CHAPTER THREE

System Design

3.1 System Design

Circumstances that we find ourselves in today in the field of microcontrollers had their beginnings in the development of technology of integrated circuits. This development has made it possible to integrate hundreds of thousands of transistors into one chip. That was a prerequisite for production of microprocessors, and the first computers were made by adding external peripherals such as memory, input-output lines, timers and other. Further increasing of the volume of the package resulted in creation of integrated circuits. These integrated circuits contained both processor and peripherals. That is how the first chip containing a microcomputer, or what would later be known as a microcontroller came about. In these project we can use various types of component.[10]

These components works to perform and satisfy the main objectives on how to detect the location of fault ,also can be divided this components according to design and objective in two group:

1-processing unit that contains microprocessor ATMEGA16, MAX232, RS232 and Power circuit sensor which shows in figure(3.1) below. the main objectives of this unit when fault occur in the system (transmission line) sensed it , by signal includes the weather of line sending from the transformer . In normal status the signal came to processing is one ,if there is any problem the signal comes to processing unit as zero. In this case the processing unit sending signal to another unit called sending and detecting unit.

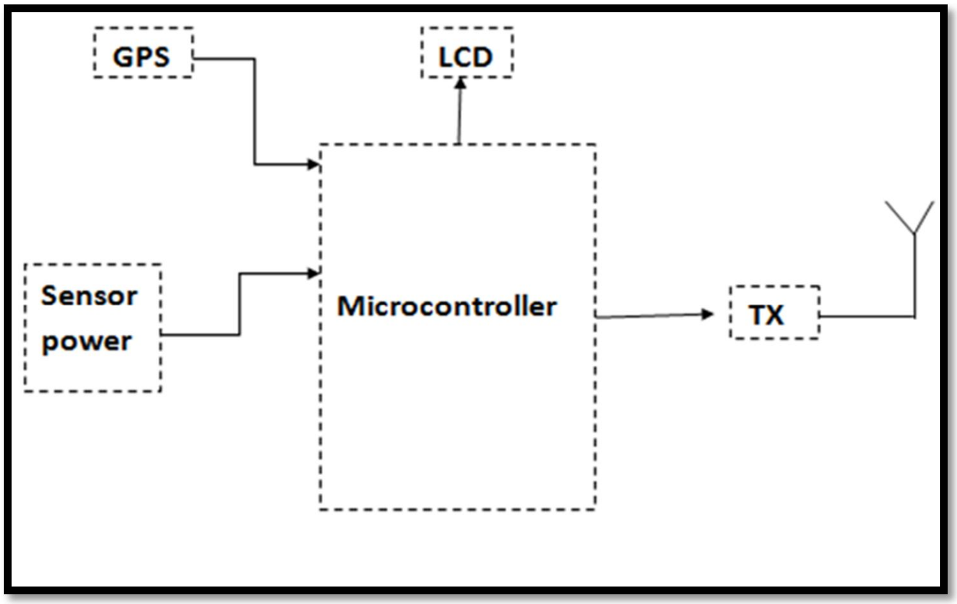
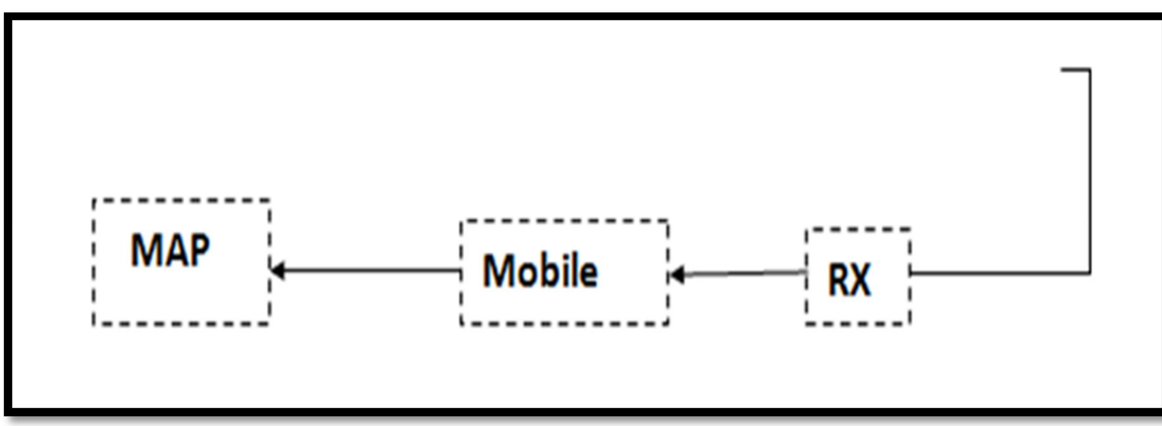


Figure (3.1) : contains of control unit

2- Sending and detecting unit : This units contains global positioning system and global system for mobile communication shows in figure(3.2) below ,after the power circuit sensed the fault and control unit send the signal to the sending and detecting unit .the detecting unit Represented to GPS detect the location of fault ,and sending unit Represented to GSM send message to control unit mobile which including the detail and information of the fault .



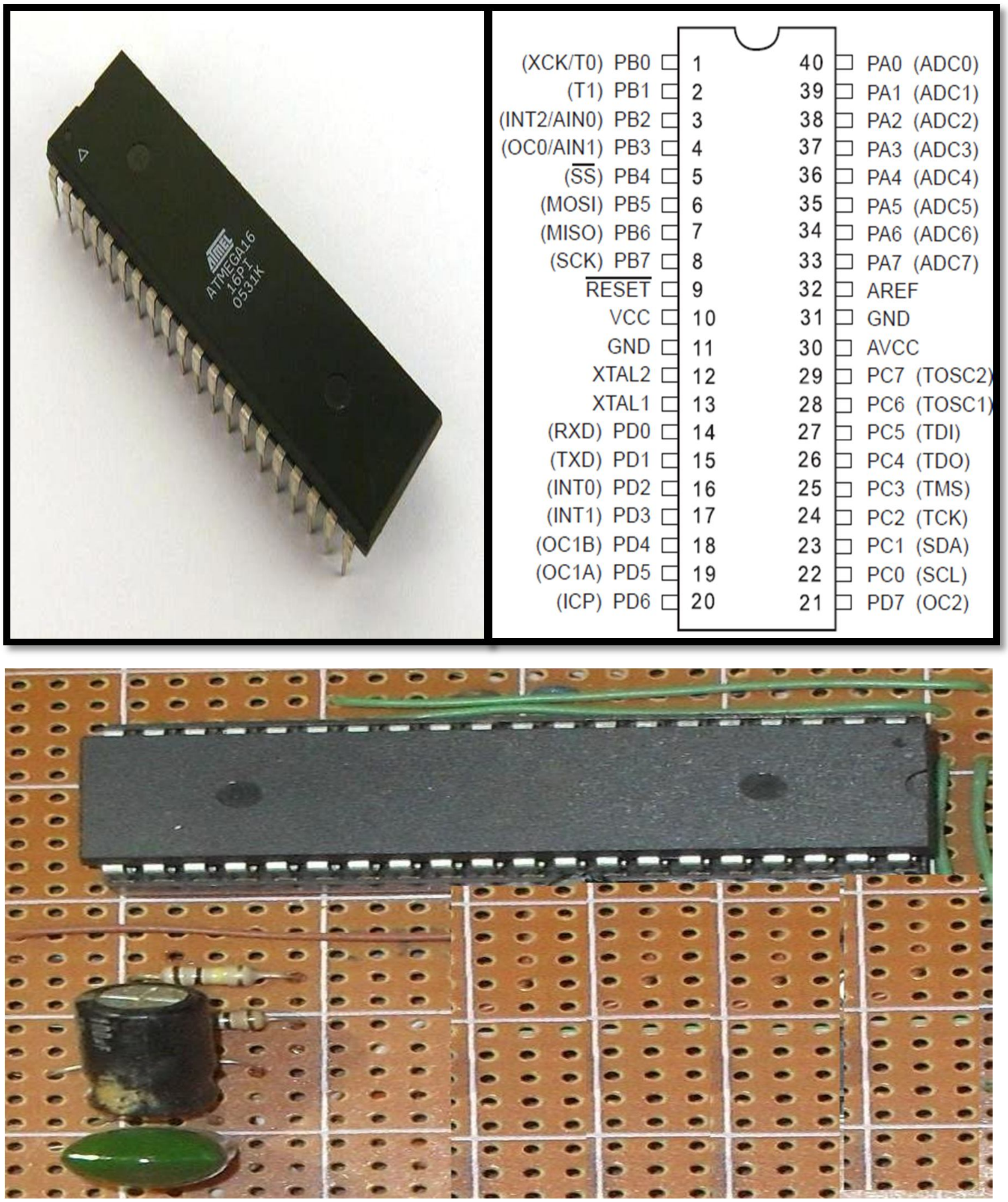
Figure(3.2) sending and detecting module (GPS and GSM)

3.2 8-bit AVR Microcontroller (AT mega 16 L)

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.[11]

The ATmega16 provides the following features: 16K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1K byte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents

but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the Asynchronous Timer continue to run[12]. The device is manufactured using Atmel's high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega16 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications. The ATmega16 AVR is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.[13]



Figure(3.3) :blocks diagrams of microcontroller

Table (3.1) pins Descriptions function of ATMEGA16

Pin	Descriptions
VCC	Digital supply voltage
GND	Ground.
Port A (PA7..PA0)	Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port,
Port B (PB7..PB0)	Port B is an 8-bit bi-directional I/O port with internal pull-up resistors and another special function as illustrated in the block diagram
Port C (PC7..PC0)	Port C is an 8-bit bi-directional I/O port with internal pull-up resistors and another special function as illustrated in the block diagram
Port D (PD7..PD0)	Port D is an 8-bit bi-directional I/O port with internal pull-up resistors and another special function as illustrated in the block diagram
RESET	Reset Input
XTAL1	Input to the inverting Oscillator amplifier and input to the internal clock operating circuit
XTAL2	Output from the inverting Oscillator amplifier
AVCC	is the supply voltage pin for Port A and the A/D Converter
AREF	is the analog reference pin for the A/D Converter

3.3 Global Positioning System (GPS)

It is space based satellite navigation system that provides location and time information in all weather conditions anywhere on or near the earth where there is unobstructed line of sight to four or more GPS Satellites. Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS system in addition to GPS other systems are in use or under development. The design of GPS is based partly on similar ground based Radio Navigation systems the first Navigation satellite system transit was used by US 1960. GPS is owned and operated by United States as a national resource. The satellites carry very stable atomic clocks that are synchronized to each other and to ground clocks A GPS reviver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time. It is sometimes above is representative of a receiver start-up situation. Most receivers have a track algorithm, sometimes called a tracker, that combines sets of satellite measurements collected at different time-in effect, taking advantage of a the fact that successive receiver positions are usually close to each other. After a set of measurements are processed, the tracker predicts the receiver location corresponding to the next set of satellite measurements. When the new measurements are collected, the receiver uses a weighting scheme to combine the new measurements with the tracker prediction. In general a tracker can (a) improve receiver position and time accuracy, (b) reject bad measurements, and (c) estimate receiver speed and direction.[15]

3.3.1 ACCURACY

Most receiver lose accuracy in the interpretation of the signals and are only accurate to 100 nanoseconds.

GPS time is theoretically accurate to about 14 nanoseconds.

3.3.2 TIMEKEEPING

Leap seconds GPS navigation message includes the difference between GPS time and UTS. As of July 2012, GPS time is 16 seconds ahead of UTS because of the leap second added to UTS June. 30,2012 Receivers subtract this offset from GPS time to calculate UTS and specific time zone values. New GPS units may not show the correct UTS time until after receiving the UTS offset massage. The GPS- UTS offset field can accommodate 255 leap second (eight bits)

3.3.3 ERROR SOURCES AND ANALYSIS

Magnitude of residual errors from these sources depends on geometric dilution of precision. Artificial errors may result from jamming devices and threaten ships and aircraft or from intentional signed degradation through selective availability, which limited accuracy to- 6-12 m, but has now been switched off

3.3.4 STRUCTURE

The space segment is composed of 24 to 32 satellites in medium earth orbit and also includes the payload adapters to the boosters required to launch them into orbit. The control segment is composed of a master control station (MCS), an alternate master control station, and a host of dedicated and shared ground antennas and monitor stations. The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service and tens of millions of civil, commercial, and scientific user of the Standard Positioning Service The period of the carrier frequency multiplied by the speed of light gives the wavelength, which is about 0.19 meters. Accuracy within 1% of wavelength in detecting the leading edge reduces this component of pseudo range error to as little as 2 millimeters. [15]

3.4 Global System for Mobile Communication (GSM)

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz . It is estimated that many countries outside of Europe will join the GSM partnership.

GSM is now an international standard for mobile service. It offers high mobility. Subscribers can easily roam worldwide and access any GSM network.[16]

GSM is a digital cellular network. At the time the standard was developed it offered much higher capacity than analog systems. It also allowed for a more optimal allocation of the radio spectrum, which therefore allows for a larger number of subscribers.

GSM offers a number of services including voice communications, Short Message Service (SMS), fax, voice mail, and other supplemental services such as call forwarding and caller ID.

Currently there are several bands in use in GSM. 450 MHz, 850 MHZ, 900 MHz, 1800 MHz, and 1900 MHz are the most common ones.

Some bands also have Extended GSM (EGSM) bands added to them, increasing the amount of spectrum available for each band .[17]

3.4.1 GSM Specifications

- **frequency band** The frequency range specified for GSM is 800 to 900 MHz (mobile station to base station).
- **duplex distance** The duplex distance is 80 MHz . Duplex distance is the distance between the uplink and downlink frequencies. A channel has two frequencies, 80 MHz apart.
- **channel separation** The separation between adjacent carrier frequencies. In GSM, this is 200 kHz.
- **Modulation** Modulation is the process of sending a signal by changing the characteristics of a carrier frequency. This is done in GSM via Gaussian minimum shift keying (GMSK).
- **transmission rate** GSM is a digital system with an over-the-air bit rate of 270 kbps.
- **access method** GSM utilizes the time division multiple access (TDMA) concept. TDMA is a technique in which several different calls may share the same carrier. Each call is assigned a particular time slot.
- **speech coder** GSM uses linear predictive coding (LPC). The purpose of LPC is to reduce the bit rate. The LPC provides parameters for a filter that mimics the vocal tract. The signal passes through this filter, leaving behind a residual signal. Speech is encoded at 13 kbps.

3.4.2 GSM Network Architecture

A GSM network is made up of multiple components and interfaces that facilitate sending and receiving of signaling and traffic messages. It is a collection of transceivers, controllers, switches, routers, and registers.

A Public Land Mobile Network (PLMN) is a network that is owned and operated by one GSM service provider or administration, which includes all of the components and equipment as described below.

3.4.2.1 Mobile Station (MS)

The Mobile Station (MS) is made up of two components:

1- Mobile Equipment (ME) This refers to the physical phone itself. The phone must be able to operate on a GSM network. Older phones operated on a single band only. Newer phones are dual-band, triple-band, and even quad-band capable. A quad-band phone has the technical capability to operate on any GSM network worldwide.

Each phone is uniquely identified by the International Mobile Equipment Identity (IMEI) number. This number is burned into the phone by the manufacturer. The IMEI can usually be found by removing the battery of the phone and reading the panel in the battery well.

It is possible to change the IMEI on a phone to reflect a different IMEI. This is known as IMEI spoofing or IMEI cloning. This is usually done on stolen phones. The average user does not have the technical ability to change a phone's IMEI.

2- Subscriber Identity Module (SIM) The SIM is a small smart card that is inserted into the phone and carries information specific to the subscriber, such as IMSI, TMSI, Ki (used for encryption), Service Provider Name (SPN), and Local Area Identity (LAI). The SIM can also store phone numbers (MSISDN) dialed and received, the Kc (used for encryption), phone books, and data for other applications. A SIM card can be removed from one phone, inserted into another GSM capable phone and the subscriber will get the same service as always.

Each SIM card is protected by a 4-digit Personal Identification Number (PIN). In order to unlock a card, the user must enter the PIN. If a PIN is entered incorrectly three times in a row, the card blocks itself and cannot be used. It can only be unblocked with an 8-digit Personal Unblocking Key (PUK), which is also stored on the SIM card

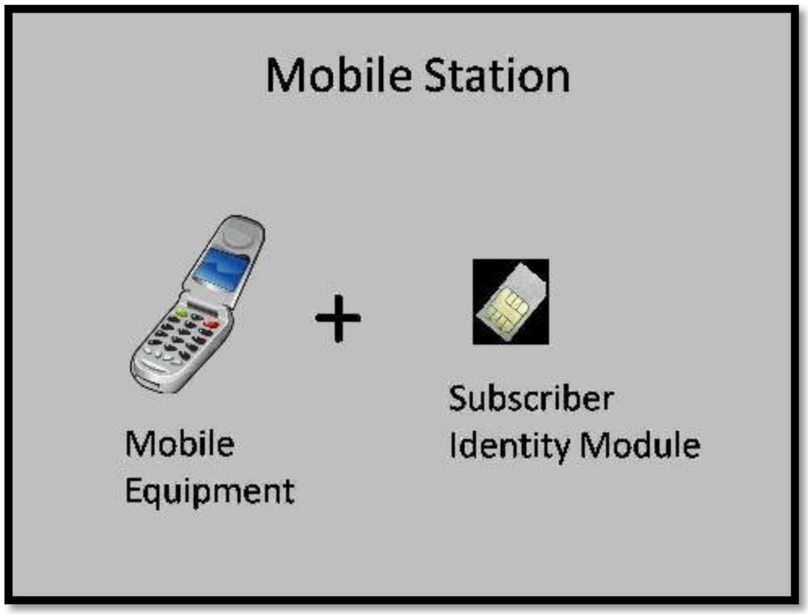


Figure (3.4) describe the mobile station

3.4.2.2 Base Transceiver Station (BTS)

The BTS is the Mobile Station's access point to the network. It is responsible for carrying out radio communications between the network and the MS. It handles speech encoding, encryption, multiplexing (TDMA), and modulation/demodulation of the radio signals. It is also capable of frequency hopping. A BTS will have between 1 and 16 Transceivers (TRX), depending on the geography and user demand of an area. Each TRX represents one ARFCN.

One BTS usually covers a single 120 degree sector of an area. Usually a tower with 3 BTSs will accommodate all 360 degrees around the tower.

However, depending on geography and user demand of an area, a cell may be divided up into one or two sectors, or a cell may be serviced by several BTSs with redundant sector coverage.

A BTS is assigned a Cell Identity. The cell identity is 16-bit number (double octet) that identifies that cell in a particular Location Area. The cell identity is part of the Cell Global Identification (CGI), which is discussed in the section about the Visitor Location Register (VLR).

The interface between the MS and the BTS is known as the Um Interface or the Air Interface.[17]

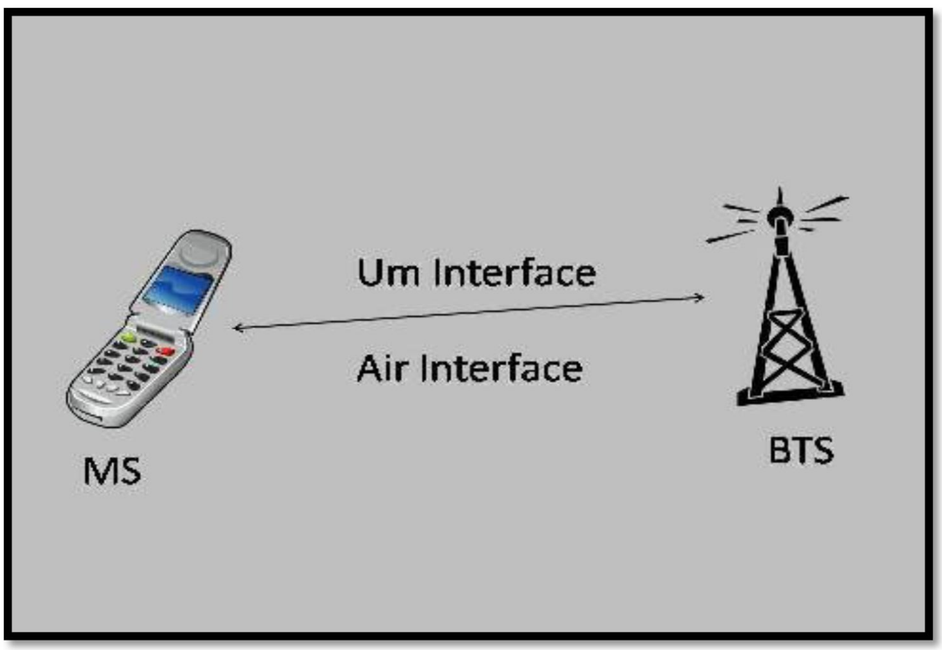


Figure (3.5)the um interface or Air interface

3.5 Liquid crystal display (LCD)

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.

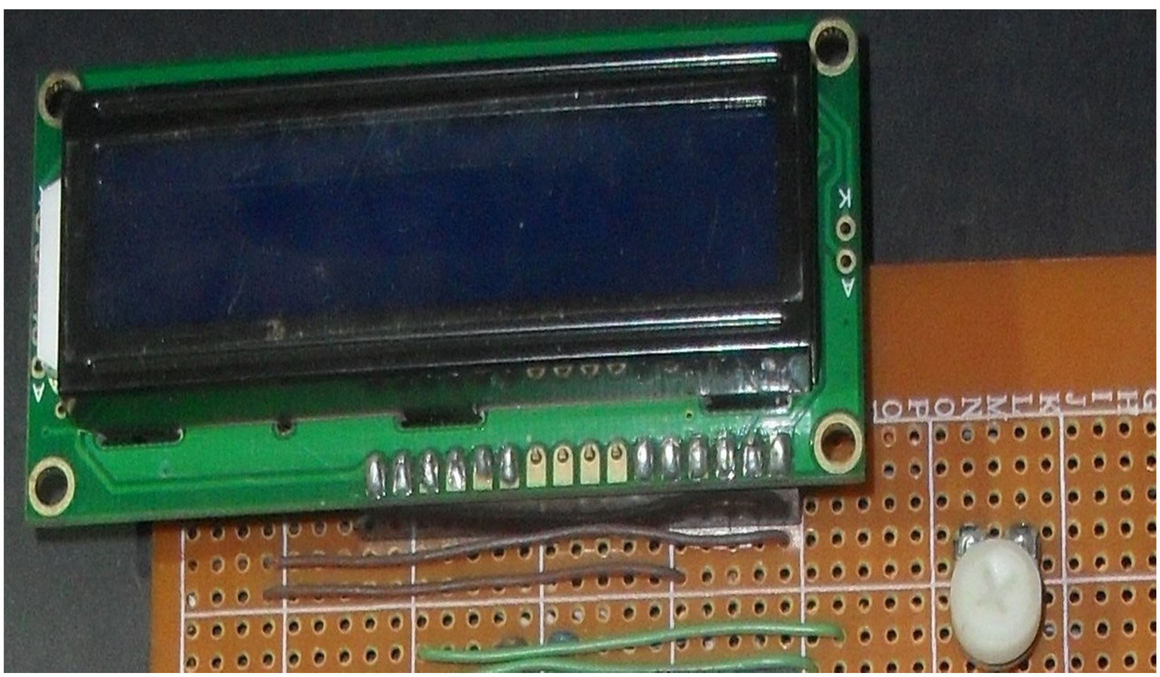
A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.[18]

3.5.1 Features of LCD

1-LCDs are economical

2- easily programmable

3-animations and so on.



Figure(3.6)pins of lcd and distribution how it connection

3.6 Power supply circuit

That convert and step down AC current to DC current which is requiring for the micro controller usually (5v) and consisting of :

1- Transformer to step down

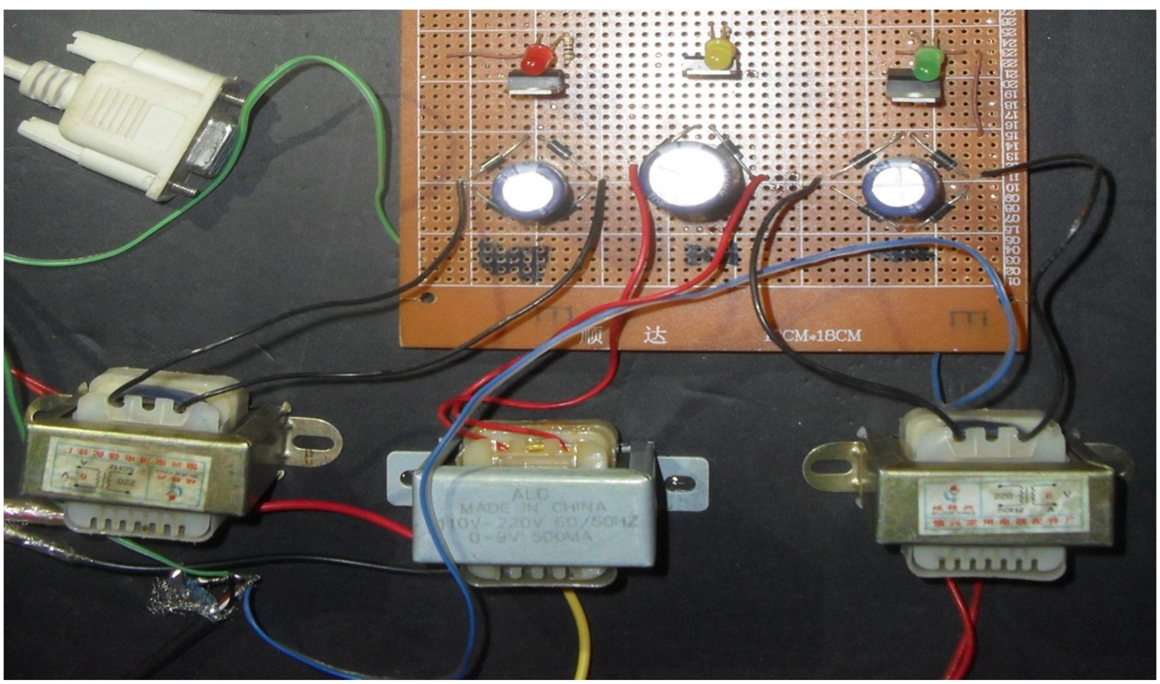
The transformer is the device which has two sets of windings, one primary and the other one is the secondary. Mains 220v or 120v is fed to the primary winding which is transferred to the secondary winding to produce a lower induced voltage there.

The low stepped down voltage available at the secondary of the transformer is used for the intended application in electronic circuits, however before this secondary voltage can be used, it needs to be first rectified, meaning the voltage needs to be made into a DC first.

2- Diode to convert AC to DC current

3- Capacitor to filtering

4- Regulator to product the circuit when the voltage is increase



Figure(3.7) power supply circuit

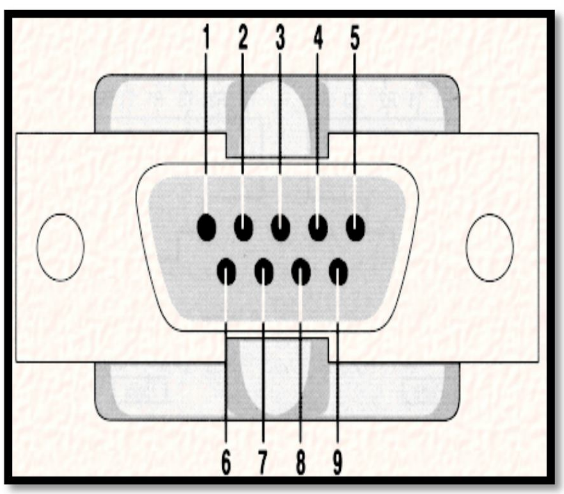
3.7 RS232

RS-232 (Recommended standard-232) is a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices. In other words, RS-232 is a long established standard that describes the physical interface and protocol for relatively low-speed serial data communication between computers and related devices. An industry trade group, the Electronic Industries Association (EIA), defined it originally for teletypewriter devices. In 1987, the EIA released a new version of the standard and changed the name to EIA-232-D. Many people, however, still refer to the standard as RS-232C, or just RS- 232.

RS-232 is the interface that your computer uses to talk to and exchange data with your modem and other serial devices. The serial ports on most computers use a subset of the RS-232C standard.[19]

3.7.1 RS232 on DB9 (9-pin D-type connector)

There is a standardized pin out for RS-232 on a DB9 connector, as shown below



Pin	Description
1	Data carrier detect (-DCD)
2	Received data (RxD)
3	Transmitted data (TxD)
4	Data terminal ready (DTR)
5	Signal ground (GND)
6	Data set ready (-DSR)
7	Request to send (-RTS)
8	Clear to send (-CTS)
9	Ring indicator (RI)

Figure (3.8)RS232 on DB9 connector and pins description

*The simplest connection between a PC and microcontroller requires a minimum of three pins, TxD, RxD, and ground

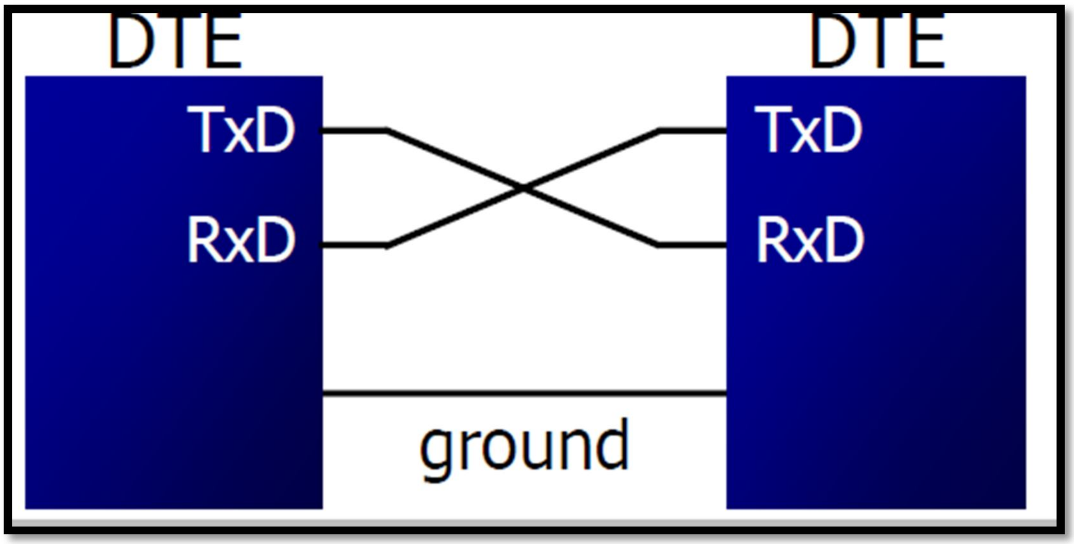


Figure (3.9)null modem connection

 DTE (data terminal equipment) refers to terminal and computers that send and receive data

 DCE (data communication equipment)

refers to communication equipment, such as modems

3.8 MAX 232

We need a line driver (voltage converter) to convert the R232's signals to TTL voltage levels that will be acceptable to 8051's or family of at mega TxD and RxD pins .[20]

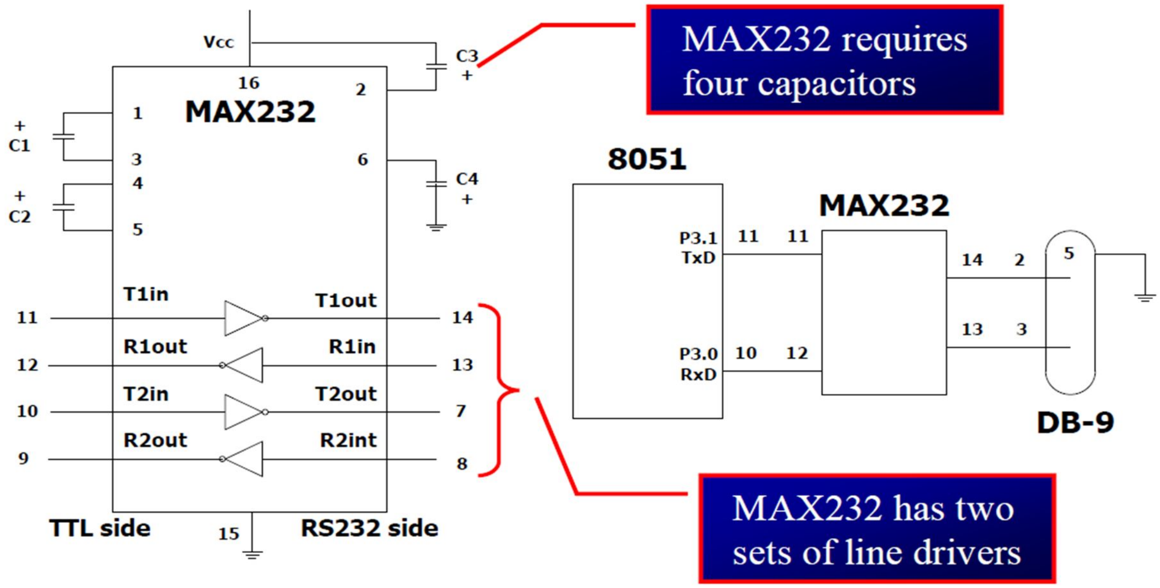


Figure (3.10) pins of MAX 232 and interfacing with microcontroller

3.9 Solar charger

as the sources of conventional energy deplete day by day, resorting to alternative sources of energy like solar and wind energy has become need of the hour. Solar-powered lighting systems are already available in rural as well as urban areas. These include solar lanterns, solar home lighting systems, solar streetlights, solar garden lights and solar power packs. All of them consist of four components: solar photovoltaic module, rechargeable battery, solar charge controller and load. In the solar-powered lighting system, the solar charge controller plays an important role as the system's overall success depends mainly on it. It is considered as an indispensable link between the solar panel, battery and load.[21] **The microcontroller-based solar charge controller described here has the following features:**

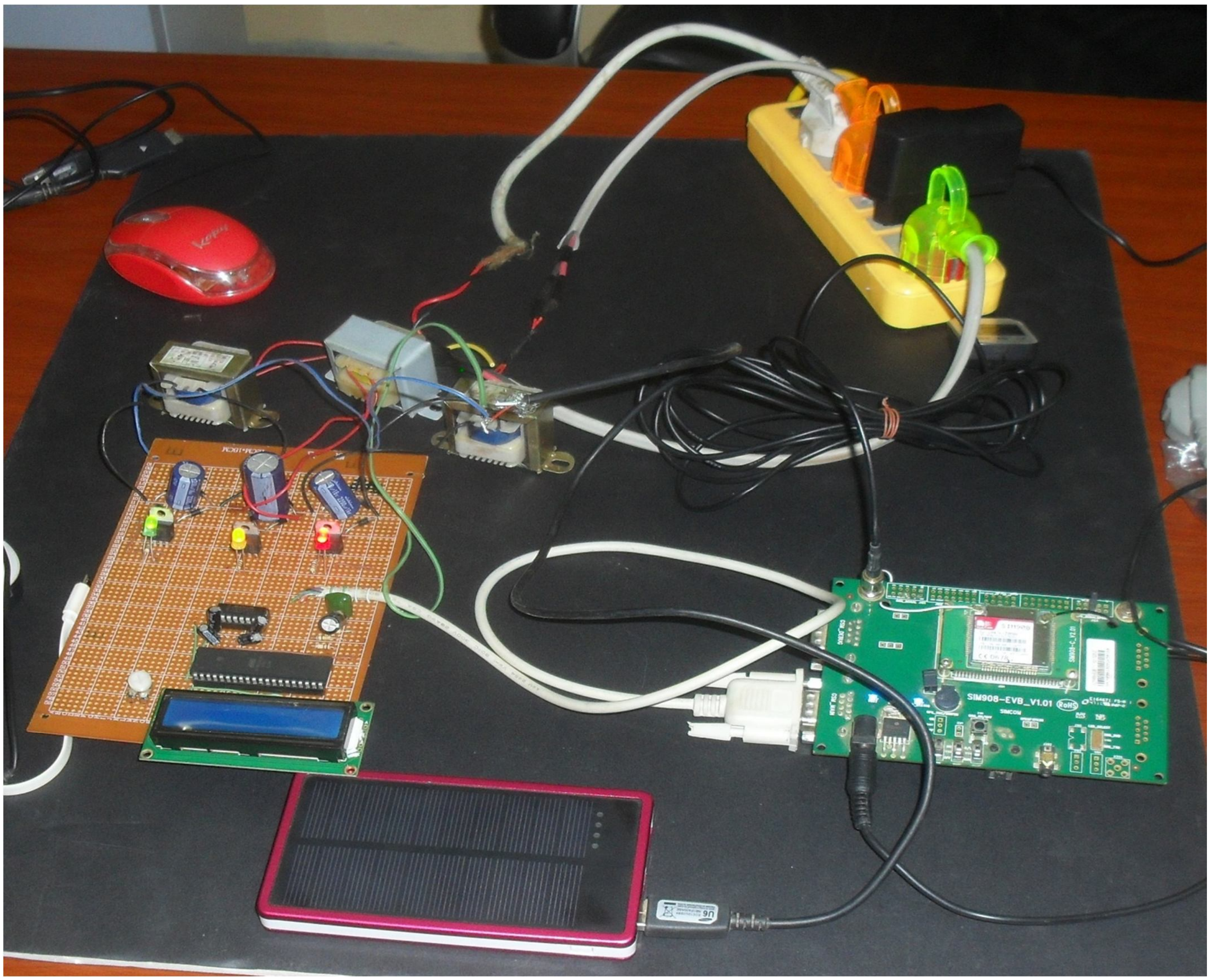
1. Automatic dusk-to-dawn operation of the load
2. Built-in digital voltmeter (0V-20V range)
3. Parallel- or shunt-type regulation

4. Charging current changes to ‘pulsed’ at full charge

5. Low current consumption

6. Highly efficient design based on microcontroller

All this components shows in figure (3.10) works together to perform and satisfy the main objective how to detect the fault in transmission line



Figure(3.11) all component of the design