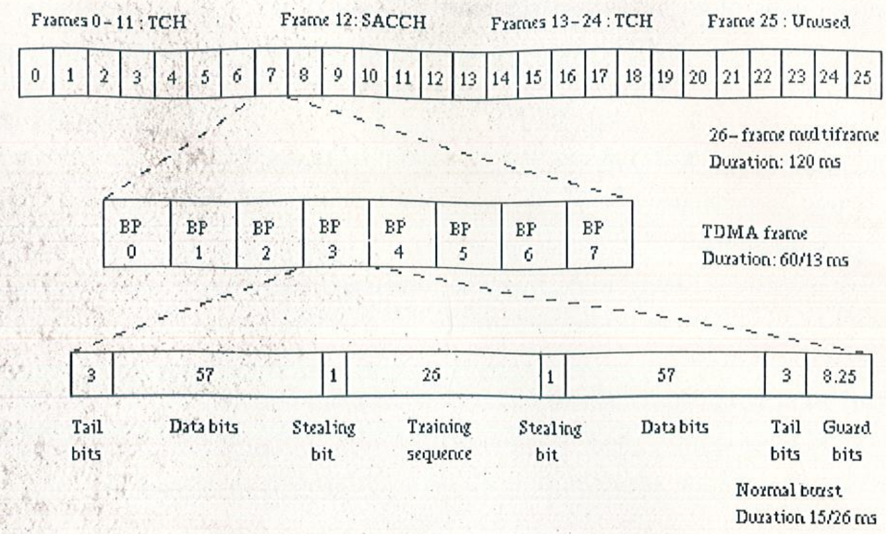


Figure 3.2: **Organization of bursts, TDMA frames, and multiframes for speech and data**

3.4.3 Control channels

Common channels can be accessed both by idle mode and dedicated mode mobiles. The common channels are used by idle mode mobiles to exchange the signalling information required to change to dedicated mode. Mobiles already in dedicated mode monitor the surrounding base stations for handover and other information. The common channels are defined within a 51-frame multiframe, so that dedicated mobiles using the 26-frame multiframe TCH structure can still monitor control channels. The common channels include:

Broadcast Control Channel (BCCH)

> Continually broadcasts, on the downlink, information including base station identity, frequency allocations, and frequency-hopping sequences.

Frequency Correction Channel (FCCH) and Synchronisation Channel (SCH)

> Used to synchronise the mobile to the time slot structure of a cell by defining the boundaries of burst periods, and the time slot numbering. Every cell in a GSM network broadcasts exactly one FCCH and one SCH, which are by definition on time slot number 0 (within a TDMA frame).

Random Access Channel (RACH)

> Slotted Aloha channel used by the mobile to request access to the network.

Paging Channel (PCH)

> Used to alert the mobile station of an incoming call.

Access Grant Channel (AGCH)

Used to allocate an SDCCH to a mobile for signalling (in order to obtain a dedicated channel), following a request on the RACH.

3.4.4 Burst structure

There are four different types of bursts used for transmission in GSM. The normal burst is used to carry data and most signalling. It has a total length of 156.25 bits, made up of two 57 bit information bits, a 26 bit training sequence used for equalization, 1 stealing bit for each information block (used for FACCH), 3 tail bits at each end, and an 8.25 bit guard sequence, as shown in Figure 2. The 156.25 bits are transmitted in 0.577 ms, giving a gross bit rate of 270.833 kbps.

The F burst, used on the FCCH, and the S burst, used on the SCH, have the same length as a normal burst, but a different internal structure, which differentiates them from normal bursts (thus allowing synchronization). The access burst is shorter than the normal burst, and is used only on the RACH.

3.4.5 Speech coding

GSM is a digital system, so speech which is inherently analog, has to be digitized. The method employed by ISDN, and by current telephone systems for multiplexing voice lines over high speed trunks and optical fiber lines, is Pulse Coded Modulation (PCM). The output stream from PCM is 64 kbps, too high a rate to be feasible over a radio link. The 64 kbps signal, although simple to implement, contains much redundancy. The GSM group studied several speech coding algorithms on the basis of subjective speech quality and complexity (which is related to cost, processing delay, and power consumption once implemented) before arriving at the choice of a Regular Pulse Excited -- Linear Predictive Coder (RPE--LPC) with a Long Term Predictor loop. Basically, information from previous samples, which does not change very quickly, is used to predict the current sample. The coefficients of the linear combination of the previous samples, plus an encoded form of the residual, the difference between the predicted and actual sample, represent the signal. Speech is divided into 20 millisecond samples, each of which is encoded as 260 bits, giving a total bit rate of 13 kbps. This is the so-called Full-Rate speech coding. Recently, an Enhanced Full-Rate (EFR) speech coding algorithm has been implemented by some North American GSM1900 operators. This is said to provide improved speech quality using the existing 13 kbps bit rate.

3.4.6 Channel coding and modulation

Because of natural and man-made electromagnetic interference, the encoded speech or data signal transmitted over the radio interface must be protected from errors. GSM uses convolutional encoding and block interleaving to achieve this protection. The exact algorithms used differ for speech and for different data rates. The method used for speech blocks will be described below.

Recall that the speech codec produces a 260 bit block for every 20 ms speech sample. From subjective testing, it was found that some bits of this block were more important for perceived speech quality than others. The bits are thus divided into three classes:

- **Class Ia** 50 bits - most sensitive to bit errors
- **Class Ib** 132 bits - moderately sensitive to bit errors
- **Class II** 78 bits - least sensitive to bit errors

Class Ia bits have a 3 bit Cyclic Redundancy Code added for error detection. If an error is detected, the frame is judged too damaged to be comprehensible and it is discarded. It is replaced by a slightly attenuated version of the previous correctly received frame. These 53 bits, together with the 132 Class Ib bits and a 4 bit tail sequence (a total of 189 bits), are input into a 1/2 rate convolution encoder of constraint length 4. Each input bit is encoded as two output bits, based on a combination of the previous 4 input bits. The convolution encoder thus outputs 378 bits, to which are added the 78 remaining Class II bits, which are unprotected. Thus every 20 ms speech sample is encoded as 456 bits, giving a bit rate of 22.8 kbps.

To further protect against the burst errors common to the radio interface, each sample is interleaved. The 456 bits output by the convolution encoder are divided into 8 blocks of 57 bits, and these blocks are transmitted in eight consecutive time-slot bursts. Since each time-slot burst can carry two 57 bit blocks, each burst carries traffic from two different speech samples.

Recall that each time-slot burst is transmitted at a gross bit rate of 270.833 kbps. This digital signal is modulated onto the analog carrier frequency using Gaussian-filtered Minimum Shift Keying (GMSK). GMSK was selected over other modulation schemes as a compromise between spectral efficiency, complexity of the transmitter, and limited spurious emissions. The complexity of the transmitter is related to power consumption, which should be minimized for the mobile station. The spurious radio emissions, outside of the allotted bandwidth, must be strictly controlled so as to limit adjacent channel interference, and allow for the co-existence of GSM and the older analog systems (at least for the time being).

3.4.7 Multipath equalization

At the 900 MHz range, radio waves bounce off everything - buildings, hills, cars, airplanes, etc. Thus many reflected signals, each with a different phase, can reach an antenna. Equalization is used to extract the desired signal from the unwanted reflections. It works by finding out how a known transmitted signal is modified by multipath fading, and constructing an inverse filter to extract the rest of the desired signal. This known signal is the 26-bit training sequence transmitted in the middle of every time-slot burst. The actual implementation of the equalizer is not specified in the GSM specifications.

3.4.8 Frequency hopping

The mobile station already has to be frequency agile, meaning it can move between a transmit, receive, and monitor time slot within one TDMA frame, which normally are on different frequencies. GSM makes use of this inherent frequency agility to implement slow frequency hopping, where the mobile and BTS transmit each TDMA frame on a different carrier frequency. The frequency hopping algorithm is broadcast on the Broadcast Control Channel. Since multipath fading is dependent on carrier frequency, slow frequency hopping helps alleviate the problem. In addition, co-channel interference is in effect randomized.

3.4.9 Discontinuous transmission

Minimizing co-channel interference is a goal in any cellular system, since it allows better service for a given cell size, or the use of smaller cells, thus increasing the overall capacity of the system. Discontinuous transmission (DTX) is a method that takes advantage of the fact that a person speaks less that 40 percent of the time in normal conversation, by turning the transmitter off during silence periods. An added benefit of DTX is that power is conserved at the mobile unit.

The most important component of DTX is, of course, Voice Activity Detection. It must distinguish between voice and noise inputs, a task that is not as trivial as it appears, considering background noise. If a voice signal is misinterpreted as noise, the transmitter is turned off and a very annoying effect called clipping is heard at the receiving end. If, on the other hand, noise is misinterpreted as a voice signal too often, the efficiency of DTX is dramatically decreased. Another factor to consider is that when the transmitter is turned off, there is total silence heard at the receiving end, due to the digital nature of GSM. To assure the receiver that the connection is not dead, *comfort noise* is created at the receiving end by trying to match the characteristics of the transmitting end's background noise.

3.4.10 Discontinuous reception

Another method used to conserve power at the mobile station is discontinuous reception. The paging channel, used by the base station to signal an incoming call, is structured into sub-channels. Each mobile station needs to listen only to its own sub-channel. In the time between successive paging sub-channels, the mobile can go into sleep mode, when almost no power is used.

3.4.11 Power control

There are five classes of mobile stations defined, according to their peak transmitter power, rated at 20, 8, 5, 2, and 0.8 watts. To minimize co-channel interference and to conserve power, both the mobiles and the Base Transceiver Stations operate at the lowest power level that will maintain an acceptable signal quality. Power levels can be stepped up or down in steps of 2 dB from the peak power for the class down to a minimum of 13 dBm (20 milliwatts).

The mobile station measures the signal strength or signal quality (based on the Bit Error Ratio), and passes the information to the Base Station Controller, which ultimately decides if and when the power level should be changed. Power control should be handled carefully, since there is the possibility of instability. This arises from having mobiles in co-channel cells alternatingly increase their power in response to increased co-channel interference caused by the other mobile increasing its power. This in unlikely to occur in practice but it is (or was as of 1991) under study.

3.5 Network aspects

Ensuring the transmission of voice or data of a given quality over the radio link is only part of the function of a cellular mobile network. A GSM mobile can seamlessly roam nationally and internationally, which requires that registration, authentication, call routing and location updating functions exist and are standardized in GSM networks. In addition, the fact that the geographical area covered by the network is divided into cells necessitates the implementation of a handover mechanism. These functions are performed by the Network Subsystem, mainly using the Mobile Application Part (MAP) built on top of the Signalling System No. 7 protocol.

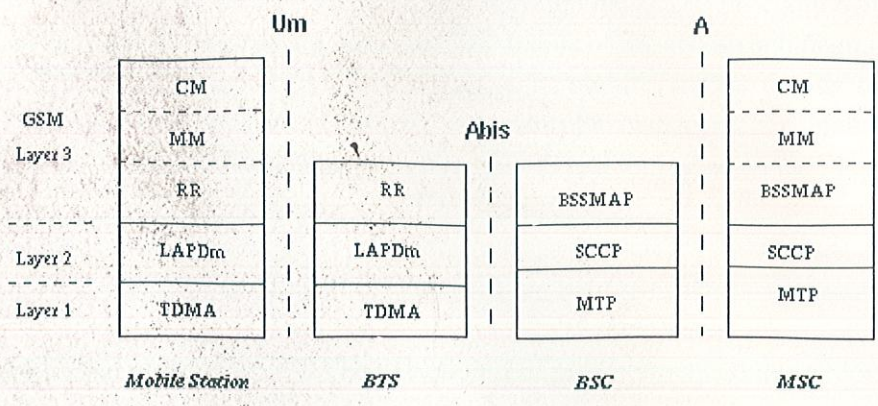


Figure 3.3: Signalling protocol structure in GSM

The signalling protocol in GSM is structured into three general layers, depending on the interface, as shown in Figure 3. Layer 1 is the physical layer, which uses the channel structures discussed above over the air interface. Layer 2 is the data link layer. Across the Um interface, the data link layer is a modified version of the LAPD protocol used in ISDN, called LAPDm. Across the A interface, the Message Transfer Part layer 2 of Signalling System Number 7 is used. Layer 3 of the GSM signalling protocol is itself divided into 3 sublayers.

Radio Resources Management

> Controls the setup, maintenance, and termination of radio and fixed channels, including handovers.

Mobility Management

> Manages the location updating and registration procedures, as well as security and authentication.

Connection Management

> Handles general call control, similar to CCITT Recommendation Q.931, and manages Supplementary Services and the Short Message Service.

Signalling between the different entities in the fixed part of the network, such as between the HLR and VLR, is accomplished throught the Mobile Application Part (MAP). MAP is built on top of the Transaction Capabilities Application Part (TCAP, the top layer of Signalling System Number 7. The specification of the MAP is quite complex, and at over 500 pages, it is one of the longest documents in the GSM recommendations.

3.5.1 Radio resources management

The radio resources management (RR) layer oversees the establishment of a link, both radio and fixed, between the mobile station and the MSC. The main functional components involved are the mobile station, and the Base Station Subsystem, as well as the MSC. The RR layer is concerned with the management of an RR-session, which is the time that a mobile is in dedicated mode, as well as the configuration of radio channels including the allocation of dedicated channels.

An RR-session is always initiated by a mobile station through the access procedure, either for an outgoing call, or in response to a paging message. The details of the access and paging procedures, such as when a dedicated channel is actually assigned to the mobile, and the paging sub-channel structure, are handled in the RR layer. In addition, it handles the management of radio features such as power control, discontinuous transmission and reception, and timing advance.

3.5.2 Handover

In a cellular network, the radio and fixed links required are not permanently allocated for the duration of a call. Handover, or handoff as it is called in North America, is the switching of an on-going call to a different channel or cell. The execution and measurements required for handover form one of basic functions of the RR layer.

There are four different types of handover in the GSM system, which involve transferring a call between:

- Channels (time slots) in the same cell
- Cells (Base Transceiver Stations) under the control of the same Base Station Controller (BSC),
- Cells under the control of different BSCs, but belonging to the same Mobile services Switching Center (MSC), and
- Cells under the control of different MSCs.

The first two types of handover, called internal handovers, involve only one Base Station Controller (BSC). To save signalling bandwidth, they are managed by the BSC without involving the Mobile services Switching Center (MSC), except to notify it at the completion of the handover. The last two types of handover, called external handovers, are handled by the MSCs involved. An important aspect of GSM is that the original MSC, the *anchor MSC*, remains responsible for most call-related functions, with the exception of subsequent inter-BSC handovers under the control of the new MSC, called the *relay MSC*.

Handovers can be initiated by either the mobile or the MSC (as a means of traffic load balancing). During its idle time slots, the mobile scans the Broadcast Control Channel of up to 16 neighboring cells, and forms a list of the six best candidates for possible handover, based on the received signal strength. This information is passed to the BSC and MSC, at least once per second, and is used by the handover algorithm.

The algorithm for when a handover decision should be taken is not specified in the GSM recommendations. There are two basic algorithms used, both closely tied in with power control. This is because the BSC usually does not know whether the poor signal quality is due to multipath fading or to the mobile having moved to another cell. This is especially true in small urban cells.

The 'minimum acceptable performance' algorithm gives precedence to power control over handover, so that when the signal degrades beyond a certain point, the power level of the mobile is increased. If further power increases do not improve the signal, then a handover is considered. This is the simpler and more common method, but it creates 'smeared' cell boundaries when a mobile transmitting at peak power goes some distance beyond its original cell boundaries into another cell.

The 'power budget' method uses handover to try to maintain or improve a certain level of signal quality at the same or lower power level. It thus gives precedence to handover over power control. It avoids the 'smeared' cell boundary problem and reduces co-channel interference, but it is quite complicated.

3.6 Mobility management

The Mobility Management layer (MM) is built on top of the RR layer, and handles the functions that arise from the mobility of the subscriber, as well as the authentication and security aspects. Location management is concerned with the procedures that enable the system to know the current location of a powered-on mobile station so that incoming call routing can be completed.

3.6.1 Location updating

A powered-on mobile is informed of an incoming call by a paging message sent over the PAGCH channel of a cell. One extreme would be to page every cell in the network for each call, which is obviously a waste of radio bandwidth. The other extreme would be for the mobile to notify the system, via location updating messages, of its current location at the individual cell level. This would require paging messages to be sent to exactly one cell, but would be very wasteful due to the large number of location updating messages. A compromise solution used in GSM is to group cells into *location areas*. Updating messages are required when moving between location areas, and mobile stations are paged in the cells of their current location area.

The location updating procedures, and subsequent call routing, use the MSC and two location registers: the Home Location Register (HLR) and the Visitor Location Register (VLR). When a mobile station is switched on in a new location area, or it moves to a new location area or different operator's PLMN, it must register with the network to indicate its current location. In the normal case, a location update message is sent to the new MSC/VLR, which records the location area information, and then sends the location information to the subscriber's HLR. The information sent to the HLR is normally the SS7 address of the new VLR, although it may be a routing number. The reason a routing number is not normally assigned, even though it would reduce signalling, is that there is only a limited number of routing numbers available in the new MSC/VLR and they are allocated on demand for incoming calls. If the subscriber is entitled to service, the HLR sends a subset of the subscriber information, needed for call control, to the new MSC/VLR, and sends a message to the old MSC/VLR to cancel the old registration.

For reliability reasons, GSM also has a periodic location updating procedure. If an HLR or MSC/VLR fails, to have each mobile register simultaneously to bring the database up to date would cause overloading. Therefore, the database is updated as location updating events occur. The enabling of periodic updating, and the time period between periodic updates, is controlled by the operator, and is a trade-off between signalling traffic and speed of recovery. If a mobile does not register after the updating time period, it is deregistered.

A procedure related to location updating is the IMSI attach and detach. A detach lets the network know that the mobile station is unreachable, and avoids having to needlessly allocate channels and send paging messages. An attach is similar to a location update, and informs the system that the mobile is reachable again. The activation of IMSI attach/detach is up to the operator on an individual cell basis.

3.6.2 Authentication and security

Since the radio medium can be accessed by anyone, authentication of users to prove that they are who they claim to be, is a very important element of a mobile network. Authentication involves two functional entities, the SIM card in the mobile, and the Authentication Center (AuC). Each subscriber is given a secret key, one copy of which is stored in the SIM card and the other in the AuC. During authentication, the AuC generates a random number that it sends to the mobile. Both the mobile and the AuC then use the random number, in conjuction with the subscriber's secret key and a ciphering algorithm called A3, to generate a signed response (SRES) that is sent back to the AuC. If the number sent by the mobile is the same as the one calculated by the AuC, the subscriber is authenticated.

The same initial random number and subscriber key are also used to compute the ciphering key using an algorithm called A8. This ciphering key, together with the TDMA frame number, use the A5 algorithm to create a 114 bit sequence that is XORed with the 114 bits of a burst (the two 57 bit blocks). Enciphering is an option for the fairly paranoid, since the signal is already coded, interleaved, and transmitted in a TDMA manner, thus providing protection from all but the most persistent and dedicated eavesdroppers.

Another level of security is performed on the mobile equipment itself, as opposed to the mobile subscriber. As mentioned earlier, each GSM terminal is identified by a unique International Mobile Equipment Identity (IMEI) number. A list of IMEIs in the network is stored in the Equipment Identity Register (EIR). The status returned in response to an IMEI query to the EIR is one of the following:

White-listed

The terminal is allowed to connect to the network.

Grey-listed

The terminal is under observation from the network for possible problems.

Black-listed

The terminal has either been reported stolen, or is not type approved (the correct type of terminal for a GSM network). The terminal is not allowed to connect to the network.

3.7 Communication management

The Communication Management layer (CM) is responsible for Call Control (CC), supplementary service management, and short message service management. Each of these may be considered as a separate sublayer within the CM layer. Call control attempts to follow the ISDN procedures specified in Q.931, although routing to a roaming mobile subscriber is obviously unique to GSM. Other functions of the CC sublayer include call establishment, selection of the type of service (including alternating between services during a call), and call release.

3.7.1 Call routing

Unlike routing in the fixed network, where a terminal is semi-permanently wired to a central office, a GSM user can roam nationally and even internationally. The directory number dialed to reach a mobile subscriber is called the Mobile Subscriber ISDN (MSISDN), which is defined by the E.164 numbering plan. This number includes a country code and a National Destination Code which identifies the subscriber's operator. The first few digits of the remaining subscriber number may identify the subscriber's HLR within the home PLMN.

An incoming mobile terminating call is directed to the Gateway MSC (GMSC) function. The GMSC is basically a switch which is able to interrogate the subscriber's HLR to obtain routing information, and thus contains a table linking MSISDNs to their corresponding HLR. A simplification is to have a GSMC handle one specific PLMN. It should be noted that the GMSC function is distinct from the MSC function, but is usually implemented in an MSC. The routing information that is returned to the GMSC is the Mobile Station Roaming Number (MSRN), which is also defined by the E.164 numbering plan. MSRNs are related to the geographical numbering plan, and not assigned to subscribers, nor are they visible to subscribers.

The most general routing procedure begins with the GMSC querying the called subscriber's HLR for an MSRN. The HLR typically stores only the SS7 address of the subscriber's current VLR, and does not have the MSRN (see the location updating section). The HLR must therefore query the subscriber's current VLR, which will temporarily allocate an MSRN from its pool for the call. This MSRN is returned to the HLR and back to the GMSC, which can then route the call to the new MSC. At the new MSC, the IMSI corresponding to the MSRN is looked up, and the mobile is paged in its current location area.

CHAPTER 4

COMPONENTS DESCRIPTION

- Temperature Sensor LM 35
- Power Supply
- Microcontroller AT89S52
- Analog to Digital Converter: ADC0848
- Adjustable Regulator: LM317
- GSM Modem: SIM 300
- 16x2 LCD

4.1 Temperature Sensor LM35

4.1.2 Specifications of LM35 are:

1. +Vs – It is the pin for providing the power supply to the sensor.
2. Vout – It gives output from the sensor in terms of voltage.
3. GND – It grounds the device

4.1.3 Basic Description

- The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.
- Low output impedance, linear output, and precise inherent calibration.
- Easy interfacing to readout or control circuitry.
- Can be used with single power supplies.
- For every ^{0}C change in temperature, it shows variâtion of 10mV in the output.

4.1.4 Operation

A block diagram of the LM35 is shown in Figure 2.1 the LM35 measures temperature using a band gap-based temperature sensor. A delta-sigma analog-to digital converter (ADC) converts the measured temperature to a digital value that is calibrated in °C; for °F applications, a lookup table or conversion routine must be used. The LM35 can measure temperature over the range of -55_C to +125_C in 0.5_C increments. For every ^{0}C change in temperature, it shows variation of 10mV in the output.

4.2 MICROCONTROLLER: AT89S52

Following are the criteria for selecting a microcontroller:

1. The first and the foremost criteria in choosing a microcontroller is that it must meet the task at hand effectively.

Among other considerations in this category are:

- Speed-It should be highest one that the microcontroller supports.
- Packaging-Check whether comes in 40 pin dual in line package or quad flat package or some other packing format. This is important in terms of space assembling technique and prototyping the end product.
- Power consumption- This is especially critical for battery powered products.
- The amount of RAM and ROM available on the chip.
- The number of I/O pins and the timers available on the chip.

2. The second criterion in choosing a microcontroller is how easy it is in developing products around it. Key considerations include the availability of an assembler, debugger code efficient C language compiler, emulator, technical support and both in house and outside expertise.

3. The third criterion in choosing a microcontroller is its ready availability in needed quantities both at present and in future. For some designers this is even more important than first two criteria.

Since AT89c52 is meeting all these requirements considerably well we have chosen this microcontroller.

4.2.1 Description

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

4.2.2 Pin Diagram

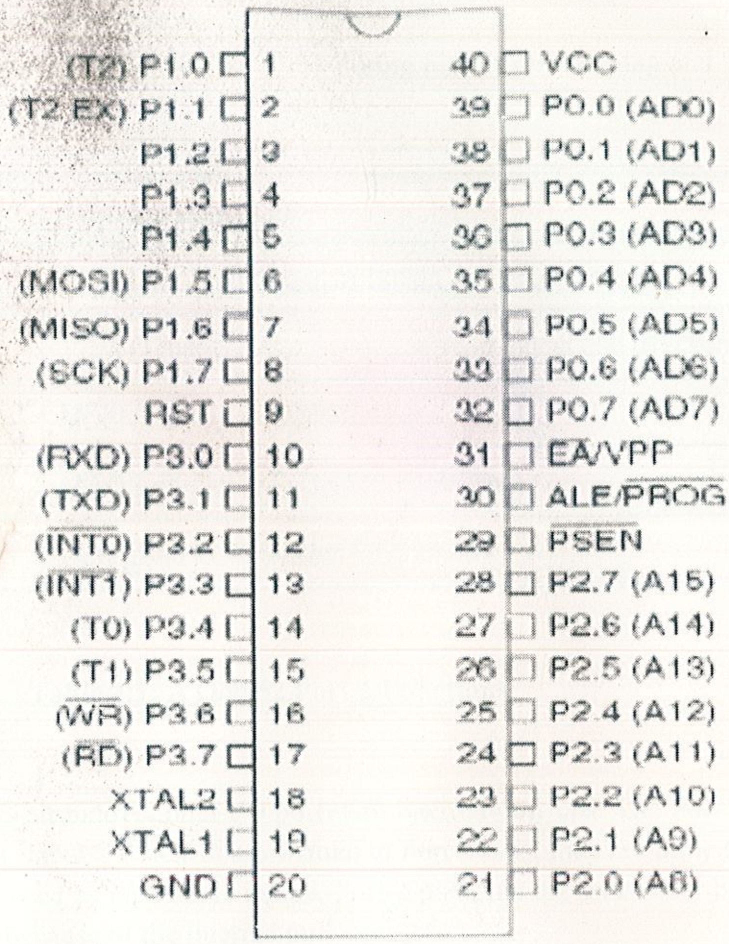


Figure 4.1: Pin Diagram AT89S52

VCC: Supply voltage.

GND: Ground.

Port 0: Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

Port 1: Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal

pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups.
In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX), respectively, as shown in the following table.
Port 1 also receives the low-order address bytes during Flash programming and verification.

Port Pin	Alternate Functions
P1.0	T2 (external count input to Timer/Counter 2), clock-out
P1.1	T2EX (Timer/Counter 2 capture/reload trigger and direction control)
P1.5	MOSI (used for In-System Programming)
P1.6	MISO (used for In-System Programming)
P1.7	SCK (used for In-System Programming)

Table 4.1: AT89S52 Port 1 Functions

Port 2: Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups.
Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3: Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 receives some control signals for Flash programming and verification. Port 3 also serves the functions of various special features of the AT89S52, as shown in the following table.

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{\text{WR}}$ (external data memory write strobe)
P3.7	$\overline{\text{RD}}$ (external data memory read strobe)

Table 4.2: Port 3 Functions

RST: Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives high for 98 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.

ALE/PROG: Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

PSEN: Program Store Enable (PSEN) is the read strobe to external program memory.
When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP: External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions.This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming.

XTAL1: Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2: Output from the inverting oscillator amplifier.

4.3 POWER SUPPLY

4.3.1 Description

The power supply provides 5V dc power to the circuit. Transformer T steps down the 220 volts ac voltage from mains to a safe value i.e 12-15 volts. The bridge rectifier removes the negative voltage, i.e rectifies the ac voltage. A 100 u F capacitor filters it and removes the ripples.

The LM7805 linear voltage regulator circuit belongs to the LM78XX family of integrated circuits. This basically means that the LM7805 is just one of several types of fixed linear voltage integrated circuits that can be installed in various electronic devices. The LM78XX integrated circuit family is often used in electronic devices which need a controlled power supply. Simply put, if the device requires 5 Volts to function properly, the LM7805 is the integrated circuit you should use to regulate to that specific voltage level. The LM78XX family has several subtypes, with the final two numbers designating their operating voltage. So if the last two numbers are "05", then that integrated circuit operates at a 5 Volt output. If the last two numbers are 12, then it's 12 volts. One more important thing to remember is that the LM78XX families of voltage regulator circuits are all positive voltage regulators.

Features of LM 7805:

- Output Current up to 1A
- Output Voltages of 5 volt
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

4.3.2 Circuit Diagram

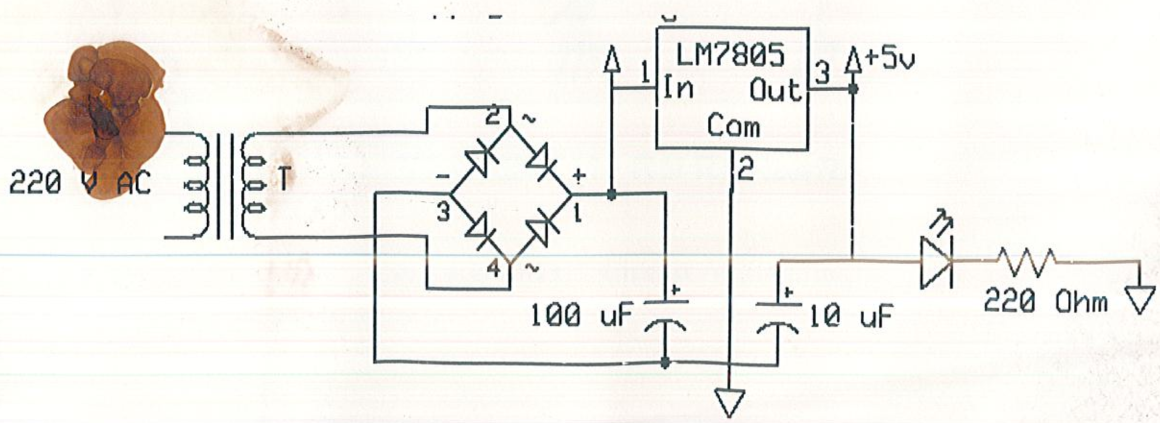


Figure 4.2: Circuit Diagram of Power Supply

4.4 LM 317

4.4.1 Description

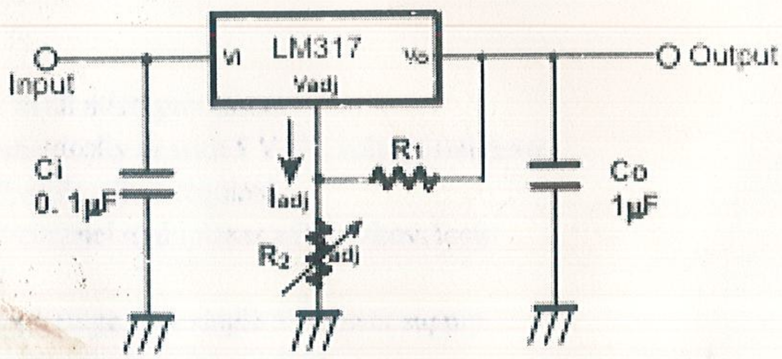
This monolithic integrated circuit is an adjustable 3-terminal positive voltage regulator designed to supply more than 1.5A of load current with an output voltage adjustable over a 1.2V to 37V. It employs internal current limiting, thermal shut-down and safe area compensation.

In this project, the GSM modem SIM 300 requires 4.1 Volts for operation and the rest of the components work at 5 Volts. Since we were not able to find a battery of 4.1 volts with the desired current rating, we are using LM317 voltage regulator to provide supply to SIM 300.

4.4.2 Features

- Output Current In Excess of 1.5A
- Output Adjustable Between 1.2V and 37V
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe Operating Area Compensation
- TO-220 Package

4.4.3 Typical Application



$$V_O = 1.25V\,(1 + R_2 / R_1) + I_{adj} R_2$$

Figure 4.3: LM317 Circuit Application

- Ci is required when regulator is located an appreciable distance from power supply filter.
- Co is not needed for stability, however, it does improve transient response.

Since IADJ is controlled to less than 100μA, the error associated with this term is negligible in most applications.

4.5 BAUD RATE GENERATOR CRYSTAL OSCILLATOR

It helps to give you exact clock rates for most of the common baud rates for the UART, especially for the higher speeds (9600, 19200). This gives us the minimum crystal frequency possible for the desired baud rate. The frequency can be evenly multiplied to obtain higher clock speeds.

Figure 4.4: Crystal Oscillator

4.6 ADC 0848

4.6.1 Features

- Easy interface to all microprocessors
- Operates ratiometrically or with 5 V DC voltage reference
- No zero or full-scale adjust required
- 4-channel or 8-channel multiplexer with address logic
- Internal clock
- 0V to 5V voltage range with single 5V power supply
- [illegible] standard width 20-pin or 24-pin DIP
- [illegible] Pin Molded Chip Carrier Package

4.6.2 Key Specifications

- Resolution 8 bits
- Total Unadjusted Error ±1/2 LSB and ±1 LSB

- Single supply 5 V DC
- Low power 15Mw
- Conversion Time 40 usec

4.6.3 Pin Diagram

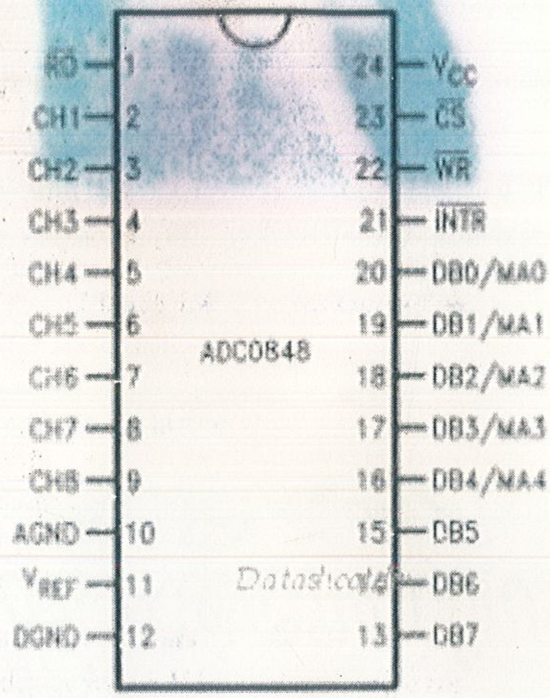


Figure 4.5: Pin Diagram ADC0848

4.7 SIM 300

The SIMCOM SIM300 module connects to a specific application and the air interface. SIM300 can be integrated with a wide range of applications,

Designed for global market, SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. SIM300 provides GPRS multi-slot class 10 capability and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.

With a tiny configuration of 40mm x 33mm x 2.85 mm , SIM300 can fit almost all the space requirement in your application, such as Smart phone, PDA phone and other mobile device.

The physical interface to the mobile application is made through a 60 pins board-to-board connector, which provides all hardware interfaces between the module and customers' boards except the RF antenna interface.

- The keypad and SPI LCD interface will give you the flexibility to develop customized applications.
- Two serial ports can help you easily develop your applications.
- Two audio channels include two microphones inputs and two speaker outputs. This can be easily configured by AT command.

SIM300 provide RF antenna interface with two alternatives: antenna connector and antenna pad. The antenna connector is MURATA MM9329-2700. And customer's antenna can be soldered to the antenna pad.

The SIM300 is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode.

The SIM300 is integrated with the TCP/IP protocol, Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications.

4.7.1 SIM300 key features at a glance

Table 4: SIM300 key features Feature	Implementation
Power supply	Single supply voltage 3.4V – 4.5V
Power saving	Typical power consumption in SLEEP mode to 2.5mA
Frequency bands	• SIM300 Tri-band: EGSM 900, DCS 1800, PCS 1900. The band can be set by AT COMMAND, and default band is EGSM 900 and DCS 1800. • Compliant to GSM Phase 2/2+
GSM class	Small MS
Transmit power	• Class 4 (2W) at EGSM900 • Class 1 (1W) at DCS1800 and PCS 1900

GPRS connectivity	• GPRS multi-slot class 10 • GPRS mobile station class B
Temperature range	• Normal operation: -20°C to +55°C • Restricted operation: -25°C to -20°C and +55°C to +70°C • Storage temperature -40°C to +80°C
DATA *GPRS:* *CSD:*	• GPRS data downlink transfer: max. 85.6 kbps • GPRS data uplink transfer: max. 42.8 kbps • Coding scheme: CS-1, CS-2, CS-3 and CS-4 • SIM300 supports the protocols PAP (Password Authentication Protocol) usually used for PPP connections. • The SIM300 integrates the TCP/IP protocol. • Support Packet Switched Broadcast Control Channel (PBCCH) • CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent • Unstructured Supplementary Services Data (USSD) support
SMS	• MT, MO, CB, Text and PDU mode • SMS storage: SIM card • Support transmission of SMS alternatively over CSD or GPRS. User can choose preferred mode.
FAX	Group 3 Class 1
SIM interface	Supported SIM card: 1.8V ,3V
External antenna	Connected via 50 Ohm antenna connector or antenna pad

Audio features	Speech codec modes: • Half Rate (ETS 06.20) • Full Rate (ETS 06.10) • Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) • Echo suppression
Two serial interfaces	• Serial Port 1 Seven lines on Serial Port Interface • Serial Port 1 can be used for CSD FAX, GPRS service and send
AT command of controlling module. • Serial Port 1 can use multiplexing function, but you can not use the Serial Port 2 at the same time; • Autobauding supports baud rate from 1200 bps to 115200bps. • Serial port 2 Two lines on Serial Port Interface /TXD and /RXD • Serial Port 2 only used for transmitting AT command.	
Phonebook management	Supported phonebook types: SM, FD, LD, RC, ON, MC.
SIM Application Toolkit	Supports SAT class 3, GSM 11.14 Release 98
Real time clock	Implemented
Timer function	Programmable via AT command
Physical characteristics	Size: 40±0.15 x 33±0.15 x 3.3±0.3 mm (including application connector) 40±0.15 x 33±0.15 x 2.85±0.3 mm (excluding application connector) Weight: 8g
Firmware upgrade	Firmware upgradeable over serial interface

Table 4.3: SIM 300 Features

4.7.2 SIM300 Pin description

Table 5: Board-to-Board Connector pin description Power Supply			
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS
VBAT		Eight BAT pins of the board-to-board connector are dedicated to connect the supply voltage. The power supply of SIM300 has to be a single voltage source of VBAT= 3.4V...4.5V. It must be able to provide sufficient current in a transmit burst which typically rises to 2A.mostly, these 8 pins are voltage input	Vmax= 4.5V Vmin=3.4V Vnorm=4.0V
VRTC	I/O	Current input for RTC when the battery is not supplied for the system. Current output for backup battery when the main battery is present and the backup battery in low voltage state.	Vmax=2.0V Vmin=1.2V Vnorm=1.8V Inorm= 20uA
VDD_EXT	O	Supply 3.0V voltage for external circuit. By measure this pin, user can judge the system is on or off. When the voltage is low, the system is off. Otherwise, the system is on.	Vmax=3.15V Vmin=2.85V Vnorm=3.0V Imax=60mA
GND		Digital ground	

Power on or power off			
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS

PWRKEY	I	Voltage input for power on key. PWRKEY get a low level Voltage for user to power on or power off the system, The user should keep pressing the key for a moment when power on or power off the system. Because the system need margin time assert the software.	VILmax=0.3*VBAT VIHmin=0.7*VBAT VImax=VBAT
Audio interfaces			
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS
MIC1P MIC1N	I	Positive and negative voice-band input	Audio DC Characteristics
MIC2P MIC2N	I	Auxiliary positive and negative voice-band input	
SPK1P SPK1N	O	Positive and negative voice-band output	
SPK2P SPK2N	O	Auxiliary positive and negative voice-band output	
Buzzer	O	Buzzer Output	
AGND		Analog ground	
General purpose input/output			
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS
KBC0~KBC4	O	The GPO can be configured by AT command for outputting high or low level voltage. All of the GPOs are initial low without any setting from AT command.	VILmin=0V VILmax=0.3 *VDD_EXT VIHmin=0.7*VDD_EXT VIHmax= VDD_EXT+0.3 VOLmin=GND VOLmax=0.2V VOHmin= VDD_EXT-0.2 VOHmax= VDD_EXT
KBR0~KBR4	I		
SPI_DATA	I/O		
SPI_CLK	O		

SPI_CS	O		
SPI_D/C	O		
SPI_RST	O		
Network LED	O		
GPIO8	I/O	Normal Input/Output Port	
Serial 1 interface			
PIN NAME	I/O	DESCRIPTION	DC CHARACTERISTICS
DTR	I	Data Terminal Ready	VILmin=0V VILmax=0.3*VDD_EXT VIHmin=0.7*VDD_EXT VIHmax= VDD_EXT+0.3 VOLmin=GND
RXD	I	Receive Data	
TXD	O	Transmit Data	
RTS	I	Request to Send	
CTS	O	Clear to Send	

Table 4.4: SIM 300 Pin Description

4.7.3 Operating modes

The following table summarizes the various operating modes, each operating modes is referred to in the following chapters.

Mode	Function

Normal operation	GSM/GPRS SLEEP	Module will automatically go into SLEEP mode if DTR is set to high level and there is no on air or audio activity is required and no hardware interrupt (such as GPIO interrupt or data on serial port). In this case, the current consumption of module will reduce to the minimal level. During sleep mode, the module can still receive paging message and SMS from the system normally.
GSM IDLE		Software is active. Module has registered to the GSM network, and the module is ready to send and receive.
GSM TALK		CSD connection is going on between two subscribers. In this case, the power consumption depends on network settings such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
GPRS IDLE		Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration (e.g. multi-slot settings).
GPRS DATA		There is GPRS data in transfer (PPP or TCP or UDP). In this case, power consumption is related with network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multi-slot settings).
POWER DOWN		Normal shutdown by sending the "AT+CPOWD=1" command or using the PERKEY. The power management ASIC disconnects the power supply from the base band part of the module, only the power supply for the RTC is remained. Software is not active. The serial interfaces are not accessible. Operating voltage (connected to VBAT) remains applied.

Minimum functionality mode (without remove power supply)	Use the "AT+CFUN" command can set the module to a minimum functionality mode without remove the power supply. In this case, the RF part of the module will not work or the SIM card is not accessible, or RF part and SIM card be closed all, the serial interfaces is still accessible. The power consumption in this case is very low.
Alarm mode	RTC alert function launches this restricted operation while the module is in POWER DOWN mode. SIM300 will not be registered to GSM network and only parts of AT commands can be available.

Table 4.5: Overview of SIM 300 operating modes

4.8 16x2 LCD

4.8.1 Description

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

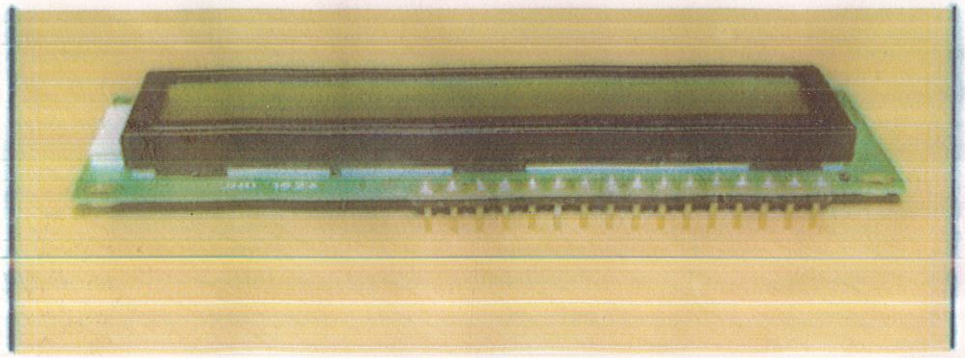


Figure 4.6: 16x2 LCD

A **16x2 LCD** means it can 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 two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an 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 to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

4.8.2 Pin Diagram:

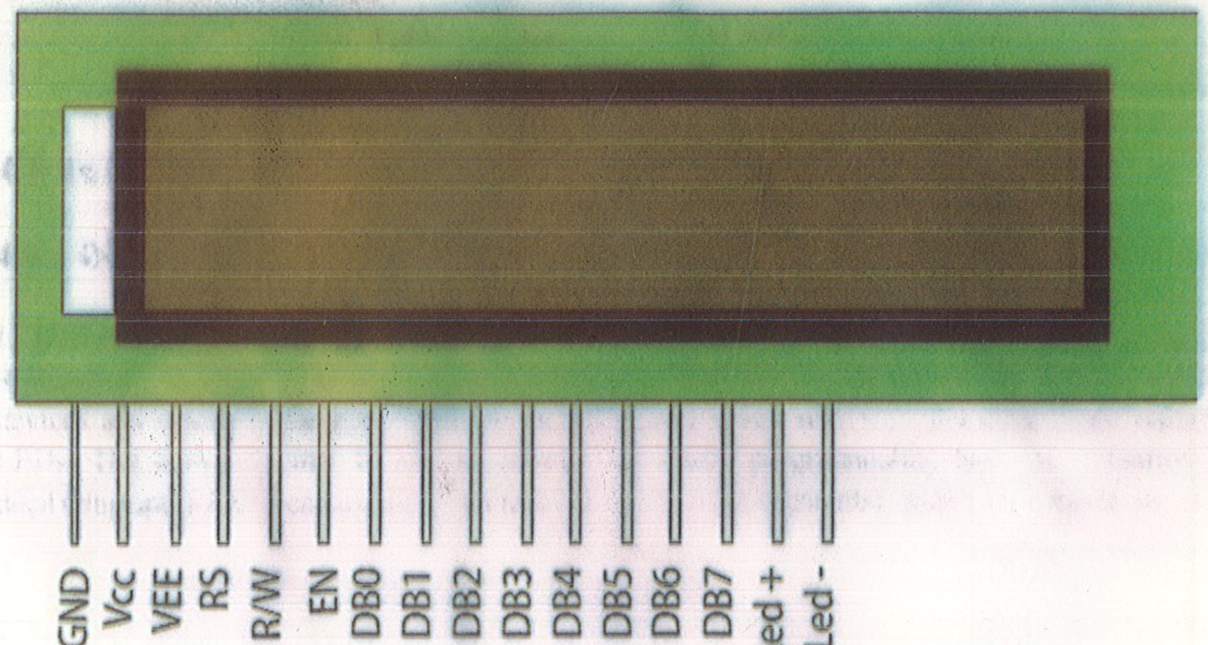


Figure 4.7: 16x2 LCD Pin Diagram

4.8.3 Pin Description

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 4.6: 16x2 LCD Pin Description

CHAPTER 5

WORKING AND CODE

The Mobile Health Care System will consist of body sensors which can be mounted on a wearable wrist band. We can have body sensors measuring temperature, pulse, blood pressure etc. The sensor band will be connected to a microcontroller via a wire or it may also be made wireless. The microcontroller will send AT command to the patient's mobile phone whenever the body parameters measured cross a certain pre-defined threshold. The AT command will indicate the patient's mobile phone to send a message to the doctor's mobile phone according to the level of urgency. Next the doctor may reply back to the patient or a nearby nurse to take corrective or precautionary action. In case of an emergency the doctor may himself pay a visit to the patient with the help of the location sent along in the message through GPS or send in an ambulance.

5.1 Block Diagram

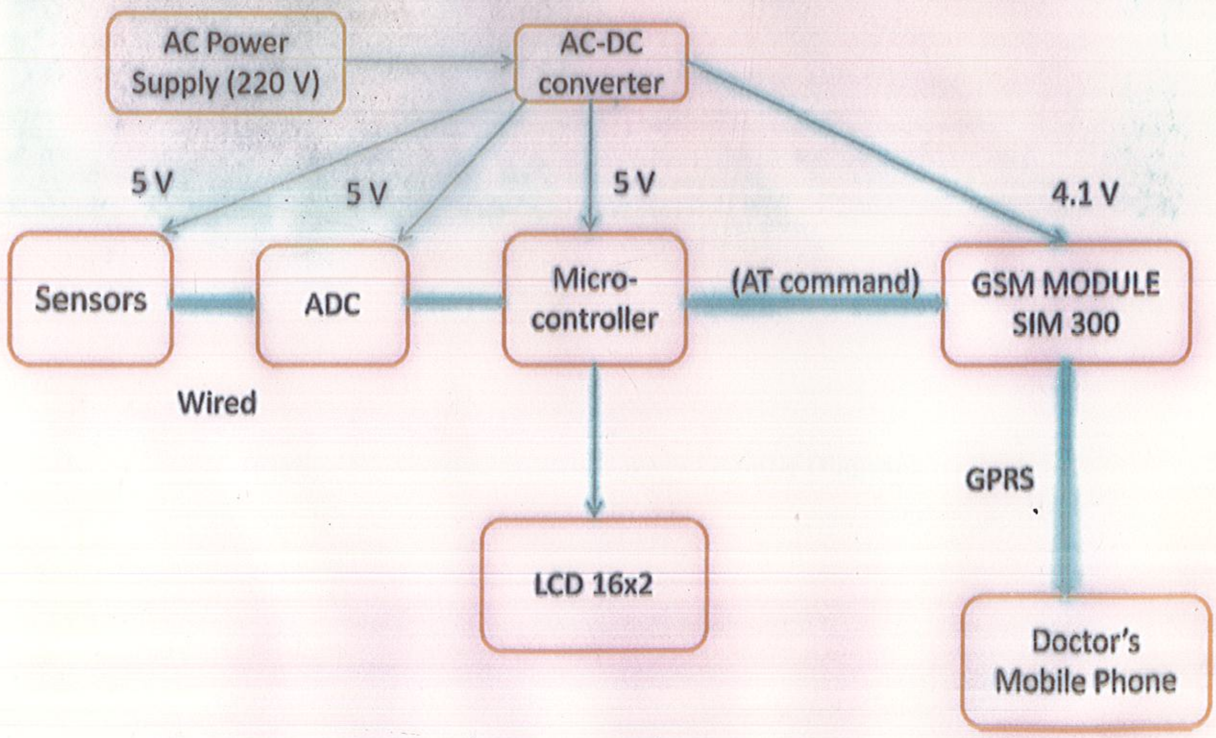


Figure 5.1: Mobile Health Care Block Diagram

5.2 Schematic Diagram

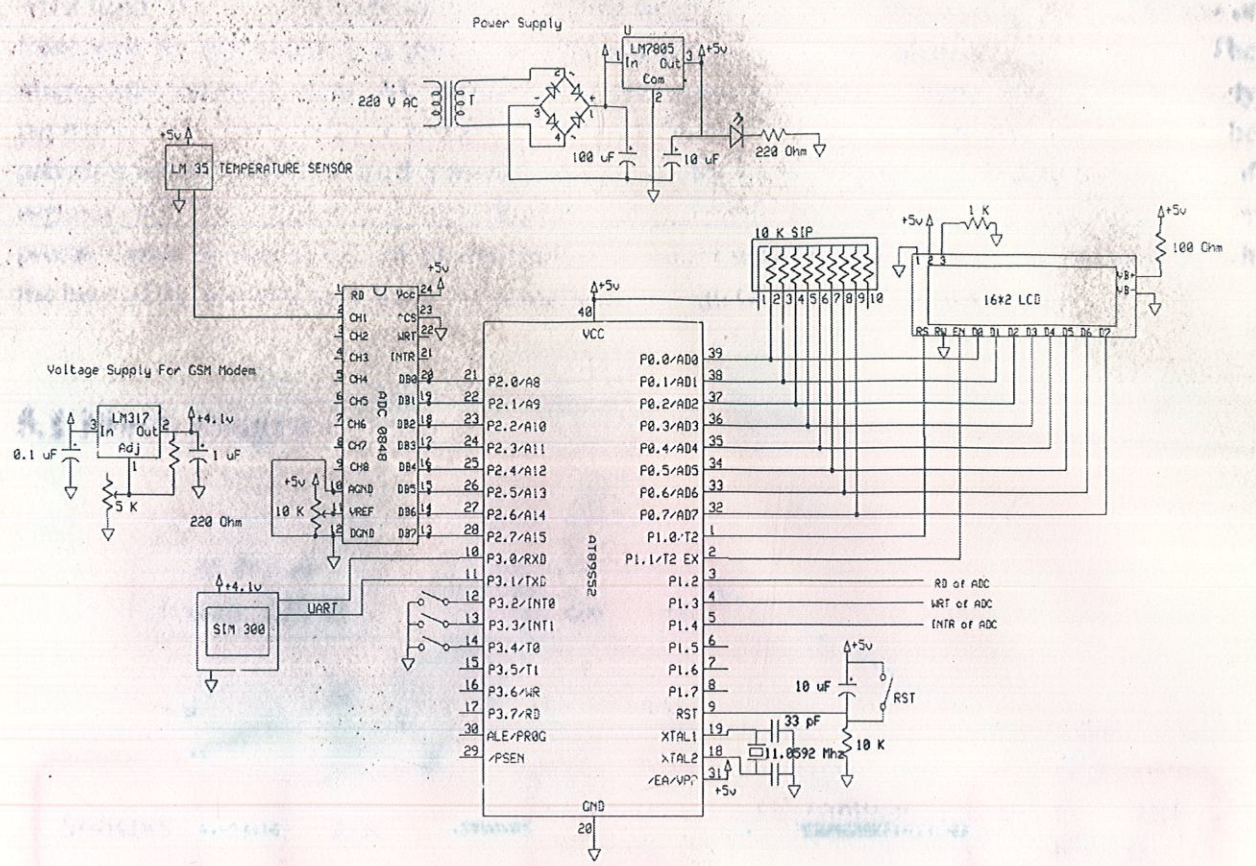


Figure 5.2: Mobile Health Care Schematic Diagram

In figure 5.2, the schematic diagram of Mobile Health Care is shown. As we can see, the very first circuit is the Power Supply. We need a constant DC voltage for LM-35 temperature sensor (+5v), ADC 0848 analog to digital converter (+5v), AT89S52 MCU (+5v), and 16*2 LCD (+5v). The circuit uses an LM7805 voltage regulator and a voltage rectifier and converts 220 V AC to 5V DC. The GSM Modem SIM 300 needs a DC voltage of 4.1 V at a higher current rating, so we make another circuit Power Supply For GSM Modem. The circuit scales down 5V to 4.1V DC using an LM317 linear voltage regulator.

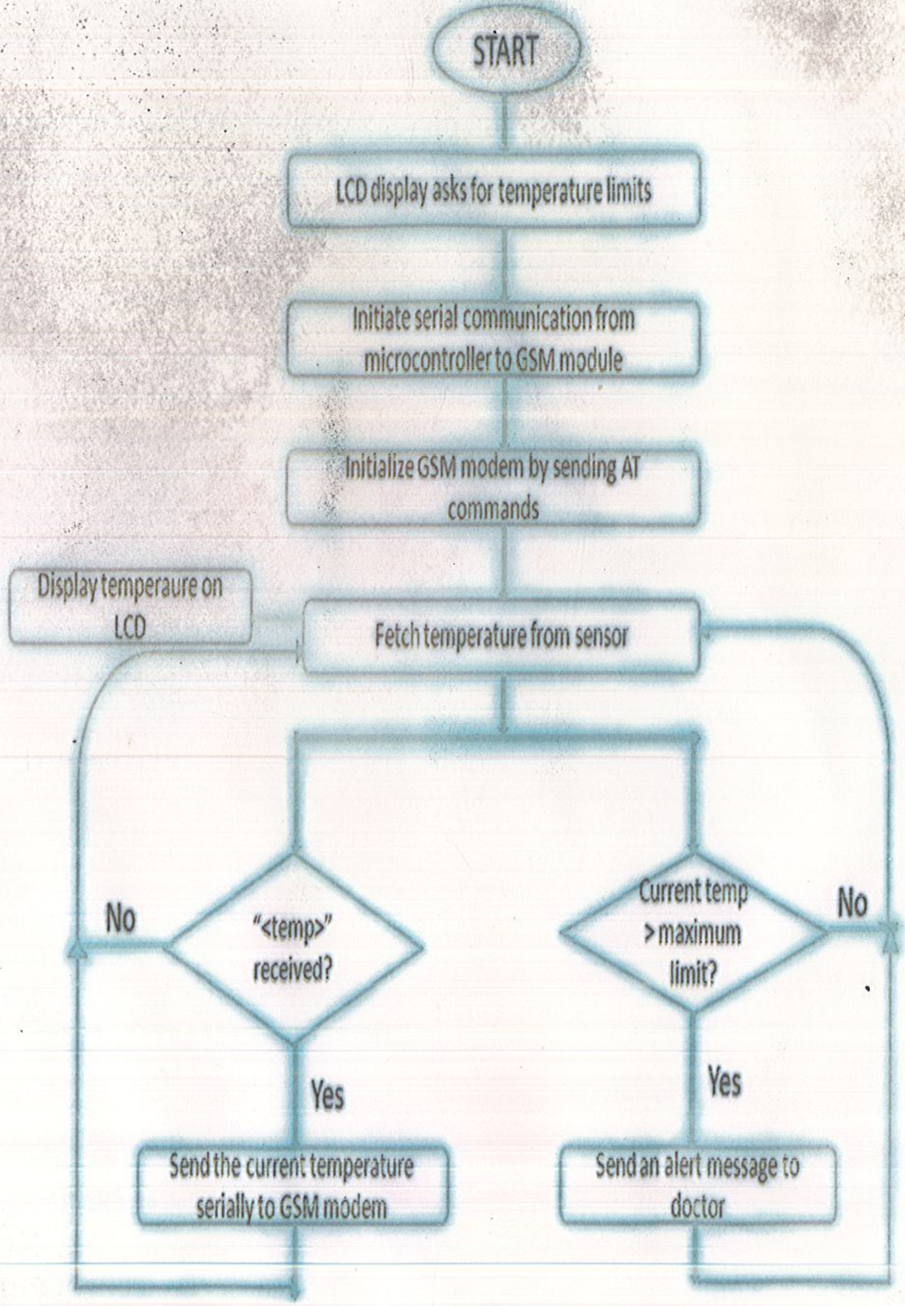
After giving the power supply to all the components, we see how the system works. The LM-35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. LM-35 analog temperature sensor keeps on giving the temperature every few seconds in the form of analog voltage and it keeps sending the data to ADC0848 analog to digital converter.ADC0848 is a CMOS 8-bit successive approximation A/D converter with versatile analog input multiplexers. The A to D converter converts the temperature (in terms of voltage) to degree Celsius and stores it. Now the A to D converter is interfaced with the MCU. The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The MCU is further interfaced with the 16*2 LCD.

When we switch on the system, we have to set the threshold temperature on the LCD for the demonstration so that the system is activated when the temperature exceeds that threshold value. The MCU keeps on asking for the new temperature value from A to D converter every few seconds and keeps comparing it with the threshold value. The MCU also gives the received temperature value to the LCD so that the temperature recordings can be demonstrated. The MCU is also interfaced with GSM Modem SIM 300 using UART. SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz.

Once the temperature exceeds the threshold value, the MCU sends a command (AT commands) to the GSM modem to send an SMS to the number fed in it. The GSM modem will keep sending the SMS every few seconds until the temperature drops below the threshold value.

We have used the LCD just to demonstrate the functioning of our system. Whenever the MCU receives the temperature, it instantaneously gives it to LCD so that the current temperature is displayed. We have also added one more application based on the properties of GSM modem. The mobile user can check the temperature by sending "<temp>" as an SMS to the number of the GSM modem. Whenever a GSM modem receives an SMS "<temp>", it asks for the current temperature from the MCU and replies with that temperature in form of an SMS. In this way, the user can check the temperature whenever he wants to.

5.3 FLOW CHART



5.4 Code

```
#include<regx51.h>
/************************************************************/
sbit WRT = P1^3;
sbit RDD = P1^2;
sbit INTR= P1^4;
sbit K1 = P3^2;
sbit K2 = P3^3;
sbit K3 = P3^4;
//***********************************************************/
#define LCD P0
sbit RS = P1^0;              //LCD Register Select
sbit EN = P1^1;              //LCD Enable

void delay2(unsigned int);
void lcd_data(unsigned char);
void lcd_cmd(char);
void main_lcd(unsigned char[]);
unsigned char disp_1[]={'T','E','M','P',':','-','>'};
/**********************************************************/
char arrg[30], arr[10], arr2[10];
int c1=0, flag = 0;
int max = 20, pos,pos2, check = 0;
unsigned char adc[3];
void clr_arrg(void);
void confirm(void);
unsigned int value;
//*******************************************
void clr_arrg()
{
        int k;
        for(k=0;k<=19;k++)
        {
                arrg[k]=0;
        }
}

//*******************************************
void tx_UART(char);
/******************************************/
```

```
void init_serial()
{
        TMOD = 0x21;            // Timer 1, 8 bit Auto-reload
        TH1 = 0xFD;         // 9600 Baud Rate
        SCON = 0x50;
        IE = 0x90;          // For Enabling Serial Port Interrupt
        TR1 = 1;
}
//********************************************
void tx_UART(char v)                            // Transmiting data on the Serial Port
{
        TI=0;
        SBUF = v;
        while(TI!=1);
        TI = 0;
}
/***********************************************/
void confirm()                                  // Reply in case of Command execution
{
        int a;
        char code arr3[]="at+cmgs=";
        char code arr4[]="9013906792";
        char code arr5[]="INFO : COMMAND EXECUTED";
        for(a=0;a<=7;a++)
        {
                tx_UART(arr3[a]);
        }
        tx_UART('"');
        for(a=0;a<=9;a++)
        {
                tx_UART(arr4[a]);
        }
        tx_UART('"');
        tx_UART(0x0D);
        for(a=0;a<=22;a++)
        {
                tx_UART(arr5[a]);
        }
        tx_UART(26);

}
//********************************************
void alert_user()                               // Sends a message in case of Temperature
exceed
{
```

```
        int a;
        char code arr3[]="at+cmgs=";
        char code arr4[]="9013906792";
        char code arr5[]="ALERT : TEMPERATURE EXCEEDED";
        for(a=0;a<=7;a++)
        {
                tx_UART(arr3[a]);
        }
        tx_UART('"');
        for(a=0;a<=9;a++)
        {
                tx_UART(arr4[a]);
        }
        tx_UART('"');
        tx_UART(0x0D);
        for(a=0;a<=27;a++)
        {
                tx_UART(arr5[a]);
        }
        tx_UART(26);

}
//*******************************************
//*******************************************
void init_gsm()                                         // Initializing the GSM Modem
{
        int a;
        char code arr1[]="at";
        char code arr2[]="at+cmgf=1";
        char code arr3[]="at+cmgs=";
        char code arr4[]="9013906792";
        char code arr5[]="ALERT : SYSTEM ACTIVATED";
        char code arr6[]="at+cmgd=1";

        for(a=0;a<=1;a++)
        {
                tx_UART(arr1[a]);
        }
        for(a=0;a<=8;a++)
        {
                tx_UART(arr2[a]);
        }
        tx_UART(0x0D);
        for(a=0;a<=8;a++)
        {
```

```
            tx_UART(arr6[a]);
        }
        tx_UART(0x0D);
        for(a=0;a<=7;a++)
        {
            tx_UART(arr3[a]);
        }
        tx_UART("");
        for(a=0;a<=9;a++)
        {
            tx_UART(arr4[a]);
        }
        tx_UART("");
        tx_UART(0x0D);
        for(a=0;a<=23;a++)
        {
            tx_UART(arr5[a]);
        }
        tx_UART(26);
}

//*******************************************

void store_arr(int val)
{
        int in=0;
        int v1;
        pos=0;
        for(in=0;in<=9;in++)
        {
            arr[in]=' ';
        }
        in=0;
        while(val!=0)
        {
          arr[in]=val%10;
          arr[in]=arr[in]+48;
          val=val/10;
          in++;
          pos++;
        }
        lcd_cmd(0xC0);
        for(v1=pos-1;v1>=0;v1--)
            {
            lcd_data(arr[v1]);
            }
```

```
}
/*******************************************************/
void current_temp()                                   // Displays the Current Temperature :
Please modify it with your no.
{
        int a;
        char code arr3[]="at+cmgs=";
        char code arr4[]="9013906792";
        char code arr5[]="INFO : TEMPERATURE = ";
        store_arr(value);
        for(a=0;a<=7;a++)
        {
                tx_UART(arr3[a]);
        }
        for(a=0;a<=9;a++)
        {
                tx_UART(arr4[a]);
        }
        tx_UART(0x0D);
        for(a=0;a<=20;a++)
        {
                tx_UART(arr5[a]);
        }
        for(a = pos-1;a >= 0; a--)
        {
                tx_UART(arr[a]);
        }
        tx_UART(26);
}
/*******************************************************/
void serial() interrupt 4                              // receives the Message during a Serial
Interrupt
{
        char rec;
        RI=0;
        rec = SBUF;
        if(rec == '<')
        {
                c1 = 0;
                arrg[c1]=rec;
                c1++;
        }
        else if(rec == '>' && c1 == 5)
                {
                arrg[c1] = rec;
```

```
            c1=0;
            check = 1;
            confirm();
            }
    else
            {
            if(c1>17)
                {
                c1=0;
                }
            arrg[c1]=rec;
            c1++;
            }
}
//*********************************************
unsigned int delay(unsigned int xdel)
 {
 unsigned int k,l;
 for(k=0;k<=xdel;k++)
   for(l=0;l<=200;l++);
 return 0;
 }
/************************************************/
unsigned int conversion(unsigned int m)
  {
  unsigned char z,d1,d2,d3;
  z=m/10;         // divide by 10
  d1=m%10;        // MSB
  d1=d1+48;
  d2=z%10;                  // Middle digit
  d2=d2+48;
  d3=z/10;        // LSB
  d3=d3+48;
  adc[2]=d1;
  adc[1,0]=d3;
  return 0;
  }
//*********************************************
void set_limit()                              // Sets the Limit for temperature on the LCD
        {
        lcd_init();
        lcd_data('E');lcd_data('N');lcd_data('T');lcd_data('E');lcd_data('R');lcd_data('
');lcd_data('T');lcd_data('E');
        lcd_data('M');lcd_data('P');lcd_data('
');lcd_data('L');lcd_data('I');lcd_data('M');lcd_data('I');lcd_data('T');
```

```
lcd_cmd(0xC3);
lcd_data('*');lcd_data('C');lcd_data(' ');
lcd_cmd(0xC0);
lcd_data('2');lcd_data('0');
while(flag == 0)
        {
        if(K1 == 0)
                {
                delay(100);
                if(max != 50)
                        {
                        max = max + 1;
                        lcd_cmd(0xC0);
                        lcd_data(' ');lcd_data(' ');lcd_data(' ');
                        lcd_cmd(0xC0);
                        store_arr(max);
                        }
                }
        else if(K2 == 0)
                {
                delay(100);
                if(max != 20)
                        {
                        max = max - 1;
                        lcd_cmd(0xC0);
                        lcd_data(' ');lcd_data(' ');lcd_data(' ');
                        lcd_cmd(0xC0);
                        store_arr(max);
                        }
                }
        else if(K3 == 0 && max > 19)
                {
                delay(100);
                lcd_cmd(0x80);
                lcd_data('O');lcd_data('K');
                delay(500);
            flag = 1;
                }
        }
    }

//******************************************

void init_display1()
{
            lcd_cmd(0x80);
```

```
                lcd_data(' ');lcd_data(' ');lcd_data('
');lcd_data('G');lcd_data('S');lcd_data('M');lcd_data(' ');lcd_data('B');
                lcd_data('A');lcd_data('S');lcd_data('E');lcd_data('D');lcd_data(' ');lcd_data('
');lcd_data(' ');lcd_data(' ');
                lcd_cmd(0xC0);
                lcd_data(' ');lcd_data('
');lcd_data('T');lcd_data('E');lcd_data('M');lcd_data('P');lcd_data(' ');lcd_data('M');

        lcd_data('O');lcd_data('N');lcd_data('I');lcd_data('T');lcd_data('O');lcd_data('R');lcd_data('
');lcd_data(' ');
}

//****************************************

void main()                                    // Main function
        {
        unsigned int a;
        char code arr7[]="at+cmgr=1";
        char code arr6[]="at+cmgd=1";
        clr_arrg();
        lcd_init();
        init_display1();
        delay2(2000);
        set_limit();
        init_serial();
        init_gsm();
        delay2(1500);
        INTR = 1; //enable read, write and interupt pins of ADC
        WRT = 1;
        RDD = 1;
        while(1)
        {
        P2 = 0x08;//
        P2 = 0xFF;
        while(INTR==1);
        RDD = 0;
        delay(500);
        value = P2;
        RDD = 1;
        conversion(value);
   main_lcd(adc);
        if(value > max)
                {
                alert_user();
                }
        if(check == 1)
```

```
            {
        check = 0;
        current_temp();
            }
    delay2(2000);
    for(a=0;a<=8;a++)
            {
                    tx_UART(arr7[a]);
            }
            tx_UART(0x0D);
            for(a=0;a<=8;a++)
            {
                    tx_UART(arr6[a]);
            }
            tx_UART(0x0D);
        }
    }
/**************************************************/
//Functions for LCD Display //

void lcd_init()
{
RS=1;
lcd_cmd(0x38);
lcd_cmd(0x01);
lcd_cmd(0x0C);
lcd_cmd(0x80);

EN=1;
delay2(6);
EN=0;

}

void lcd_data(unsigned char dta)            // Sending DATA to the LCD
{
RS=0;
LCD = dta;
EN=1;
delay2(6);
EN=0;
}

void lcd_cmd(char cmmd;)                    // Sending Commands to the LCD
{
```

```
RS=1;
LCD = cmmd;
EN=1;
delay2(6);
EN=0;
}


void delay2(unsigned int DD)
{unsigned int i,j;
for(i=1;i<=DD;i++)
{
for(j=1;j<=50;j++);
}
}

void main_lcd(unsigned char man[])          // Displays the Temperature Value on LCD
  {
unsigned int g,m;

lcd_init();
for(g=0;g<3;g++)
  {
lcd_data(man[g]);
delay2(20);
  }
lcd_data(' ');
delay2(20);
lcd_data('C');
delay2(20);
  }
```

CONCLUSION

Over the past few decades, technology has touched lives, literally. While use of technology in healthcare has been made in a hospital environment, a larger scope lies for technology to become simple. Mobile Health Care is fast becoming a common reality. From Cardiac Monitoring to Diabetes Management and more, healthcare services that were once restrained within doctors being around the patient 24 hours are now finding their spot under technologically sound and improved healthcare. That's a win-win for both doctors/caregivers and patients. Mobile Health Care makes objective, pertinent information available to caregivers in a timely manner, or as and when the need arises, prevent any kind of critical disaster to occur. This way, the patients are taken care of and the doctors are able to perform their job effectively too. Also, this addresses the issue of ever-less-available resources like healthcare staff and physical presence of the doctor.

Additionally, it helps improve patient health, thanks to early diagnosis and preventive care.
Also this concept is called mHealth a term used for the practice of medical and public health, supported by mobile devices in reference to using mobile communication devices like mobile phones can be implemented by using the basic concept of wireless transmission of patient's health status. This concept of m-Health can be integrated in larger scale implementations like public health management systems where database of a large number of patients can be stored and monitored through wireless communication which can also be retrieved to maintain a proper record of the patient's health status and previous record. m-Health is a subdivision of e-Health Which deals with the usage of Information Coding Theory(ICT) like computers, communication satellites, patient monitors for health services and information. m-Health applications include the use of mobile devices in collecting community and clinical health data, delivery of healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vital signs, and direct provision of care. While m-Health certainly has application for industrialized nations, the field has emerged in recent years as largely an application for developing countries, stemming from the rapid rise of mobile phone penetration in low income nations. The field, then, largely emerges as a means of providing greater access to larger segments of a population in developing countries, as well as improving the capacity of health systems in such countries to provide quality healthcare. Within the m-Heath space, projects operate with a variety of objectives, including increased access to healthcare and health-related information (particularly for hard-to-reach populations); improved ability to diagnose and track diseases; timelier, more actionable public health information; and expanded access to ongoing medical education and training for health
workers.

The motivation behind the development of the m-Health field arises from two factors. The first factor concerns the myriad constraints felt by healthcare systems of 60 developing nations. These constraints include high population growth a high burden of disease prevalence, low health care workforce, large numbers of rural inhabitants, and limited financial resources to support healthcare infrastructure and health information systems. The second factor is the recent rapid rise in mobile phone penetration in developing countries to large segments of the healthcare workforce, as well as the population of a country as a whole. With greater access to mobile phones to all segments of a country, including rural areas, the potential of lowering information and transaction costs in order to deliver healthcare improves. The combination of these two factors has motivated much discussion of how greater access to mobile phone technology can be leveraged to mitigate the numerous pressures faced by developing countries' healthcare systems. We can also envisage concepts like **Telehealth** wherein the delivery of healthrelated services and information via telecommunications technologies. Telehealth delivery could be as simple as two health professionals discussing a case over the telephone, or as sophisticated as using videoconferencing between providers at facilities in two countries, or even as complex as robotic technology. **Telemedicine** is simple as two health professionals discussing a case over the telephone, or as complex as using satellite technology and video conferencing equipment to conduct a real-time consultation between medical specialists in two different countries. Telemedicine is most beneficial for populations living in isolated 61 communities and remote regions and is currently being applied in virtually all medical domains. Specialties that use telemedicine often use a "tele-" prefix; for example, telemedicine as applied by radiologists is called Teleradiology. Similarly telemedicine as applied by cardiologists is termed as telecardiology; etc .Telemedicine is also useful as a communication tool between a general practitioner and a specialist available at a remote location. One more future prospect of the project is its utility in monitoring the status of the patient by doctors when any one or both of them are on the move. Patient being taken to hospital in an ambulance and doctor travelling to the hospital can get constant updates about the patient status even when both of them are on the move is where our project can be instrumental. The shift is happening, or is about to happen. It's not a question of 'if,' but 'when.' The earlier the stakeholders understand the importance of remote patient care and the difference it makes to lives of millions of people across the world, the sooner we move towards a healthier world.