A

Major Project Stage-II Report

on

"WIRELESS SYSTEM FOR TRAFFIC SIGN IDENTIFICATION AND VIOLATION MONITORING"

Submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

submitted by

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SWARNA BHARATHI INSTITUTE OF SCIENCE & TECHNOLOGY, KHAMMAM
(Approved by AICTE, Govt. of TS& Affiliated to JNTUH, Hyderabad)

(2021-2022)

SWARNA BHARATHI INSTITUTE OF SCIENCE & TECHNOLOGY, KHAMMAM
(Approved by AICTE, Govt. of TS& Affiliated to JNTUH, Hyderabad)
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the major project stage-II entitled ***"WIRELESS SYSTEM FOR TRAFFIC SIGN IDENTIFICATION AND VIOLATION MONITORING"*** *is a bonafide record of work carried out by*

NANCHARLA MANIKUMAR 18M61A04A7

We hereby accord our approval of it as a major project carried out and presented in a manner required for its acceptance in partial fulfillment for the award of the degree of ***BACHELOR OF TECHNOLOGY*** *in* ***ELECTRONICS AND COMMUNICATION ENGINEERING*** of **Jawaharlal Nehru Technological University Hyderabad, Hyderabad** *during the academic year 2021-2022.*

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I thank all the members of the Teaching and Non-Teaching Staff, the Department of ECE, and all those who have helped us directly or indirectly in completing our project successfully.

DECLARATION

I hereby declare that the Major project stage-II entitled **"WIRELESS SYSTEM FOR TRAFFIC SIGN IDENTIFICATION AND VIOLATION MONITORING"** recorded in this project is based on our work carried out at the **"SWARNA BHARATHI INSTITUTE OF SCIENCE &TECHNOLOGY", Khammam** during the B. Tech course.

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ABSTRACT

In the field of Vehicular automation, the detection of traffic signs plays a vital role. The enormous growth has been faced in the field. Even though the technology warns the user about the detected traffic sign, there are chances that the user might violate them, and violating the traffic sign rules might lead to accidents where the life of people would be at stake. Hence, to avoid these problems this project has proposed a prototype in such a way that, it detects the traffic signs and acts accordingly denying the user's control in real time if he tries to violate the rules in the traffic sign. The prototype contains a traffic system, which is controlled with Arduino controller.

KEY WORD: LCD, SWITCH, RFID READER, RFID TAG, GSM, TRAFFIC LIGHT, PSU

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ACRONYMS

LCD	Liquid crystal display
GSM	Global system for mobile communication
RFID	Radiofrequency Identification
PSEN	Program Store Enable
EA	External Access enable
ASIC	Application-specific Integrated circuits
ALU	Arithmetic logic unit
CU	Control unit
CPU	Central process unit
RSIC	Reduced instruction set computer
CSIC	Complex instruction set computer
RAM	Random access memory
TDMA	Time division multiple access
BSC	Base station controller
BSS	Base station subsystem
NSS	Network station subsystem
HLR	Home location register
VLR	Visitor Location register
EIR	Equipment Identify register
AUC	Authentication Centre
PIN	Personal Identification code
PUK	Personal unlock code

CHAPTER 1
INTRODUCTION

Travel is an important part of today's fast paced life as everyone has to move around for their day -to-day work. Road transport is the most commonly used mode of travel due to its ease, low cost and availability to common man. The ease of travel is affected by such factors as the quality of road, congestion, time taken, accidents, speed, etc. The major threat is the increasing number of accidents on a daily basis. An accident survey estimated that around 3,00,000 accidents occur on Indian roads every year. These accidents not only eat lives of people but also adds on to the economic loss of the country. It is reported that over 80,000 people are killed on the Indian roads while the total economic loss owing to road accidents is estimated to be over Rs. 3,600 crores. Lack of discipline and emotions of road users cause traffic congestions which might lead to traffic violations.

Having a safe and free flow of traffic is crucial for economic development of the country as we must ensure spending less on fuels and less time on the road. Traffic enforcement authorities can deal with the challenge of regulating the traffic and enforcing rules caused by the huge number of vehicles on the road and the indiscipline of the motorists by applying modern technology. Flouting lane discipline is the single major factor in India that inhibits safe and free flow of traffic. It is also a common sight in India to see one slow moving vehicle blocking the way of hundreds of vehicles coming behind it.

If keeping slow moving vehicles to the left is enforced, one important cause of traffic jams is removed. The authorities are responsible for controlling the traffic violation and pollution, and imposing fine on the violators. The single most important rule is to follow the traffic signals in junctions. Violation of signals results in a number of accidents [6]. The major problem is the manual tracking of every single vehicle that v iolates signals. This problem can be brought under control if the tracking can be automated along with calculating and updating the fines. In the existing systems, the tracking of signal violation is implemented using image processing techniques. The cameras use infrared signals to capture the number plates of the vehicles round the clock..

1. It requires a camera in every lane of the signal.
2. These cameras require high maintenance and are prone to damage in bad weather conditions.
3. Dirt on the number plate makes image processing difficult.
4. Various font types on the number plate cause lack of precision.
5. Objects far from the camera are captured with poor resolution.
6. There is a need for a larger number of technical persons [9].

On the other hand, RFID based traffic violation detection systems use radio frequency waves to identify vehicles which are endowed with unique identification numbers in the form of RFID tags. RFID (Radio Frequency Identification) is one of the upcoming technologies in the field of engineering and innovation. It has a number of applications in the market starting from vehicle identification at tolls to security systems at malls.

These RFID based systems consist of 3 main components, namely RFID Reader, RFID Tags and RFID Database [3]. The reader has an antenna that emits the radio waves. When the tag antenna comes within the range of the reader's range, it responds to the reader with the unique identification number of that tag. Tags can be classified into 2 types: passive tags and active tags. A passive tag contains no internal power source whereas an active tag contains its own power source which runs the microchip circuitry and also helps in broadcasting the signal to the readers [7]. Similarly, there are two types of readers: λ Stationary Readers which are fixed at a specific location and able to read the tags within their range. λ Mobile Reader which are movable devices. The frequency of low frequency tags varies between 30 ~ 300 kHz that of high frequency tags varies from 3 ~ 30 MHz and that of ultra high frequency varies between 300 ~ 3000 MHz.

In this work, an RFID reader uses radio waves to read tags and hence does not require to be in line of sight. Every vehicle is endowed with an RFID tag, while RFID readers on the sides of the road. Road markings are done according to the required range. Any vehicle crossing the road marking when the signal is red will be detected from RFID tag of that vehicle.

BLOCK DIAGRAM OF THE PROJECT

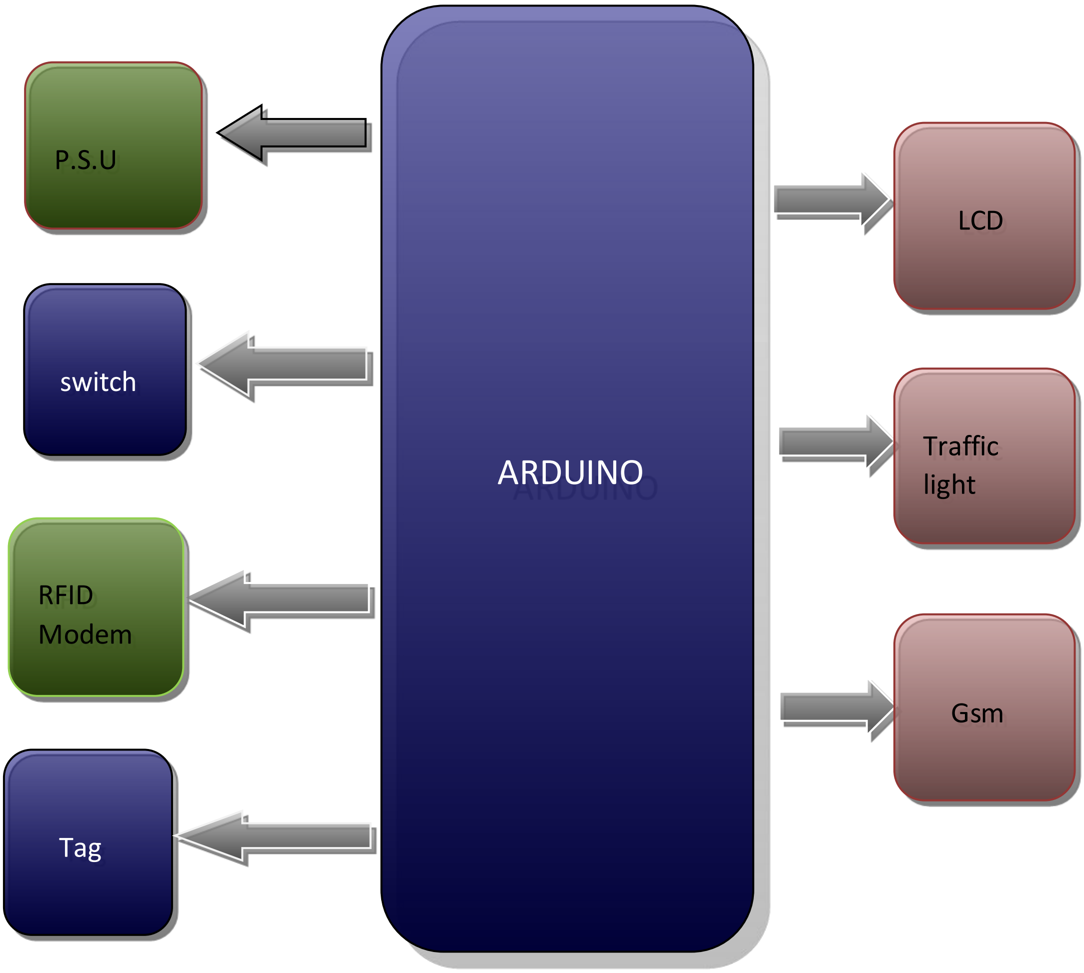


FIG-1.1 block diagram

CHAPTER 2
EMBEDDED SYSTEMS

2.1 Embedded System

An embedded system is a system which is going to do a predefined specified task is the embedded system and is even defined as combination of both software and hardware. A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. At the other extreme a general-purpose computer may be used to control the operation of a large complex processing plant, and its presence will be obvious.

All embedded systems are including computers or microprocessors. Some of these computers are however very simple systems as compared with a personal computer.

The very simplest embedded systems are capable of performing only a single function or set of functions to meet a single predetermined purpose. In more complex systems an application program that enables the embedded system to be used for a particular purpose in a specific application determines the functioning of the embedded system. The ability to have programs means that the same embedded system can be used for a variety of different purposes. In some cases a microprocessor may be designed in such a way that application software for a particular purpose can be added to the basic software in a second process, after which it is not possible to make further changes. The applications software on such processors is sometimes referred to as firmware

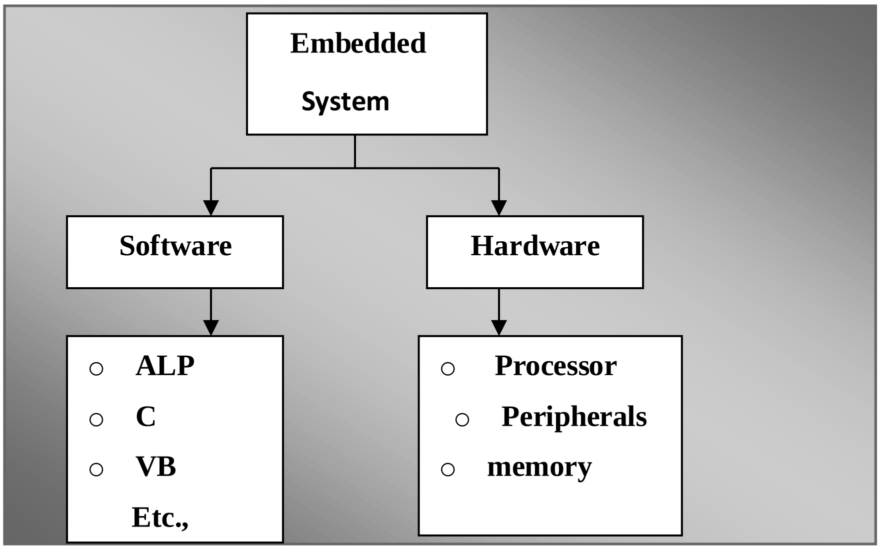


Figure 2.1 Block diagram of Embedded System

Software deals with the languages like ALP, C, VB etc., and Hardware deals with Processors, Peripherals, and Memory.

Memory: It is used to store data or addresses.

Peripherals: These are the external devices connected

Processor: It is an IC that is used to perform some task

Applications of embedded systems

- Manufacturing and process control
- Construction industry
- Transport
- Buildings and premises
- Domestic service
- Communications
- Office systems and mobile equipment
- Banking, finance, and commercial
- Medical diagnostics, monitoring, and life support
- Testing, monitoring, and diagnostic systems

Processors are classified into four types:

- Micro Processor (µp)
- Microcontroller (µc)
- Digital Signal Processor (DSP)
- Application-Specific Integrated Circuits (ASIC)

Micro Processor (µp):

A silicon chip that contains a CPU. In the world of personal computers, the terms microprocessor and CPU are used interchangeably. At the heart of all personal computers and most workstations sits a microprocessor.

Microprocessors also control the logic of almost all digital devices, from clock radios to fuel-injection systems for automobiles.

Three basic characteristics differentiate microprocessors:

- **Instruction set**: The set of instructions that the microprocessor can execute.
- **Clock speed:** Given in megahertz (MHz), the clock speed determines how many instructions per second the processor can execute.

In both cases, the higher the value, the more powerful the CPU. For example, a 32-bit microprocessor that runs at 50MHz is more powerful than a 16-bit microprocessor that runs at 25MHz. In addition to bandwidth and clock speed, microprocessors are classified as being either RISC (reduced instruction set computer) or CISC (complex instruction set computer).

A microprocessor has three basic elements, as shown above. The ALU performs all arithmetic computations, such as addition, subtraction and logic operations (AND, OR, etc). It is controlled by the Control Unit and receives its data from the Register Array.

The Register Array is a set of registers used for storing data. These registers can be accessed by the ALU very quickly. Some registers have specific functions - we will deal with these later. The Control Unit controls the entire process.

It provides the timing and a control signal for getting data into and out of the registers and the ALU and it synchronizes the execution of instructions (we will deal with instruction execution at a later date).

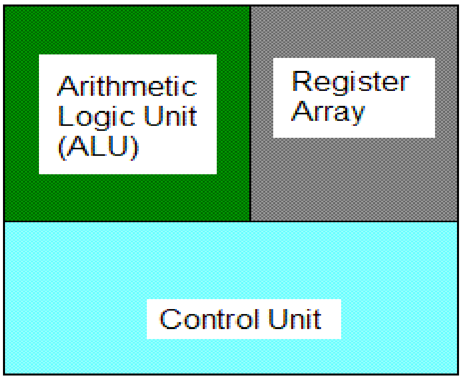


FIG-2.2 Three Basic Elements of a Microprocessor

Micro Controller (µc):

A microcontroller is a small computer on a single **integrated circuit** containing a processor core, memory, and programmable **input/output** peripherals. Program memory in the form of **NOR flash** or **OTP ROM** is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the **microprocessors** used in **personal computers** or other general purpose applications.

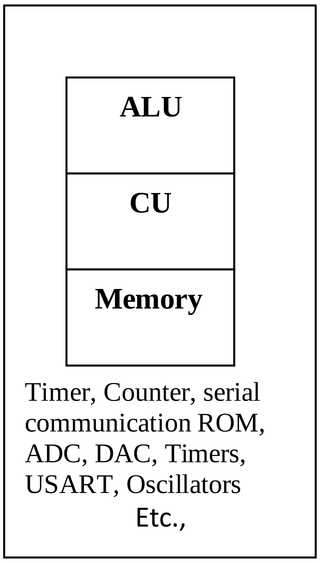


Figure 2.3 Block Diagram of Micro Controller (μc)

Digital Signal Processors (DSPs):

Digital Signal Processors is one which performs scientific and mathematical operation. Digital Signal Processor chips - specialized microprocessors with architectures designed specifically for the types of operations required in digital signal processing.

Like a general-purpose microprocessor, a DSP is a programmable device, with its own native instruction code. DSP chips are capable of carrying out millions of floating point operations per second, and like their better-known general-purpose cousins, faster and more powerful versions are continually being introduced. DSPs can also be embedded within complex "system-on-chip" devices, often containing both analog and digital circuitry.

Application Specific Integrated Circuit (ASIC)

ASIC is a combination of digital and analog circuits packed into an IC to achieve the desired control/computation function

ASIC typically contains

- CPU cores for computation and control
- Peripherals to control timing critical functions
- Memories to store data and program
- Analog circuits to provide clocks and interface to the real world which is analogy in nature

2.2 Computer Instruction Set

There are two different types of computer instruction set there are:

1. RISC (Reduced Instruction Set Computer) and
2. CISC (Complex Instruction Set computer)

2.2.1 Reduced Instruction Set Computer (RISC)

A RISC (reduced instruction set computer) is a microprocessor that is designed to perform a smaller number of types of computer instruction so that it can operate at a higher speed (perform more million instructions per second, or millions of instructions per second). Since each instruction type that a computer must perform requires additional transistors and circuitry, a larger list or set of computer instructions tends to make the microprocessor more complicated and slower in operation.

Besides performance improvement, some advantages of RISC and related design improvements are:

- A new microprocessor can be developed and tested more quickly if one of its aims is to be less complicated.
- Operating system and application programmers who use the microprocessor's instructions will find it easier to develop code with a smaller instruction set.
- The simplicity of RISC allows more freedom to choose how to use the space on a microprocessor.

Higher-level language compilers produce more efficient code than formerly because they have always tended to use the smaller set of instructions to be found in a RISC computer.

2.2.2 RISC characteristics

- **Simple instruction set:**

  In a RISC machine, the instruction set contains simple, basic instructions, from which more complex instructions can be composed.

- **1machine-cycleinstructions.**

  Most instructions complete in one machine cycle, which allows the processor to handle several instructions at the same time. This pipelining is a key technique used to speed up RISC machines.

2.2.3 Complex Instruction Set Computer (CISC)

CISC, which stands for **Complex Instruction Set Computer,** is a philosophy for designing chips that are easy to program and which make efficient use of memory. Each instruction in a CISC instruction set might perform a series of operations inside the processor. This reduces the number of instructions required to implement a given program, and allows the programmer to learn a small but flexible set of instructions.

The advantages of CISC

At the time of their initial development, CISC machines used available technologies to optimize computer performance.

- Microprogramming is as easy as assembly language to implement, and much less expensive than hardwiring a control unit.
- The ease of micro-coding new instructions allowed designers to make CISC machines upwardly compatible: a new computer could run the same programs as earlier computers because the new computer would contain a superset of the instructions of the earlier computers.
- As each instruction became more capable, fewer instructions could be used to implement a given task. This made more efficient use of the relatively slow main memory.

The disadvantages of CISC

Still, designers soon realized that the CISC philosophy had its own problems, including:

- Earlier generations of a processor family generally were contained as a subset in every new version --- so instruction set & chip hardware become more complex with each generation of computers.
- So that as many instructions as possible could be stored in memory with the least possible wasted space, individual instructions could be of almost any length---this means that different instructions will take different amounts of clock time to execute, slowing down the overall performance of the machine.
- Many specialized instructions aren't used frequently enough to justify their existence --- approximately 20% of the available instructions are used in a typical program.
- CISC instructions typically set the condition codes as a side effect of the instruction.

➢ Not only does setting the condition codes take time, but programmers have to remember to examine the condition code bits before a subsequent instruction changes them.

2.3 Memory Architecture

There two different type's memory architectures there are:

- Harvard Architecture
- Von-Neumann Architecture

2.3.1 Harvard Architecture

Computers have separate memory areas for program instructions and data. There are two or more internal data buses, which allow simultaneous access to both instructions and data. The CPU fetches program instructions on the program memory bus.

The **Harvard architecture** is a computer architecture with physically separate storage and signal pathways for instructions and data. The term originated from the Harvard Mark I relay-based computer, which stored instructions on punched tape (24 bits wide) and data in electro-mechanical counters.. Programs needed to be loaded by an operator, the processor could not boot itself.

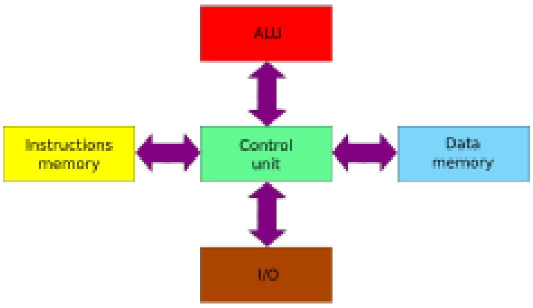


Figure 2.4 Harvard Architecture

Modern uses of the Harvard architecture:

The principal advantage of the pure Harvard architecture - simultaneous access to more than one memory system - has been reduced by modified Harvard processors using modern CPU cache systems.

Relatively pure Harvard architecture machines are used mostly in applications where tradeoffs, such as the cost and power savings from omitting caches, outweigh the programming penalties from having distinct code and data address spaces.

➢ concern to speed of execution. As a result, some DSPs have multiple data memories in distinct address spaces to facilitate SIMD and VLIW processing.

- Texas Instruments TMS320 C55x processors, as one example, have multiple parallel data busses (two write, three read) and one instruction bus.
- Microcontrollers are characterized by having small amounts of program (flash memory) and data (SRAM) memory, with no cache, and take advantage of the Harvard architecture to speed processing by concurrent instruction and data access.
- The separate storage means the program and data memories can have different bit depths, for example using 16-bit wide instructions and 8-bit wide data. They also mean that instruction pre-fetch can be performed in parallel with other activities. Examples include, the AVR by Atmel Corp, the PIC by Microchip Technology, Inc. and the ARM Cortex-M3 processor (not all ARM chips have Harvard architecture).

Even in these cases, it is common to have special instructions to access program memory as data for read-only tables, or for reprogramming.

2.3.2 Von-Neumann Architecture

A computer has a single, common memory space in which both program instructions and data are stored. There is a single internal data bus that fetches both instructions and data. The **von Neumann architecture** is a design model for a stored-program digital computer that uses a central processing unit (CPU) and a single separate storage structure ("memory") to hold both instructions and data. It is named after the mathematician and early computer scientist John von Neumann. Such computers implement a universal Turing machine and have a sequential architecture.

A **stored-program** digital computer is one that keeps its programmed instructions, as well as its data, in read-write, random-access memory (RAM). Stored-program computers were advancement over the program-controlled computers of the 1940s, such as the Colossus and the ENIAC, which were programmed by setting switches and inserting patch leads to route data and to control signals between various functional units. In the vast majority of modern computers, the same memory is used for both data and program instructions.

The mechanisms for transferring the data and instructions between the CPU and memory are, however, considerably more complex than the original von Neumann architecture.

The terms "von Neumann architecture" and "stored-program computer" are generally used interchangeably, and that usage is followed in this article.

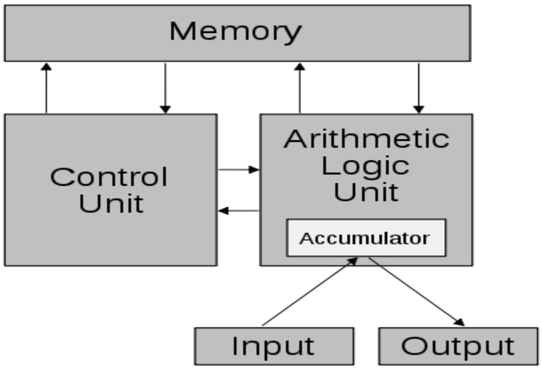


Figure 2.5 Schematic of the Von-Neumann Architecture.

Basic Difference between Harvard and Von-Neumann Architecture

- The primary difference between Harvard architecture and the Von Neumann architecture is in the Von Neumann architecture data and programs are stored in the same memory and managed by the same information handling system.
- Whereas the Harvard architecture stores data and programs in separate memory devices and they are handled by different subsystems.
- In a computer using the Von-Neumann architecture without cache; the central processing unit (CPU) can either be reading and instruction or writing/reading data to/from the memory. Both of these operations cannot occur simultaneously as the data and instructions use the same system bus.
- Today, the vast majority of computers are designed and built using the Von Neumann architecture template primarily because of the dynamic capabilities and efficiencies gained in designing, implementing, operating one memory system as opposed to two. It is much more flexible and allows for many concepts unavailable to Harvard architecture such as self-programming, word processing and so on.

CHAPTER 3

POWER SUPPLY

3.1 Block Diagram

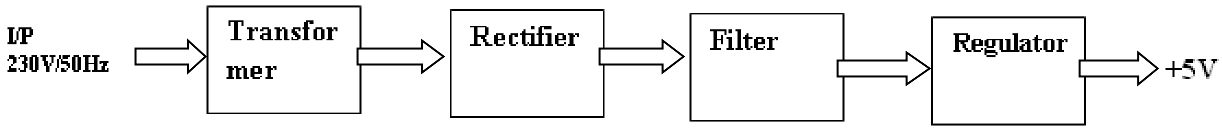


Figure 3.1 Power Supply

3.2 Circuit Diagram

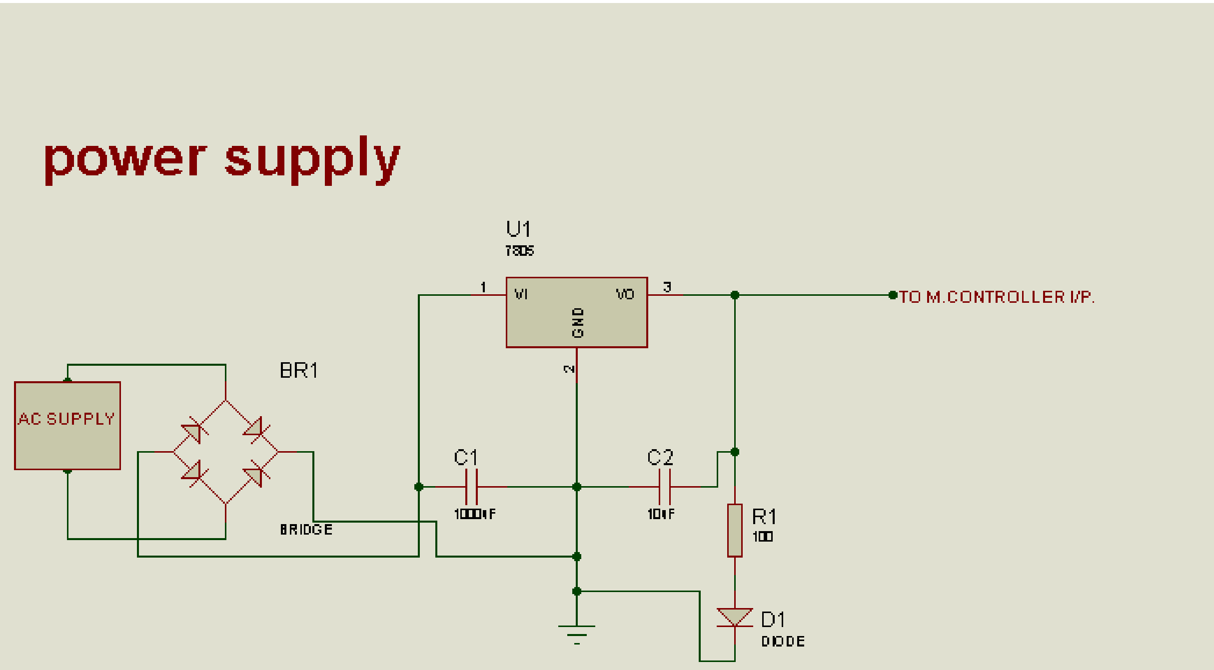


Figure 3.2 Circuit Diagram

Description

3.2.1 Transformer

A **transformer** is a device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying current in the first or *primary* winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the *secondary* winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction.

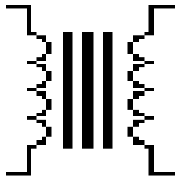


Figure 3.3 Transformer Symbol

(or)

Transformer is a device that converts the one form energy to another form of energy like a transducer.

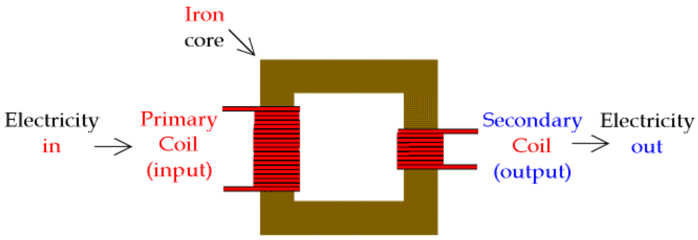


Figure 3.4 Transformer

Basic Principle:

A transformer makes use of Faraday's law and the ferromagnetic properties of an iron core to efficiently raise or lower AC voltages. It of course cannot increase power so that if the voltage is raised, the current is proportionally lowered and vice versa.

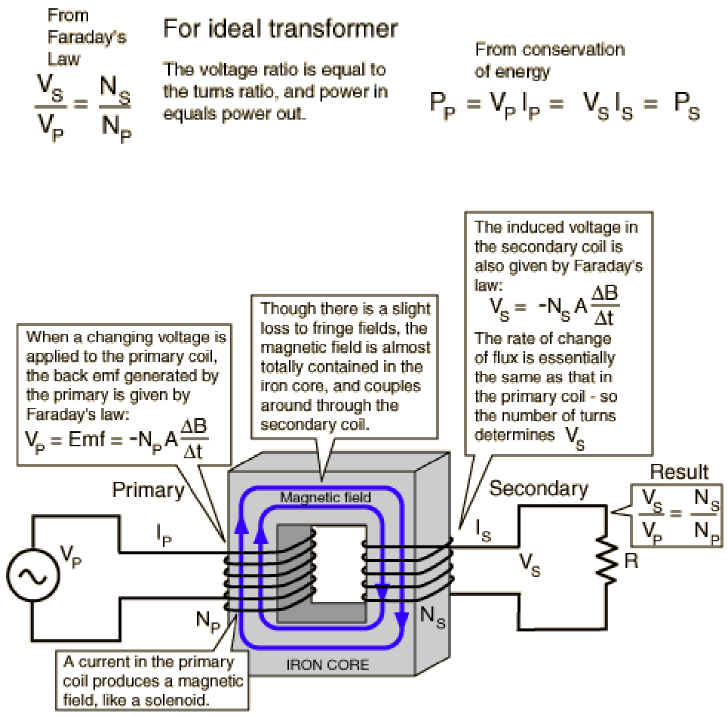


Figure:3.5 Basic Principle

Transformer Working

A transformer consists of two coils (often called 'windings') linked by an iron core, as shown in figure below. There is no electrical connection between the coils, instead they are linked by a magnetic field created in the core.

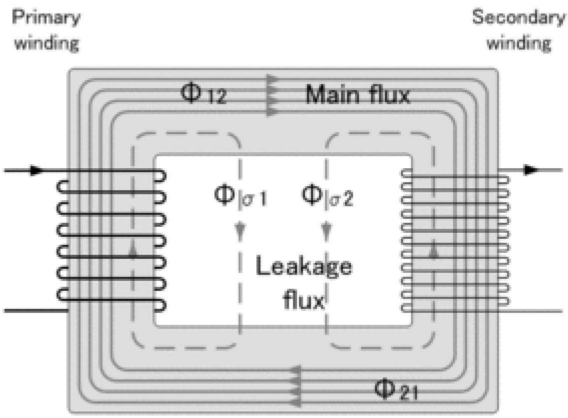


Figure:3.6 Basic Transformer

Transformers are used to convert electricity from one voltage to another with minimal loss of power. They only work with AC (alternating current) because they require a changing magnetic field to be created in their core. Transformers can increase voltage (step-up) as well as reduce voltage (step-down).

Alternating current flowing in the primary (input) coil creates a continually changing magnetic field in the iron core. This field also passes through the secondary (output) coil and the changing strength of the magnetic field induces an alternating voltage in the secondary coil. If the secondary coil is connected to a load the induced voltage will make an induced current flow. The correct term for the induced voltage is 'induced electromotive force' which is usually abbreviated to induced e.m.f.

The iron core is laminated to prevent 'eddy currents' flowing in the core. These are currents produced by the alternating magnetic field inducing a small voltage in the core, just like that induced in the secondary coil. Eddy currents waste power by needlessly heating up the core but they are reduced to a negligible amount by laminating the iron because this increases the electrical resistance of the core without affecting its magnetic properties.

Transformers have two great advantages over other methods of changing voltage:

1. They provide total electrical isolation between the input and output, so they can be safely used to reduce the high voltage of the mains supply.
2. Almost no power is wasted in a transformer. They have a high efficiency (power out / power in) of 95% or more.

Classification of Transformer:

- Step-Up Transformer
- Step-Down Transformer

Step-Down Transformer:

Step down transformers are designed to reduce electrical voltage. Their primary voltage is greater than their secondary voltage. This kind of transformer "steps down" the voltage applied to it. For instance, a step down transformer is needed to use a 110v product in a country with a 220v supply.

Step down transformers convert electrical voltage from one level or phase configuration usually down to a lower level. They can include features for electrical isolation, power distribution, and control and instrumentation applications. Step down transformers typically rely on the principle of magnetic induction between coils to convert voltage and/or current levels.

Step down transformers are made from two or more coils of insulated wire wound around a core made of iron. When voltage is applied to one coil (frequently called the primary or input) it magnetizes the iron core, which induces a voltage in the other coil, (frequently called the secondary or output). The turn's ratio of the two sets of windings determines the amount of voltage transformation.

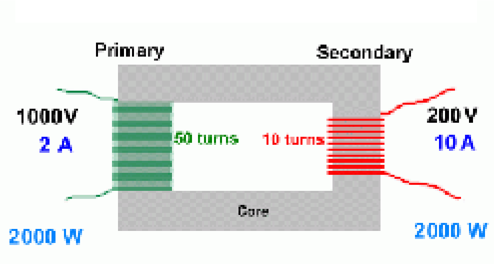


Figure:3.7 Step-Down Transformer

An example of this would be: 100 turns on the primary and 50 turns on the secondary, a ratio of 2 to 1.

Step down transformers can be considered nothing more than a voltage ratio device.

With step down transformers the voltage ratio between primary and secondary will mirror the "turn's ratio" (except for single phase smaller than 1 kva which have compensated secondary). A practical application of this 2 to 1 turn's ratio would be a 480 to 240 voltage step down. Note that if the input were 440 volts then the output would be 220 volts. The ratio between input and output voltage will stay constant. Transformers should not be operated at voltages higher than the nameplate rating, but may be operated at lower voltages than rated. Because of this it is possible to do some non-standard applications using standard transformers.

Single-phase step-down transformers 1 kva and larger may also be reverse connected to step-down or step-up voltages. (Note: single phase step up or step down transformers sized less than 1 KVA should not be reverse connected because the secondary windings have additional turns to overcome a voltage drop when the load is applied. If reverse connected, the output voltage will be less than desired.)

Step-Up Transformer:

A step-up transformer has more turns of wire on the secondary coil, which makes a larger induced voltage in the secondary coil. It is called a step up transformer because the voltage output is larger than the voltage input.

Step-up transformer 110v 220v design is one whose secondary voltage is greater than its primary voltage. This kind of transformer "steps up" the voltage applied to it. For instance, a step up transformer is needed to use a 220v product in a country with a 110v supply.

A step up transformer 110v 220v converts alternating current (AC) from one voltage to another voltage. It has no moving parts and works on a magnetic induction principle; it can be designed to "step-up" or "step-down" voltage. So a step up transformer increases the voltage and a step down transformer decreases the voltage.

The primary components for voltage transformation are the step up transformer core and coil. The insulation is placed between the turns of wire to prevent shorting to one another or to ground.

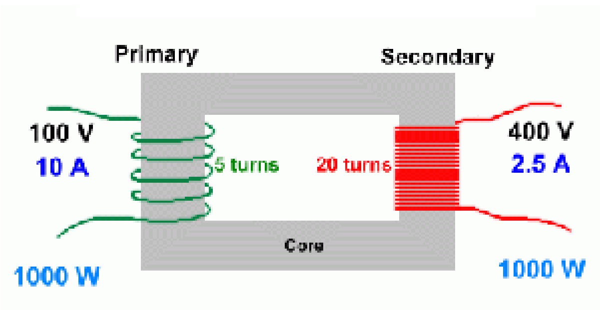


Figure:3.8 Step-Up Transformer

Applications

Generally these **Step-Up Transformers** are used in industries applications only.

Turns Ratio and Voltage

The ratio of the number of turns on the primary and secondary coils determines the ratio of the voltages...

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

...where V_p is the primary (input) voltage, V_s is the secondary (output) voltage, N_p is the number of turns on the primary coil, and N_s is the number of turns on the secondary coil.

3.2.2 Diodes

Diodes allow electricity to flow in only one direction. The arrow of the circuit symbol shows the direction in which the current can flow. Diodes are the electrical version of a valve and early diodes were actually called valves.

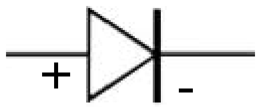


Figure 3.9 Diode Symbol

A **diode** is a device which only allows current to flow through it in one direction. In this direction, the diode is said to be 'forward-biased' and the only effect on the signal is that there will be a voltage loss of around 0.7V. In the opposite direction, the diode is said to be 'reverse-biased' and no current will flow through it.

3.2.3 Rectifier

The purpose of a rectifier is to convert an AC waveform into a DC waveform (OR) Rectifier converts AC current or voltages into DC current or voltage. There are two different rectification circuits, known as **'half-wave'** and **'full-wave' rectifiers**. Both use components called **diodes** to convert **AC into DC**.

The Half-wave Rectifier

The half-wave rectifier is the simplest type of rectifier since it only uses one diode, as shown in figure .

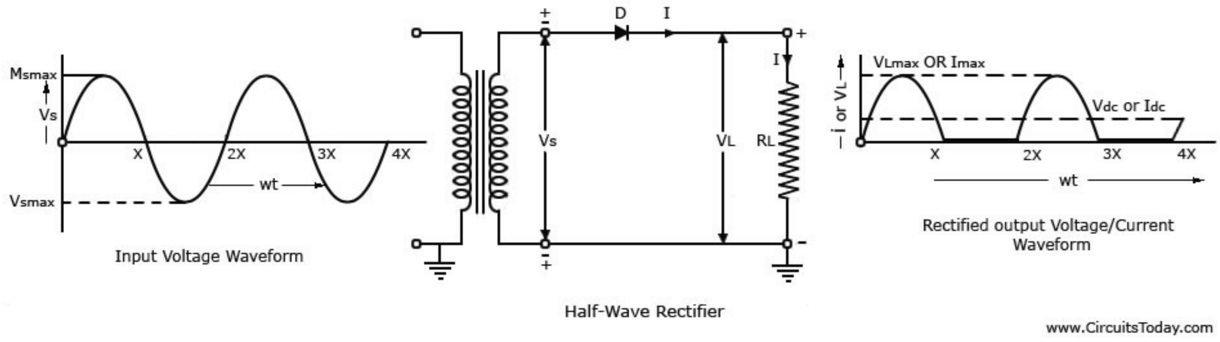


Figure 3.10 Half Wave Rectifier

Figure 2 shows the AC input waveform to this circuit and the resulting output. As you can see, when the AC input is positive, the diode is forward-biased and lets the current through. When the AC input is negative, the diode is reverse-biased and the diode does not let any current through, meaning the output is 0V. Because there is a 0.7V voltage loss across the diode, the peak output voltage will be 0.7V less than Vs.

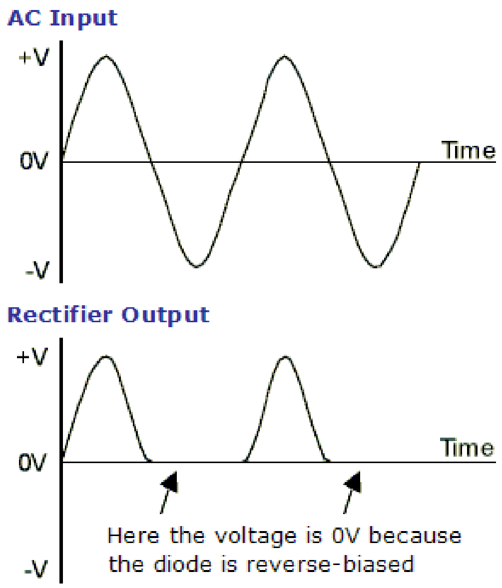


Figure 3.11 Half-Wave Rectification

While the output of the half-wave rectifier is DC (it is all positive), it would not be suitable as a power supply for a circuit. Firstly, the output voltage continually varies between 0V and Vs-0.7V, and secondly, for half the time there is no output at all.

The Full-wave Rectifier

The circuit in figure 3 addresses the second of these problems since at no time is the output voltage 0V. This time four diodes are arranged so that both the positive and negative parts of the AC waveform are converted to DC. The resulting waveform is shown in figure 4.

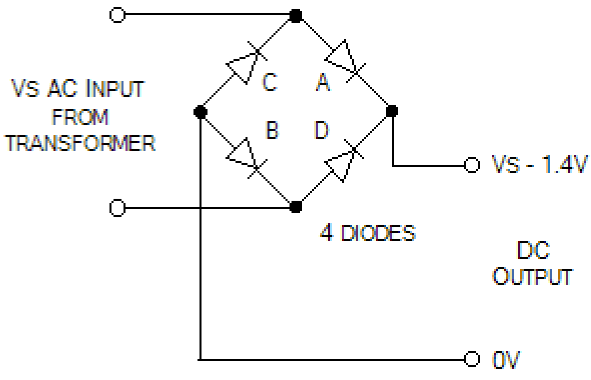


Figure 3.12 Full-Wave Rectifier

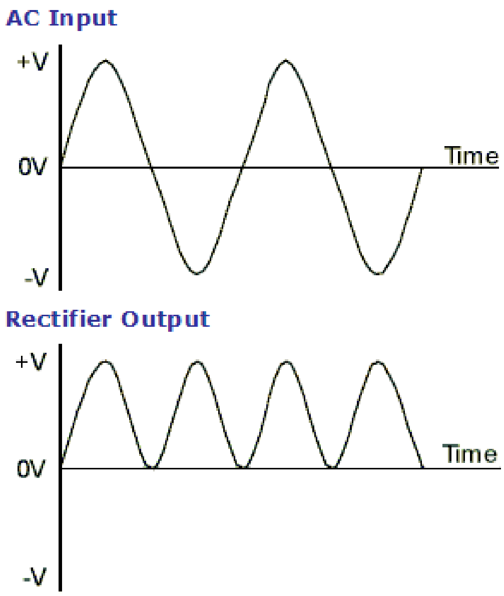


Figure 3.13 Full-Wave Rectification

When the AC input is positive, diodes A and B are forward-biased, while diodes C and D are reverse-biased. When the AC input is negative, the opposite is true - diodes C and D are forward-biased, while diodes A and B are reverse-biased.

While the full-wave rectifier is an improvement on the half-wave rectifier, its output still isn't suitable as a power supply for most circuits since the output voltage still varies between 0V and Vs-1.4V. So, if you put 12V AC in, you will 10.6V DC out.

Capacitor Filter

The **capacitor-input filter**, also called "Pi" filter due to its shape that looks like the Greek letter pi, is a type of electronic filter. Filter circuits are used to remove unwanted or undesired frequencies from a signal.

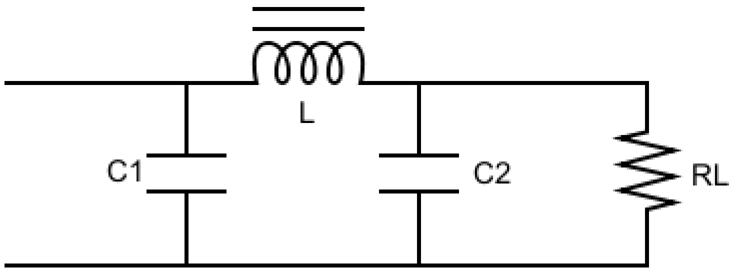


Figure:3.14 Capacitor Filter

A typical capacitor input filter consists of a filter capacitor C1, connected across the rectifier output, an inductor L, in series and another filter capacitor connected across the load.

1. The capacitor C1 offers low reactance to the AC component of the rectifier output while it offers infinite reactance to the DC component. As a result the capacitor shunts an appreciable amount of the AC component while the DC component continues its journey to the inductor L
2. The inductor L offers high reactance to the AC component but it offers almost zero reactance to the DC component. As a result the DC component flows through the inductor while the AC component is blocked.
3. The capacitor C2 bypasses the AC component which the inductor had failed to block. As a result only the DC component appears across the load RL.

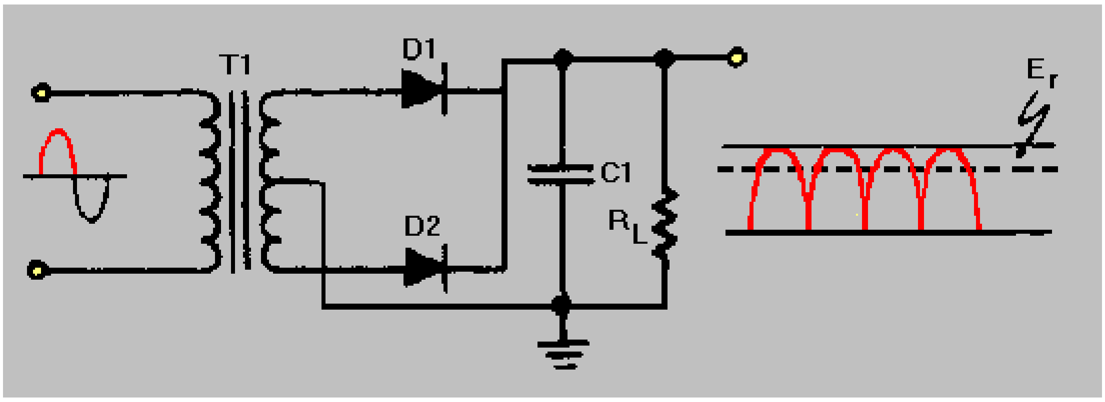


Figure:3.15 Centered Tapped Full-Wave Rectifier with a Capacitor Filter

3.2.4 Voltage Regulator:

A **voltage regulator** is an electrical regulator designed to automatically maintain a constant voltage level. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. There are two types of regulator are they.

- Positive Voltage Series (78xx) and
- Negative Voltage Series (79xx)

78xx:’78’ indicate the positive series and ‘xx’indicates the voltage rating. Suppose 7805 produces the maximum 5V.’05’indicates the regulator output is 5V.

79xx:’78’ indicate the negative series and ‘xx’indicates the voltage rating. Suppose 7905 produces the maximum -5V.’05’indicates the regulator output is -5V.

These regulators consists the three pins there are

Pin1: It is used for input pin.

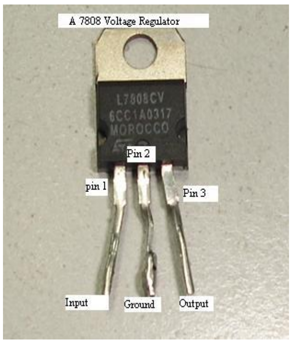


Figure 3.16 Regulator

Pin2: This is ground pin for regulator

Pin3: It is used for output pin. Through this pin we get the output.

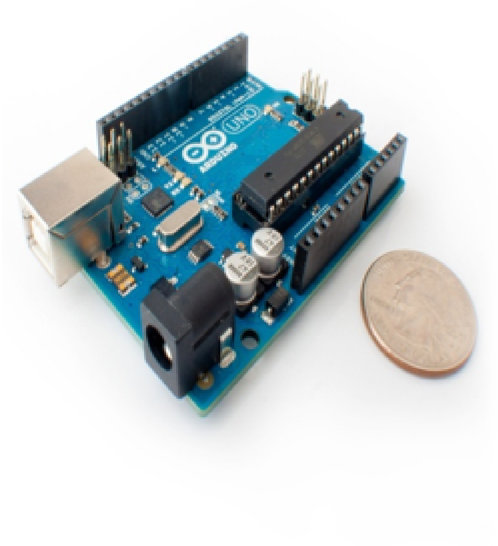
CHAPTER 4
HARDWARE

4.1 Arduino

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

The key features are −

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.



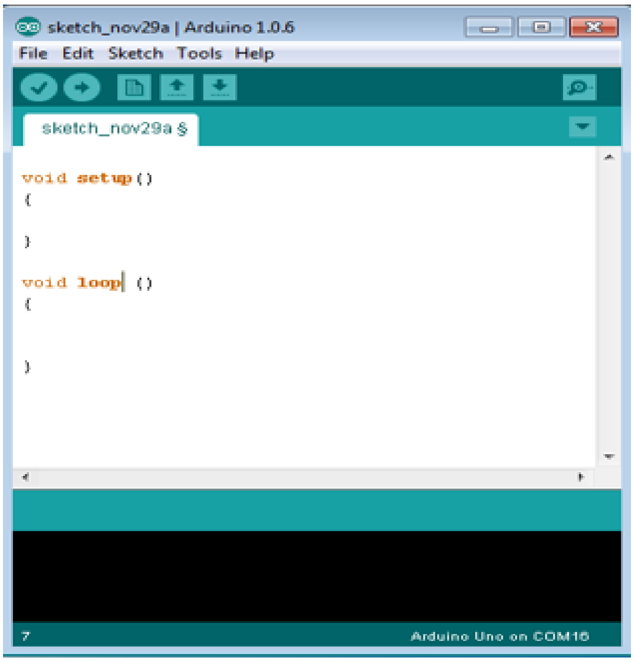


Figure 4.1 arduino uno on COM10

4.1.2 Arduino IDE

The **Arduino Integrated Development Environment (IDE)** is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

Arduino Pro IDE	
Developer(s)	Arduino Software
Preview release	v0.0.2 / 28 October 2019; 3 months ago[8]
Repository	github.com/arduino/Arduino

Written in	C, C++
Operating system	Windows, macOS, Linux
Platform	IA-32, x86-64, ARM
Type	Integrated development environment
License	LGPL or GPL license
Website	blog.arduino.cc/2019/10/18/arduino-pro-ide-alpha-preview-with-advanced-features/

In October 2019 the Arduino organization began providing early access to a new Arduino Pro IDE with debugging[9] and other advanced features.

After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up the Arduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board.

4.1.3 Installation

In this section, we will learn in easy steps, how to set up the Arduino IDE on our computer and prepare the board to receive the program via USB cable.

Step 1 − First you must have your Arduino board (you can choose your favorite board) and a USB cable. In case you use Arduino UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, you will need a standard USB cable (A plug to B plug), the kind you would connect to a USB printer as shown in the following image.

Figure 4.1.2 Standard USB Cable

In case you use Arduino Nano, you will need an A to Mini-B cable instead as shown in the following image.

Figure 4.1.3 Mini-B Cable

Step 2 − Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

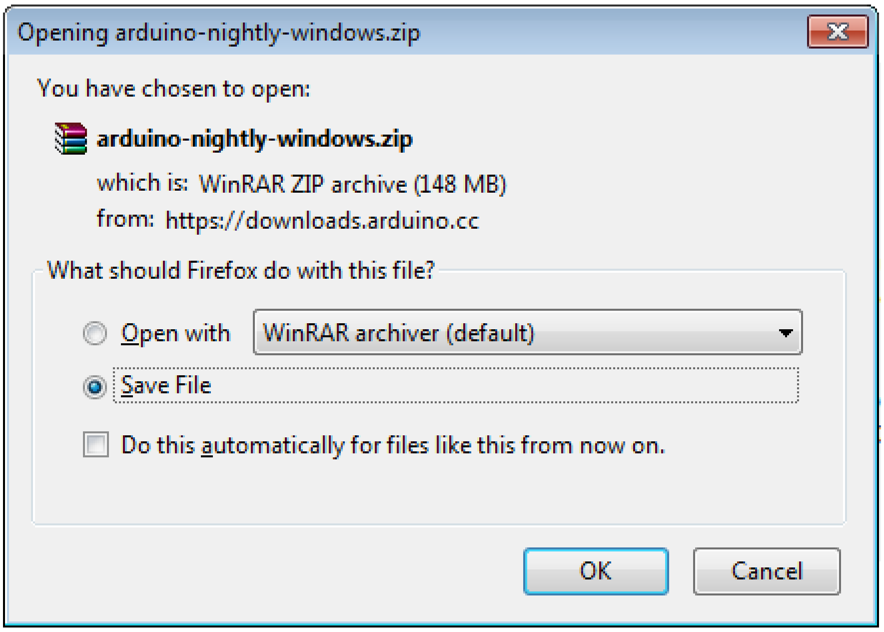


Figure 4.1.4 Downloading Arduino IDE

Step 3 − Power up your board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection.

The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port.

Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4 − Launch Arduino IDE.

After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double-click the icon to start the IDE.

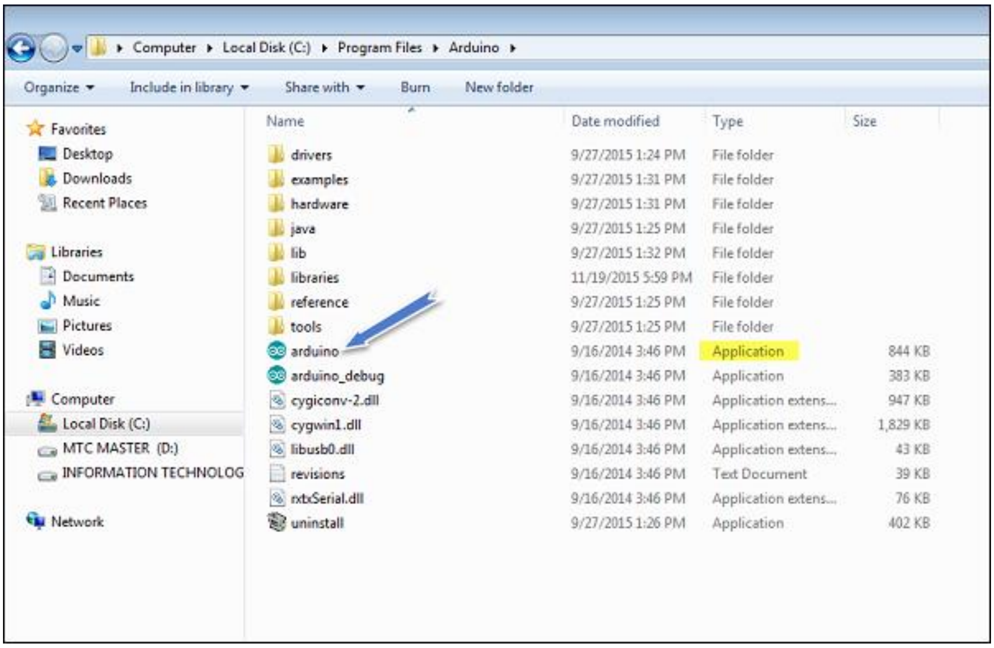


Figure 4.1.5 Launching Arduino IDE

Step 5 − Open your first project.

Once the software starts, you have two options −

- Create a new project.
- Open an existing project example.

To create a new project, select File → **New**.

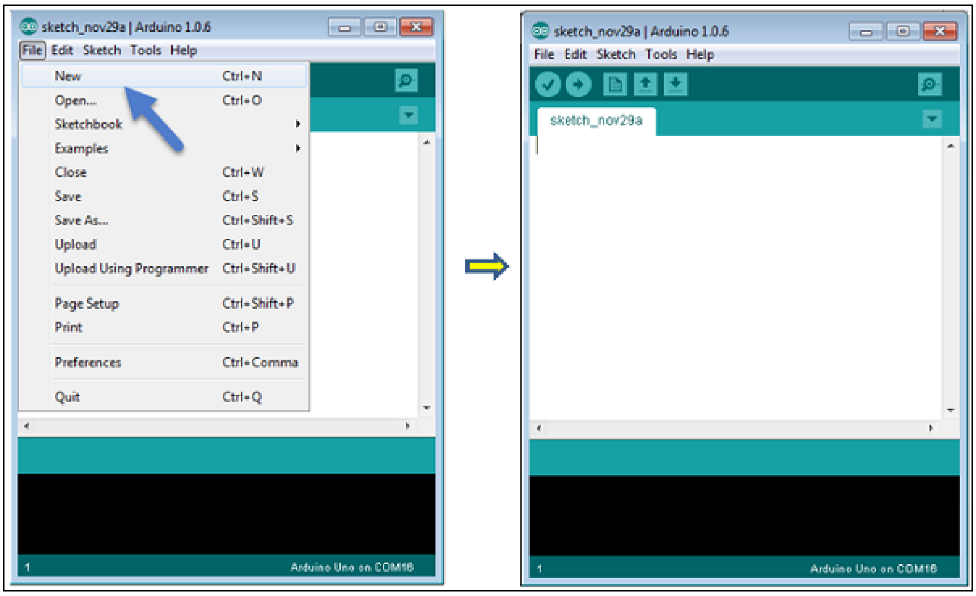


Figure 4.1.6 Creating New File

To open an existing project example, select File → Example → Basics → Blink.

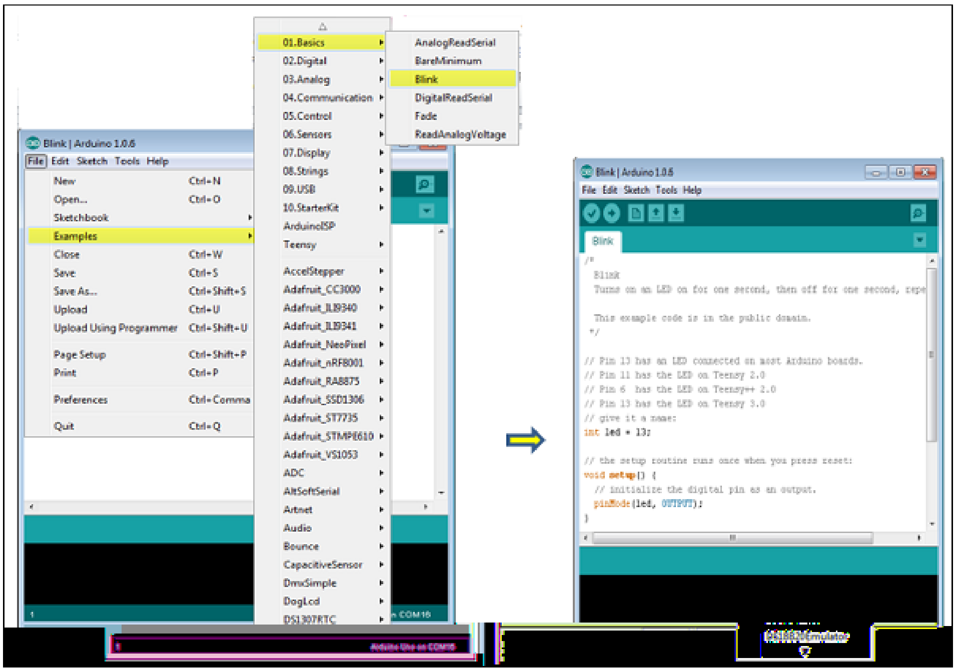


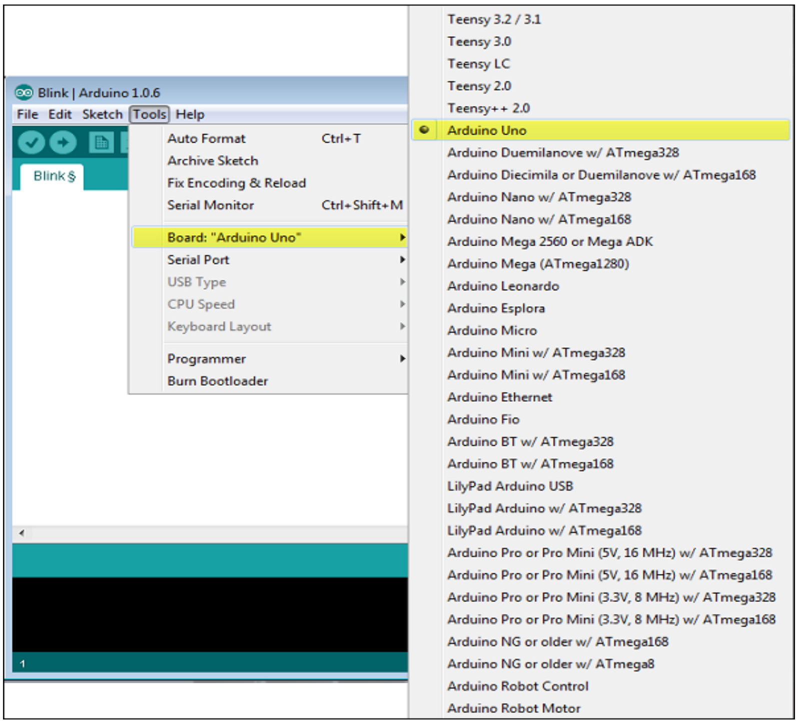
Figure 4.1.7 Example

Here, we are selecting just one of the examples with the name **Blink**. It turns the LED on and off with some time delay. You can select any other example from the list.

Step 6 − Select your Arduino board.

To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools → Board and select your board.

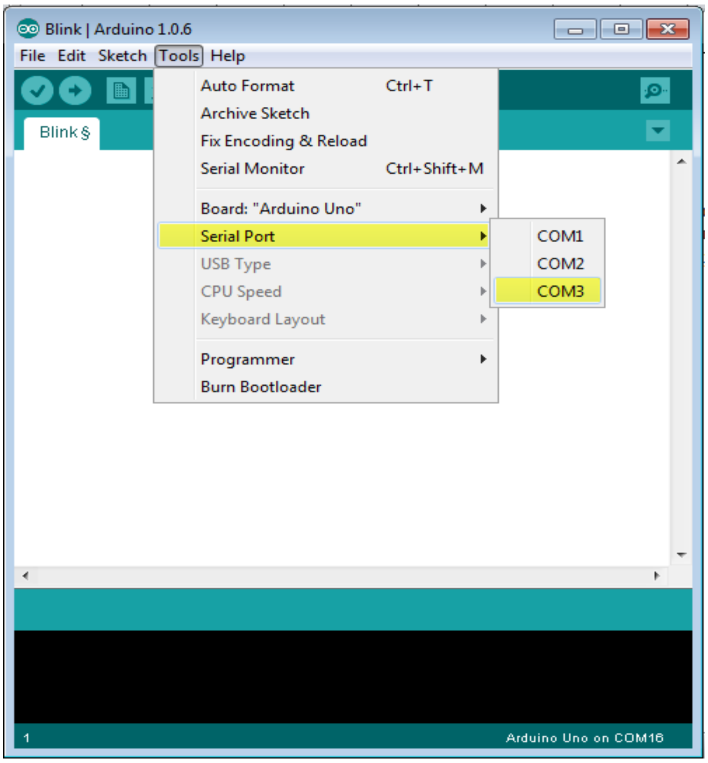


4.1.8 Arduino Selection

Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using.

Step 7 − Select your serial port.

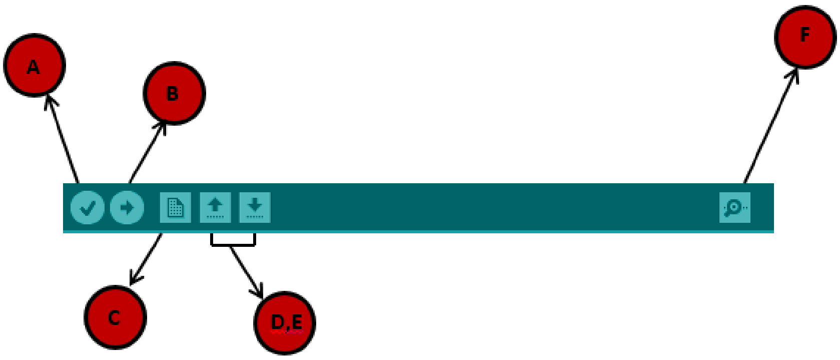
Select the serial device of the Arduino board. Go to **Tools** → **Serial Port** menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.



4.1.9 Serial Port Selection

Step 8 − Upload the program to your board.

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.



4.1.10 Arduino IDE Toolbar

A − Used to check if there is any compilation error.

B − Used to upload a program to the Arduino board.

C − Shortcut used to create a new sketch.

D − Used to directly open one of the example sketch.

E − Used to save your sketch.

F − Serial monitor used to receive serial data from the board and send the serial data to the board.

Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

Note − If you have an Arduino Mini, NG, or other board, you need to press the reset button physically on the board, immediately before clicking the upload button on the Arduino Software.

4.2 Board Types

Various kinds of Arduino boards are available depending on different microcontrollers used. However, all Arduino boards have one thing in common: they are programed through the Arduino IDE.

The differences are based on the number of inputs and outputs (the number of sensors, LEDs, and buttons you can use on a single board), speed, operating voltage, form factor etc. Some boards are designed to be embedded and have no programming interface (hardware), which you would need to buy separately. Some can run directly from a 3.7V battery, others need at least 5V.

Here is a list of different Arduino boards available.

Table 4.1 Arduino boards based on ATMEGA328 microcontroller

Board Name	Operating Volt	Clock Speed	Digital i/o	Analog Inputs	PWM	UART	Programming Interface
Arduino Uno R3	5V	16MHz	14	6	6	1	USB via ATMega16U2
Arduino Uno R3 SMD	5V	16MHz	14	6	6	1	USB via ATMega16U2
Red Board	5V	16MHz	14	6	6	1	USB via FTDI
Arduino Pro 3.3v/8 MHz	3.3V	8MHz	14	6	6	1	FTDI-Compatible Header
Arduino Pro 5V/16MHz	5V	16MHz	14	6	6	1	FTDI-Compatible Header

Arduino mini 05	5V	16MHz	14	8	6	1	FTDI-Compatible Header
Arduino Pro mini 3.3v/8mhz	3.3V	8MHz	14	8	6	1	FTDI-Compatible Header
Arduino Pro mini 5v/16mhz	5V	16MHz	14	8	6	1	FTDI-Compatible Header
Arduino Ethernet	5V	16MHz	14	6	6	1	FTDI-Compatible Header
Arduino Fio	3.3V	8MHz	14	8	6	1	FTDI-Compatible Header
LilyPad Arduino 328 main board	3.3V	8MHz	14	6	6	1	FTDI-Compatible Header
LilyPad Arduino simple board	3.3V	8MHz	9	4	5	0	FTDI-Compatible Header

Table 4.2Arduino boards based on ATMEGA32u4 microcontroller

Board Name	Operating Volt	Clock Speed	Digital i/o	Analog Inputs	PWM	UART	Programming Interface
Arduino Leonardo	5V	16MHz	20	12	7	1	Native USB
Pro micro 5V/16MHz	5V	16MHz	14	6	6	1	Native USB
Pro micro 3.3V/8MHz	5V	16MHz	14	6	6	1	Native USB
LilyPad Arduino USB	3.3V	8MHz	14	6	6	1	Native USB

Table 4.3 Arduino boards based on ATMEGA2560 microcontroller

Board Name	Operating Volt	Clock Speed	Digital i/o	Analog Inputs	PWM	UART	Programming Interface
Arduino Mega 2560 R3	5V	16MHz	54	16	14	4	USB via ATMega16U2B
Mega Pro 3.3V	3.3V	8MHz	54	16	14	4	FTDI-Compatible Header
Mega Pro 5V	5V	16MHz	54	16	14	4	FTDI-Compatible Header
Mega Pro Mini 3.3V	3.3V	8MHz	54	16	14	4	FTDI-Compatible Header

Table 4.4 Arduino boards based on AT91SAM3X8E microcontroller

Board Name	Operating Volt	Clock Speed	Digital i/o	Analog Inputs	PWM	UART	Programming Interface
Arduino Mega 2560 R3	3.3V	84MHz	54	12	12	4	USB native

Board Description:

In this chapter, we will learn about the different components on the Arduino board. We will study the Arduino UNO board because it is the most popular board in the Arduino board family. In addition, it is the best board to get started with electronics and coding. Some boards look a bit different from the one given below, but most Arduinos have majority of these components in common.

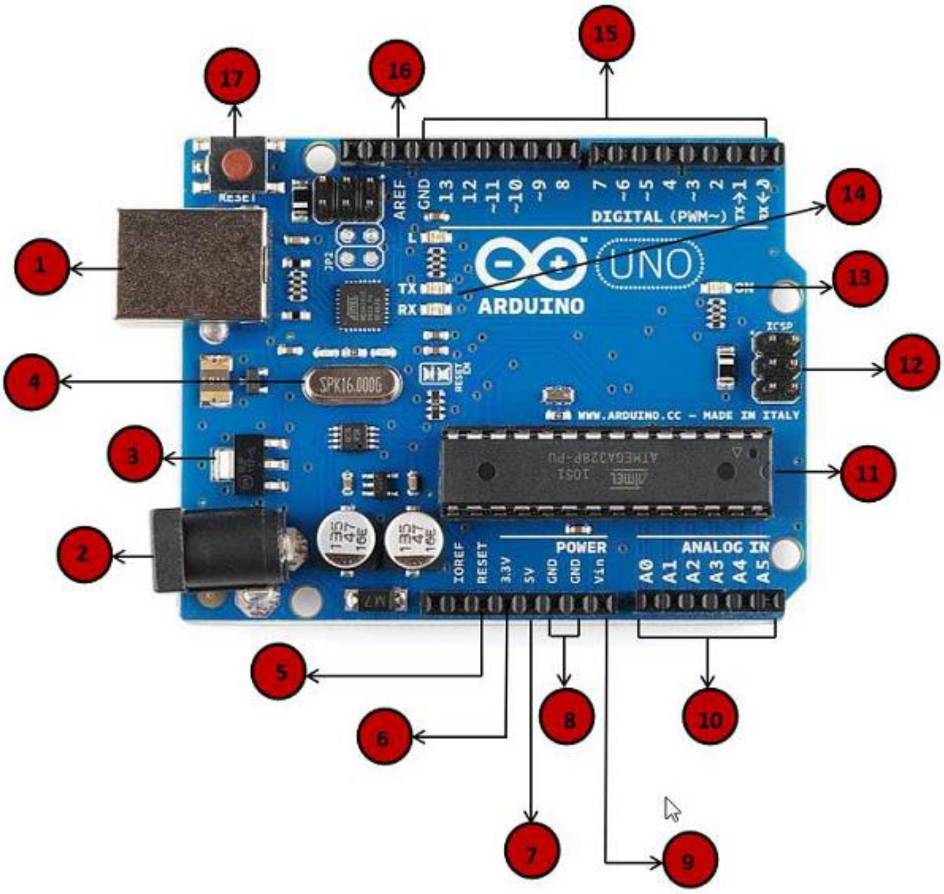


Figure 4.2 Arduino

1	**Power USB** Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection (1).
2	**Power (Barrel Jack)** Arduino boards can be powered directly from the AC mains power supply by connecting it to the Barrel Jack (2).
3	**Voltage Regulator** The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.
4	**Crystal Oscillator** The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

5,17	**Arduino Reset** You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).
6,7 8,9	**Pins (3.3, 5, GND, Vin)** • 3.3V (6) − Supply 3.3 output volt • 5V (7) − Supply 5 output volt • Most of the components used with Arduino board works fine with 3.3 volt and 5 volt. • GND (8)(Ground) − There are several GND pins on the Arduino, any of which can be used to ground your circuit. • Vin (9) − This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.
10	**Analog pins** The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.
11	**Main microcontroller** Each Arduino board has its own microcontroller (11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC. For more details about the IC construction and functions, you can refer to the data sheet.
12	**ICSP pin** Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.
13	**Power LED indicator** This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.

14	**TX and RX LEDs** On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.
15	**Digital I/O** The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled "~" can be used to generate PWM.
16	**AREF** AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

4.3 Liquid Cristal Display

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the contollers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS RW D7 D6 D5 D4 D3 D2 D1 D0). For a 4-bit data bus it only requires the supply lines plus 6 extra lines(RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

4.4.1 Description Of 16x2:

This is the first interfacing example for the Parallel Port. We will start with something simple. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if no all-Parallel Ports. It however doesn't show the use of the Status Port as an input. So what are we interfacing? A 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required to run them is on board.

Schematic Diagram

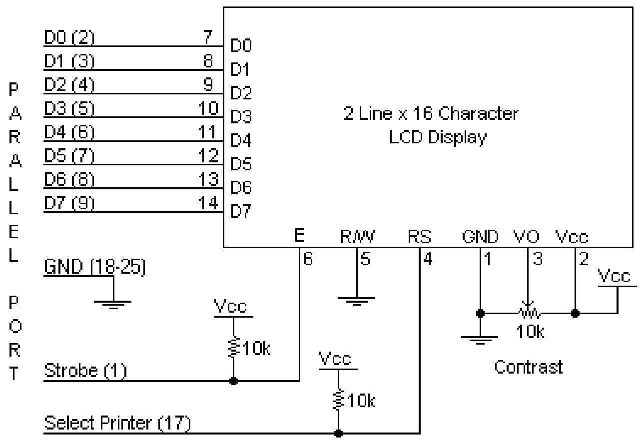


Figure 4.3 Schematic Diagram

- Above is the quite simple schematic. The LCD panel's *Enable* and *Register Select* is connected to the Control Port. The Control Port is an open collector / open drain output. While most Parallel Ports have internal pull-up resistors, there are a few which don't. Therefore by incorporating the two 10K external pull up resistors, the circuit is more portable for a wider range of computers, some of which may have no internal pull up resistors.
- We make no effort to place the Data bus into reverse direction. Therefore we hard wire the *R/W* line of the LCD panel, into write mode. This will cause no bus conflicts on the data lines.

- As a result we cannot read back the LCD's internal Busy Flag which tells us if the LCD has accepted and finished processing the last instruction. This problem is overcome by inserting known delays into our program.
- The 10k Potentiometer controls the contrast of the LCD panel. Nothing fancy here. As with all the examples, I've left the power supply out. You can use a bench power supply set to 5v or use a onboard +5 regulator. Remember a few de-coupling capacitors, especially if you have trouble with the circuit working properly.

16 x 2 Alphanumeric LCD Module Features:

- Intelligent, with built-in Hitachi HD44780 compatible LCD controller and RAM providing simple interfacing
- 61 x 15.8 mm viewing area
- 5 x 7 dot matrix format for 2.96 x 5.56 mm characters, plus cursor line
- Can display 224 different symbols
- Low power consumption (1 mA typical)
- Powerful command set and user-produced characters
- TTL and CMOS compatible
- Connector for standard 0.1-pitch pin headers

16 x 2 Alphanumeric LCD Module Specifications:

Pin	Symbol	Level	Function
1	V_{SS}	-	Power, GND
2	V_{DD}	-	Power, 5V
3	Vo	-	Power, for LCD Drive
4	RS	H/L	Register Select Signal H: Data Input L: Instruction Input
5	R/W	H/L	H: Data Read (LCD->MPU) L: Data Write (MPU->LCD)
6	E	H,H->L	Enable
7-14	DB0-DB7	H/L	Data Bus; Software selectable 4- or 8-bit mode

15	NC	-	**NOT CONNECTED**
16	NC	-	**NOT CONNECTED**

Table 4.5. 16 x 2 Alphanumeric LCD Module Specifications

FEATURES:

• 5 x 8 dots with cursor

• Built-in controller (KS 0066 or Equivalent)

• + 5V power supply (Also available for + 3V)

• 1/16 duty cycle

• B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)

• N.V. optional for + 3V power supply

Data can be placed at any location on the LCD. For 16×1 LCD, the address locations are:

POSITION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ADDRESS	LINE1	00	01	02	03	04	05	06	07	40	41	42	43	44	45	46	47

Figure 4.4 Address locations for a 1x16 line LCD

Even limited to character based modules, there is still a wide variety of shapes and sizes available. Line lengths of 8,16,20,24,32 and 40 characters are all standard, in one, two and four line versions.

Several different LC technologies exists. “supertwist” types, for example, offer Improved contrast and viewing angle over the older “twisted nematic” types. Some modules are available with back lighting, so that they can be viewed in dimly-lit conditions. The back lighting may be either “electro-luminescent”, requiring a high voltage inverter circuit, or simple LED illumination.

PIN DESCRIPTION:

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections).

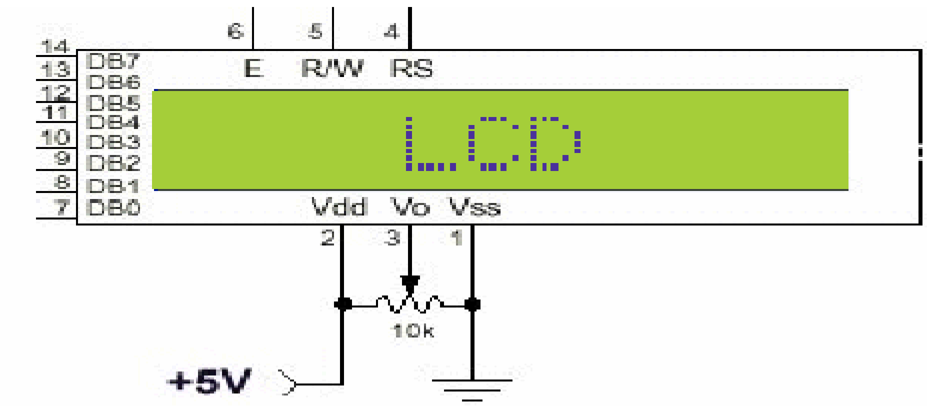


Figure 4.5 Pin diagram of 1x16 lines LCD

PIN	SYMBOL	FUNCTION
1	Vss	Power Supply(GND)
2	Vdd	Power Supply(+5V)
3	Vo	Contrast Adjust
4	RS	Instruction/Data Register Select
5	R/W	Data Bus Line
6	E	Enable Signal
7-14	DB0-DB7	Data Bus Line
15	A	Power Supply for LED B/L(+)
16	K	Power Supply for LED B/L(-)

Table 4.6 Pin specifications

CONTROL LINES:

EN: Line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) again.

RS: Line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.). When RS is high (1), the data being sent is text data which should be displayed on the screen. For example, to display the letter "T" on the screen you would set RS high.

RW: Line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD. Only one instruction ("Get LCD status") is a read command. All others are write commands, so RW will almost always be low. Finally, the data bus consists of 4 or 8 lines (depending on the mode of operation selected by the user). In the case of an 8-bit data bus, the lines are referred to as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.

Logic status on control lines:

• E - 0 Access to LCD disabled

- 1 Access to LCD enabled

• R/W - 0 Writing data to LCD

- 1 Reading data from LCD

• RS - 0 Instructions

  - 1 Character

Writing data to the LCD:

1) Set R/W bit to low

2) Set RS bit to logic 0 or 1 (instruction or character)

3) Set data to data lines (if it is writing)

4) Set E line to high

5) Set E line to low

Read data from data lines (if it is reading) on LCD:

1) Set R/W bit to high

2) Set RS bit to logic 0 or 1 (instruction or character)

3) Set data to data lines (if it is writing)

4) Set E line to high

5) Set E line to low

Entering Text:

First, a little tip: it is manually a lot easier to enter characters and commands in hexadecimal rather than binary (although, of course, you will need to translate commands from binary couple of sub-miniature hexadecimal rotary switches is a simple matter, although a little bit into hex so that you know which bits you are setting). Replacing the d.i.l. switch pack with a of re-wiring is necessary.

LCD Commands:

There are some present commands instructions in LCD, which we need to send to LCD through some microcontroller. Some important command instructions are given below:

Table 4.7 Commands

Hex Code	Command to LCD Instruction Register
0F	LCD ON, cursor ON
01	Clear display screen
02	Return home
04	Decrement cursor (shift cursor to left)
06	Increment cursor (shift cursor to right)
05	Shift display right
07	Shift display left
0E	Display ON, cursor blinking
80	Force cursor to beginning of first line
C0	Force cursor to beginning of second line
38	2 lines and 5×7 matrix
83	Cursor line 1 position 3
3C	Activate second line
08	Display OFF, cursor OFF
C1	Jump to second line, position 1
OC	Display ON, cursor OFF
C1	Jump to second line, position 1
C2	Jump to second line, position 2

4.4 RFID (Radio Frequency Identification):

Introduction

Radio Frequency Identification (RFID) technology has been attracting considerable attention with the expectation of improved supply chain visibility for both suppliers and retailers. It will also improve the consumer shopping experience by making it more likely that the products they want to purchase are available.

Recent announcements from some key retailers have brought the interest in RFID to the forefront. This guide is an attempt to familiarize the reader with RFID technology so that they can be asking the right questions when considering the technology.

What is RFID?

RFID (Radio Frequency Identification) is a method of identifying unique items using radio waves. Typical RFID systems are made up of 2 major components: readers and tags. The reader, sometimes called the interrogator, sends and receives RF data to and from the tag via antennas. A reader may have multiple antennas that are responsible for sending and receiving the radio waves. The tag, or transponder, is made up of the microchip that stores the data, an antenna, and a carrier to which the chip and antenna are mounted.

RFID technology is used today in many applications, including security and access control, transportation and supply chain tracking. It is a technology that works well for collecting multiple pieces of data on items for tracking and counting purposes in a cooperative environment.

Is All RFID Created Equal?

There are many different versions of RFID that operate at different radio frequencies. The choice of frequency is dependent on the requirements of the application.

Three primary frequency bands have been allocated for RFID use.

Low Frequency (125/134 KHz):

Most commonly used for access control and asset tracking.

Mid-Frequency (13.56 MHz):

Used where medium data rate and read ranges are required.

Ultra High-Frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz): offer the longest read ranges and high reading speeds.

Applications for RFID within the supply chain can be found at multiple frequencies and different RFID solutions may be required to meet the varying needs of the marketplace. Many of today’s RFID technologies cannot reliably cover areas wider than 4 to 5 feet, making them unsuitable for wide openings that are the norm in manufacturing, distribution and storereceiving dock environments. Since UHF (Ultra High Frequency) can cover portals up to 9 feet

wide it is gaining industry support as the choice bandwidth for inventory tracking applications including pallets and cases.

Technology providers are developing readers that work with multiple system protocols and frequencies so that users will be able to choose the RFID products that work best for their market and products.

RFID tags are further broken down into two categories:

Active RFID Tags are battery powered .They broadcast a signal to the reader and can transmit over the greatest Distances (100+ feet).Typically they can cost $4.00 - $20.00 or more and are used to track high value goods like vehicles and large containers of goods. Shipboard containers are a good example of an active RFID tag application

Passive RFID Tags do not contain a battery. Instead, they draw their power from the reader. The reader transmits a low power radio signal through its antenna to the tag, which in turn receives it through its own antenna to power the integrated circuit (chip). The tag will briefly converse with the reader for verification and the exchange of data. As a result, passive tags can transmit information over shorter distances (typically 10 feet or less) than active tags. They have a smaller memory capacity and are considerably lower in cost ($1.00 or less) making them ideal for tracking lower cost items.

There are two basic types of chips available on RFID tags, Read-Only and Read-Write.
Read only chips are programmed with unique information stored on them during the manufacturing process. The information on read-only chips can never be changed.
With Read-Write chips, the user can add information to the tag or write over existing information when the tag is within range of the reader. Read-Write chips are more expensive that Read Only chips. Another method used is something called a "WORM" chip (Write Once Read Many). It can be written once and then becomes "Read only" afterwards. This is a desirable format since companies will be able to write an EPC (electronic product code) to the tag when the product is produced and packaged.

How Will RFID Affect Our Industry?
RFID is expected to provide huge advantages to manufacturers by offering the tools to better plan production and respond more quickly to market demand. It will facilitate automation of inventory counts and speed shipping and receiving at the distribution level. For retailers, it will help to reduce stock-outs. RFID will also open other merchandising opportunities and help with the overall consumer buying experience.

Due to the current cost of the technology (both tags and infrastructure), the initial phase of adoption for retailers is at carton and pallet marking applications. The current technology being

adopted for carton and pallet labeling is passive UHF tags (850 MHz – 950 MHz). As the cost of tags and readers comes down, a wider adoption at the item marking level will develop.
In order for RFID to grow quickly, it is important that standards be developed so that the technology providers are working toward a common goal of providing low cost and compatible technologies. Not only will it drive down costs, but standards will also help users to reap the greatest benefit from their investment by providing value throughout the whole supply chain.

Organizations Focused on Developing RFID Standards:
EPC global, Inc., a division of the Uniform Code Council, and its sponsors are working to standardize a new Electronic Product Code (EPC) as the next standard for identifying products. Their goal is not to replace existing bar code standards but to expand the information available down to unique identifiers for each marked item, and to enable more automatic reading. EPC utilizes the basic structure of the Global Trade Item Number (GTIN).

EPC global, Inc. has proposed open standards for tags and readers with the intention of bringing the costs down to a level where RFID tags could be applied to individual items. The work may lead to the creation of a new global Internet network that would allow companies to track items and enable end users to access the full benefits of RFID.

EPC global, Inc. has developed a specification for RFID tags to be used in the retail sector. The specification does not mandate what type of tag to be used but is intended to provide guidelines on data structure and how the tags should perform so that they can be used over a common platform. It is tailored around the experiences gained from the implementation of UPC and its success in the marketplace for more than 25 years. The specification requires that the chip contain an Electronic Product Code (EPC). The chip must be able to communicate according to an open standard and meet some minimum requirements so that it can be read by reading devices anywhere.

6.9 The Electronic Product Code (EPC)
The EPC is a number made up of a header and 3 sets of data as shown in the figure below. The header identifies the EPC version number – which will allow for different lengths or types of EPC later on. The second part of the number identifies the EPC manager – typically this would be the manufacturer of the item the EPC is attached to. The third part is called object class and

refers to the exact type of product– most often the stock-keeping unit (SKU). The fourth series of numbers is the serial number that is unique to the item. (The second and third sets of data are similar in function to the numbers in UPC barcodes.)

01 • 0000A89 • 00016F • 000169DCO

Header	EPC Manager	Object Class	Serial Number
8-bits	28-bits	24-bits	36-bits

Figure 4.6 Example of a 96-bit EPC

Above is an example of a 96-bit EPC. It will allow sufficient capacity for 268 million companies. Each manufacturer will have the ability to create up to 16 million object classes with 68 billion serial numbers in each class. This should provide sufficient capacity to cover all products manufactured in the world for many years to come. As an interim step, the Auto-ID center is also proposing a 64-bit tag in order to minimize cost in the near term.

Potential Issues That Need Consideration When Choosing The Type Of RFID And Method For Application To Your Products Or Packaging.

Enthusiasm within the RFID industry has resulted in much hype about the technology over the past several years. As a result, it is important to embrace the technology with a bit of caution. The following are some of the issues that require close scrutiny when investigating RFID:

Tag Cost – This should not to be confused with chip cost. Although the goal is to bring the cost of the tag (chip and antenna) down to 5 cents, this goal is in the future since it both assumes manufacturing breakthroughs and is predicated on consumption in the billions of tags per year. Today, the cost is closer to "less than 50 cents" for a read/write solution in high (millions) volume. Ultimate tag cost will also be very much dependent on the type of chip required (read only versus read/write), size of the antenna needed and how it is packaged to meet a specific application.

Tag Size – Tag size is dependent on the read range desired. Although the chips are very tiny, they will not operate without being mounted to an antenna. The size of the antenna will determine the read distance performance of the tag so understanding the size of the antenna needed for the application is more important than the size of the chip alone.

Infrastructure Cost – Much focus appears to be placed on the tag cost since it is a recurring expenditure. Reader cost and infrastructure costs for implementing RFID must also be looked at very closely as well. Both the software systems requirements and physical environment, in which RFID is intended to be used, are critical to the ultimate performance of a system and may require changes to accommodate using it effectively. As an example, RFID chips cannot be read through metal objects. Other forms of electromagnetic interference may also impede performance of he technology and require changes to the physical environment where RFID will be used. The number and types of readers will also be a major expenditure depending on your application.

Read Distances – Read distances for RFID are very much dependent on the frequency chosen for the application. Tag orientation also affects the read range as the range diminishes as the tag is rotated from

being perpendicular to the path to the reader. Reading reliability is quite good when labels are alone in a reader field like cases on a conveyor line, but less certain when the labels are randomly oriented as with labeled cases on a skid. The antenna size (both on the tag and the readers) will also be a determining factor. Hand held readers are not capable of using as much power as stationary readers and as a result provide shorter read distance

Government Regulation – Governments around the world regulate the use of the frequency spectrum. Different countries have already assigned certain parts of the spectrum for other uses and as a result, there is virtually no part of the spectrum that is available everywhere in the world for use by RFID. This means that a RFID tag may not work in all countries. As an example if you choose the Ultra High Frequency (UHF) frequency that
Operates at 915MHz in the U.S. and you ship your product to Europe, they may not be able to be read it since Europe operates in the UHF spectrum at 869 MHz. This is an important consideration when operating in a global environment.

Anti-Collision – This is an important feature of RFID chips/readers since it will allow multiple tags to be read while grouped in one reader field. It is not available on all RFID tags but is an important feature if you are planning to use RFID for inventory counts, shipping and receiving where multiple tags need to be read at the same time.

Privacy Issues – Consumer groups have expressed concern over the potential (real or imagined) privacy invasion that might result with widespread RFID item marking. These groups are pushing for legislation that will require manufacturers to advise consumers that the products contain RFID devices and must provide a means so that the devices can be disabled at point of purchase. These issues are most prevalent at the item marking level and will have little impact on the implementation of carton and pallet labeling.

4.5 GSM:

Definition of GSM:

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

History

In 1982, the European Conference of Postal and Telecommunications Administrations (CEPT) created the Group Special Mobile (GSM) to develop a standard for a mobile telephone system that could be used across Europe. In 1987, a memorandum of understanding was signed by 13 countries to develop a common cellular telephone system across Europe. Finally the system created by SINTEF lead by Torleiv Maseng was selected.

In 1989, GSM responsibility was transferred to the European Telecommunications Standards Institute (ETSI) and phase I of the GSM specifications were published in 1990. The first GSM network was launched in 1991 by Radiolinja in Finland with joint technical infrastructure maintenance from Ericsson.

By the end of 1993, over a million subscribers were using GSM phone networks being operated by 70 carriers across 48 countries. As of the end of 1997, GSM service was available in more than 100 countries and has become the *de facto* standard in Europe and Asia.

GSM Frequencies

GSM networks operate in a number of different frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G). Most 2G GSM networks operate in the 900 MHz or 1800 MHz bands. Some countries in the Americas (including Canada and the United States) use the 850 MHz and 1900 MHz bands because the 900 and 1800 MHz frequency bands were already allocated. Most 3G GSM networks in Europe operate in the 2100 MHz frequency band. The rarer 400 and 450 MHz frequency bands are assigned in some countries where these frequencies were previously used for first-generation systems.

GSM-900 uses 890–915 MHz to send information from the mobile station to the base station (uplink) and 935–960 MHz for the other direction (downlink), providing 124 RF channels (channel numbers 1 to 124) spaced at 200 kHz. Duplex spacing of 45 MHz is used. In some countries the GSM-900 band has been extended to cover a larger frequency range. This 'extended GSM', E-GSM, uses 880–915 MHz (uplink) and 925–960 MHz (downlink), adding 50 channels (channel numbers 975 to 1023 and 0) to the original GSM-900 band.

Time division multiplexing is used to allow eight full-rate or sixteen half-rate speech channels per radio frequency channel. There are eight radio timeslots (giving eight burst periods) grouped into what is called a TDMA frame. Half rate channels use alternate frames in the same timeslot. The channel data rate for all 8 channels is 270.833 Kbit/s, and the frame duration is 4.615 ms.

The transmission power in the handset is limited to a maximum of 2 watts in GSM850/900 and 1 watt in GSM1800/1900. GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz and 850MHz bands in the US. The 850MHz band is also used for GSM and 3G in Australia, Canada and many South American countries. By having harmonized spectrum across most of the globe, GSM's international roaming capability allows users to access the same services when travelling abroad as at home. This gives consumers seamless and same number connectivity in more than 218 countries.

Terrestrial GSM networks now cover more than 80% of the world's population. GSM satellite roaming has also extended service access to areas where terrestrial coverage is not available.

Mobile Telephony Standards

Standard	Generation	Frequency band	Throughput	
GSM	2G	Allows transfer of voice or low-volume digital data.	9.6 kbps	9.6 kbps
GPRS	2.5G	Allows transfer of voice or moderate-volume digital data.	21.4-171.2 kbps	48 kbps
EDGE	2.75G	Allows simultaneous transfer of voice and digital data.	43.2-345.6 kbps	171 kbps
UMTS	3G	Allows simultaneous transfer of voice and high-speed digital data.	0.144-2 Mbps	384 kbps

Table 4.8 Mobile Telephony Standards

1G

The first generation of mobile telephony (written **1G**) operated using analogue communications and portable devices that were relatively large. It used primarily the following standards:

- **AMPS** (Advanced Mobile Phone System), which appeared in 1976 in the United States, was the first cellular network standard. It was used primarily in the Americas, Russia and Asia. This first-generation analogue network had weak security mechanisms which allowed hacking of telephones lines.
- **TACS** (Total Access Communication System) is the European version of the AMPS model. Using the 900 MHz frequency band, this system was largely used in England and then in Asia (Hong-Kong and Japan).
- **ETACS** (Extended Total Access Communication System) is an improved version of the TACS standard developed in the United Kingdom that uses a larger number of communication channels.

The first-generation cellular networks were made obsolete by the appearance of an entirely digital second generation.

Second Generation of Mobile Networks (2G)

The second generation of mobile networks marked a break with the first generation of cellular telephones by switching from analogue to digital. The main 2G mobile telephony standards are:

- GSM (*Global System for Mobile communications*) is the most commonly used standard in Europe at the end of the 20th century and supported in the United States. This standard uses the 900 MHz and 1800 MHz frequency bands in Europe. In the United States, however, the frequency band used is the 1900 MHz band. Portable telephones that are able to operate in Europe and the United States are therefore called **tri-band**.
- **CDMA** (*Code Division Multiple Access*) uses a spread spectrum technique that allows a radio signal to be broadcast over a large frequency range.
- **TDMA** (*Time Division Multiple Access*) uses a technique of time division of communication channels to increase the volume of data transmitted simultaneously. TDMA technology is primarily used on the American continent, in New Zealand and in the Asia-Pacific region.

With the 2G networks, it is possible to transmit voice and low volume digital data.

Extensions have been made to the GSM standard to improve throughput. One of these is the **GPRS** (*General Packet Radio System*) service which allows theoretical data rates on the order of 114 Kbit/s but with throughput closer to 40 Kbit/s in practice. As this technology does not fit within the "3G" category, it is often referred to as **2.5G**

The **EDGE** (*Enhanced Data Rates for Global Evolution*) standard, billed as **2.75G**, quadruples the throughput improvements of GPRS with its theoretical data rate of 384 Kbps, thereby allowing the access for multimedia applications. In reality, the EDGE standard allows maximum theoretical data rates of 473 Kbit/s, but it has been limited in order to comply with the IMT-2000 (*International Mobile Telecommunications-2000*) specifications from the ITU (*International Telecommunications Union*).

3G

The IMT-2000 (*International Mobile Telecommunications for the year 2000*) specifications from the International Telecommunications Union (ITU) defined the characteristics of **3G** (third generation of mobile telephony). The most important of these characteristics are:

1. High transmission data rate.
2. 144 Kbps with total coverage for mobile use.
3. 384 Kbps with medium coverage for pedestrian use.
4. 2 Mbps with reduced coverage area for stationary use.
5. World compatibility.
6. Compatibility of 3rd generation mobile services with second generation networks.

3G offers data rates of more than 144 Kbit/s, thereby allowing the access to multimedia uses such as video transmission, video-conferencing or high-speed internet access. 3G networks use different frequency bands than the previous networks: 1885-2025 MHz and 2110-2200 MHz.

The main 3G standard used in Europe is called **UMTS** (*Universal Mobile Telecommunications System*) and uses **WCDMA** (*Wideband Code Division Multiple Access*) encoding. UMTS technology uses 5 MHz bands for transferring voice and data, with data rates that can range from 384 Kbps to 2 Mbps. **HSDPA** (*High Speed Downlink Packet Access*) is a third generation mobile telephony protocol, (considered as "3.5G"), which is able to reach data rates on the order of 8 to 10 Mbps. HSDPA technology uses the 5 GHz frequency band and uses WCDMA encoding.

Introduction to the GSM Standard

The **GSM** (*Global System for Mobile communications*) network is at the start of the 21st century, the most commonly used mobile telephony standard in Europe. It is called as Second Generation (2G) standard because communications occur in an entirely digital mode, unlike the first generation of portable telephones. When it was first standardized in 1982, it was called as **Group Special Mobile** and later, it became an international standard called **"Global System for Mobile communications"** in 1991.

In Europe, the GSM standard uses the 900 MHz and 1800 MHz frequency bands. In the United States, however, the frequency band used is the 1900 MHz band. For this reason, portable telephones that are able to operate in both Europe and the United States are called **tri-band** while those that operate only in Europe are called **bi-band**.

The GSM standard allows a maximum throughput of 9.6 kbps which allows transmission of voice and low-volume digital data like text messages (**SMS**, for *Short Message Service*) or multimedia messages (**MMS**, for *Multimedia Message Service*).

GSM Standards:

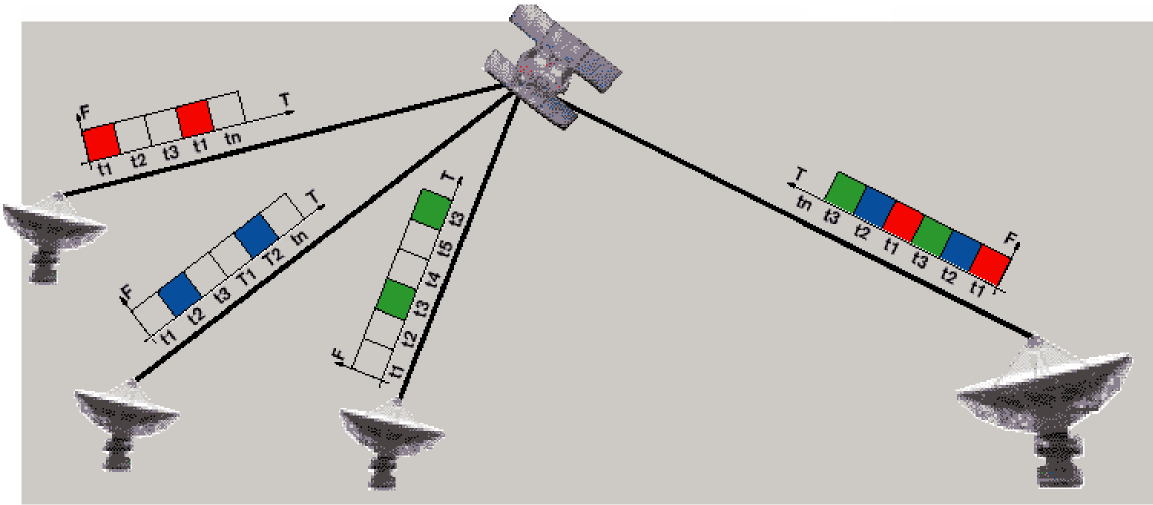
GSM uses narrowband TDMA, which allows eight simultaneous calls on the same radio frequency. There are three basic principles in multiple access, FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access). All three principles allow multiple users to share the same physical channel. But the two competing technologies differ in the way user sharing the common resource.

TDMA allows the users to share the same frequency channel by dividing the signal into different time slots. Each user takes turn in a round robin fashion for transmitting and receiving over the channel. Here, users can only transmit in their respective time slot

CDMA uses a spread spectrum technology that is it spreads the information contained in a particular signal of interest over a much greater bandwidth than the original signal. Unlike TDMA, in CDMA several users can transmit over the channel at the same time.

4.6 TDMA in brief:

In late1980's, as a search to convert the existing analog network to digital as a means to improve capacity, the cellular telecommunications industry association chose TDMA over FDMA. Time Division Multiplex Access is a type of multiplexing where two or more channels of information are transmitted over the same link by allocating a different time interval for the transmission of each channel. The most complex implementation using TDMA principle is of GSM's (Global System for Mobile communication). To reduce the effect of co-channel interference, fading and multipath, the GSM technology can use frequency hopping, where a call jumps from one channel to another channel in a short interval.



Time Division Multiple Access

Figure 4.7

TDMA systems still rely on switch to determine when to perform a handoff. Handoff occurs when a call is switched from one cell site to another while travelling. The TDMA handset constantly monitors the signals coming from other sites and reports it to the switch without caller's awareness. The switch then uses this information for making better choices for handoff at appropriate times. TDMA handset performs hard handoff, i.e., whenever the user moves from one site to another, it breaks the connection and then provides a new connection with the new site.

Advantages of TDMA:

There are lots of advantages of TDMA in cellular technologies.

1. It can easily adapt to transmission of data as well as voice communication.
2. It has an ability to carry 64 kbps to 120 Mbps of data rates. This allows the operator to do services like fax, voice band data and SMS as well as bandwidth intensive application such as multimedia and video conferencing.
3. Since TDMA technology separates users according to time, it ensures that there will be no interference from simultaneous transmissions.
4. It provides users with an extended battery life, since it transmits only portion of the time during conversations. Since the cell size grows smaller, it proves to save base station equipment, space and maintenance.

TDMA is the most cost effective technology to convert an analog system to digital.

Disadvantages of TDMA:

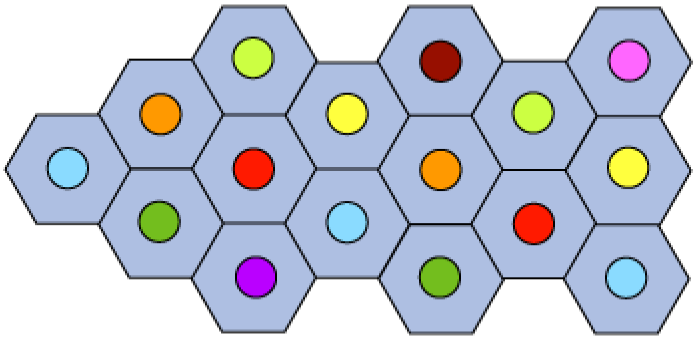
One major disadvantage using TDMA technology is that the users has a predefined time slot. When moving from one cell site to other, if all the time slots in this cell are full the user might be disconnected. Likewise, if all the time slots in the cell in which the user is currently in are already occupied, the user will not receive a dial tone.

The second problem in TDMA is that it is subjected to multipath distortion. To overcome this distortion, a time limit can be used on the system. Once the time limit is expired, the signal is ignored.

The concept of cellular network

Mobile telephone networks are based on the concept of cells, circular zones that overlap to cover a geographical area.

Figure 4.8 cellular network



Cellular networks are based on the use of a central transmitter-receiver in each cell, called a "**base station**" (or *Base Transceiver Station*, written **BTS**). The smaller the radius of a cell, the higher is the available bandwidth. So, in highly populated urban areas, there are cells with a radius of a few hundred meters, while huge cells of up to 30 kilometers provide coverage in rural areas.

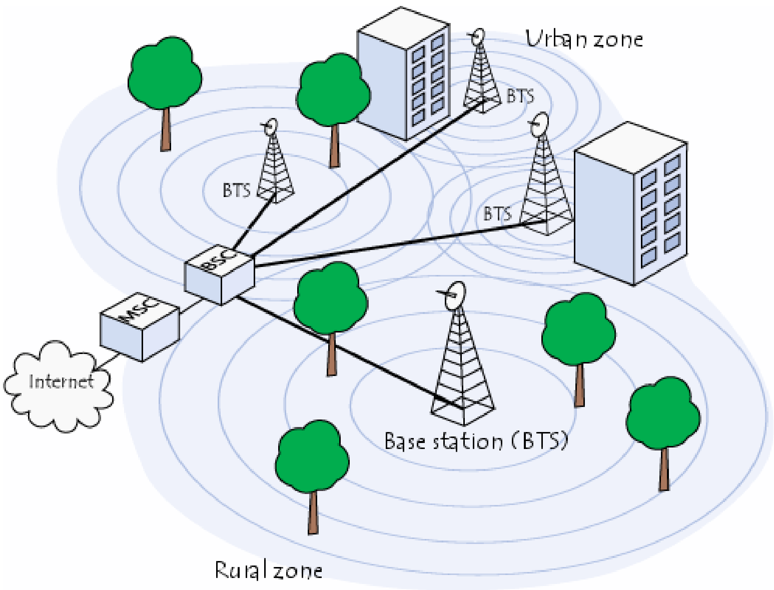
In a cellular network, each cell is surrounded by 6 neighbouring cells (thus a cell is generally drawn as a hexagon). To avoid interference, adjacent cells cannot use the same frequency. In practice, two cells using the same frequency range must be separated by a distance of two to three times the diameter of the cell.

Architecture of the GSM Network

In a GSM network, the user terminal is called a **mobile station**. A mobile station is made up of a **SIM** (*Subscriber Identity Module*) card allowing the user to be uniquely identified and a mobile terminal. The terminals (devices) are identified by a unique 15-digit identification number called **IMEI** (*International Mobile Equipment Identity*). Each SIM card also has a unique (and secret) identification number called **IMSI** (*International Mobile Subscriber Identity*). This code can be protected using a 4-digit key called a *PIN code*.

The SIM card therefore allows each user to be identified independently of the terminal used during communication with a base station. Communications occur through a radio link (air interface) between a mobile station and a base station.

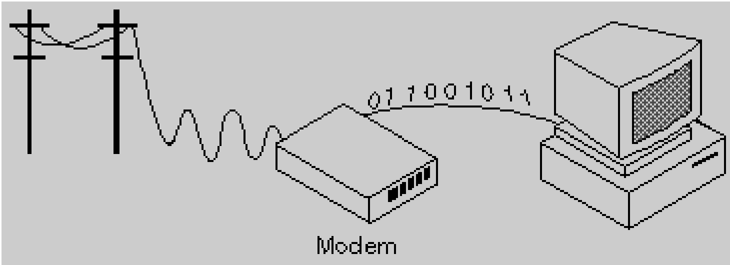
Figure 4.9 arial view



All the base stations of a cellular network are connected to a **base station controller** (**BSC**) which is responsible for managing distribution of the resources. The system consisting of the base station controller and its connected base stations is called the **Base Station Subsystem** (**BSS**).

Introduction to Modem:

Figure 4.10 modem



- **Bps:** How fast the modem can transmit and receive data. At slow rates, modems are measured in terms of baud rates. The slowest rate is 300 baud (about 25 cps). At higher speeds, modems are measured in terms of bits per second (bps). The fastest modems run at 57,600 bps, although they can achieve even higher data transfer rates by compressing the data. Obviously, the faster the transmission rate, the faster the data can be sent and received. It should be noted that the data cannot be received at a faster rate than it is being sent.
- **Auto-answer:** An auto-answer modem enables the computer to receive calls in the absence of the operator.
- **Data compression:** Some modems perform data compression, which enables them to send data at faster rates. However, the modem at the receiving end must be able to decompress the data using the same compression technique.
- **Flash memory:** Some modems come with *flash memory* rather than conventional ROM which means that the communications protocols can be easily updated if necessary.
- **Fax capability:** Most modern modems are fax modems, which mean that they can send and receive faxes.

4.7 GSM Modem:

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

Figure 4.11

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

A SIM card contains the following information:

- Subscriber telephone number (MSISDN)
- International subscriber number (**IMSI, International Mobile Subscriber Identity)**
- State of the SIM card
- Service code (operator)
- Authentication key
- PIN (***Personal Identification Code***)
- PUK (***Personal Unlock Code***)

Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. In addition to the standard AT commands, GSM modems support an extended set of AT commands.

These extended AT commands are defined in the GSM standards. With the extended AT commands, the following operations can be performed:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

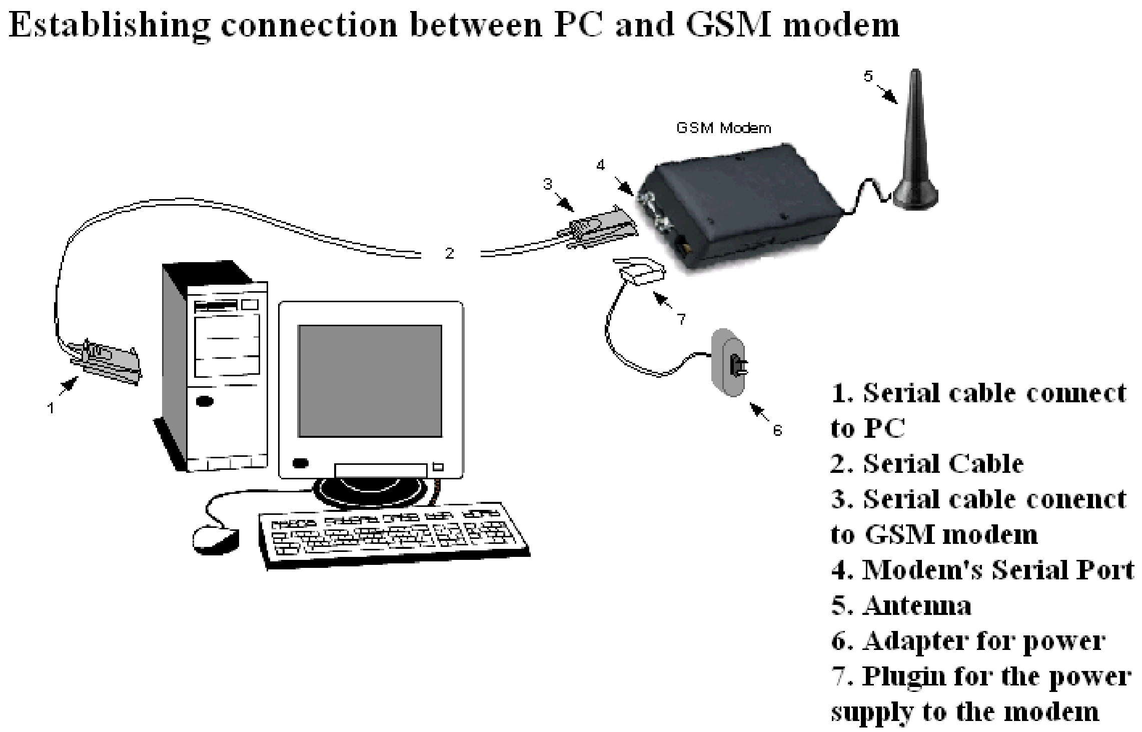


Figure 4.12

The number of SMS messages that can be processed by a GSM modem per minute is very low i.e., about 6 to 10 SMS messages per minute.

CHAPTER 5
RESULT:

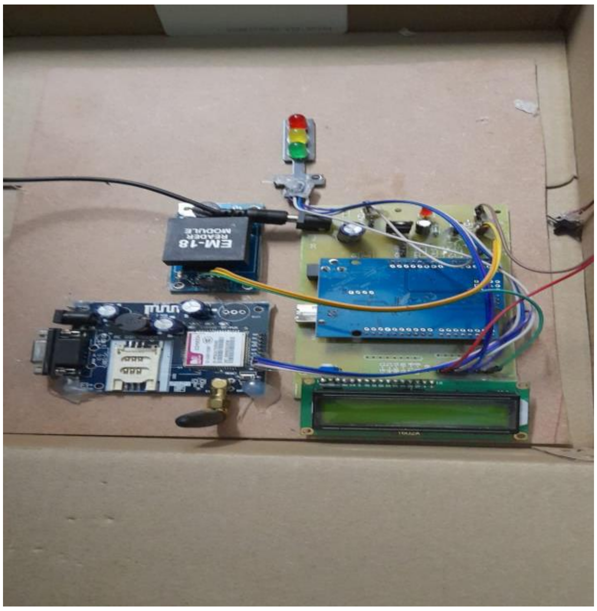


Fig:5.1: traffic sign identification and violation monitoring **fig: 5.2: RFID tag cards**

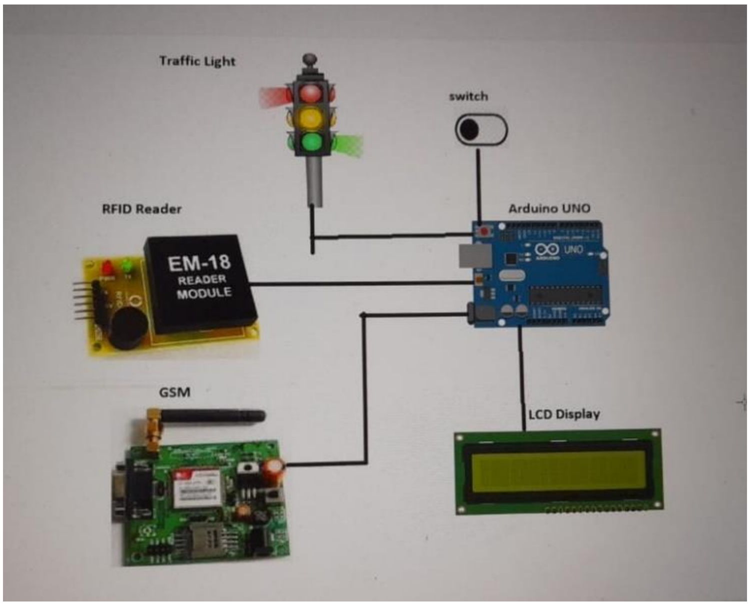


Fig:5.3: circuit connections

The components like lcd displays, rfid reader, traffic lights and finally switch is connected to Arduino UNO. All those connections are showed in above figure 5.3. when we switch on the plug it shows it is in normal mode. All three signals will on.

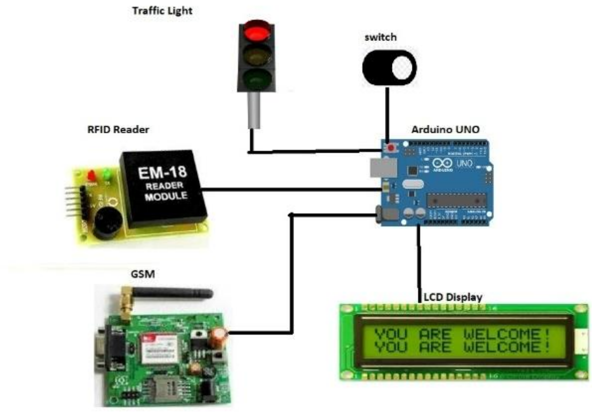


Fig5.4: activation mode

After switch on the activated mode the lcd display shows YOU ARE WELCOME message as shown in the figure.

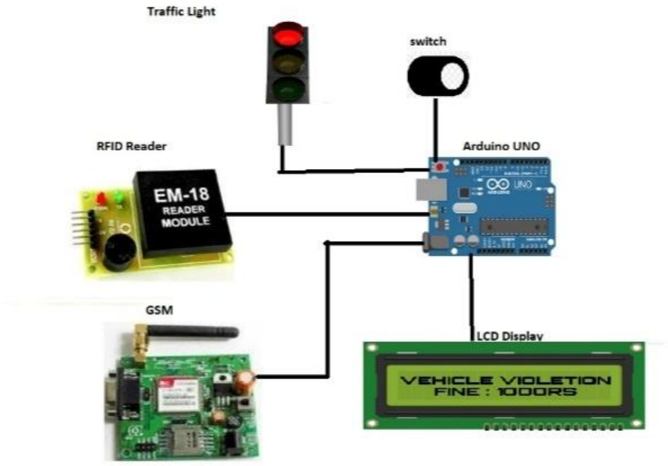


Fig 5.5 violation mode

In activation mode any vehicle jumps or violate the traffic rules then automatically the rfid tag reader detect the vehicle and it sends message to the use by the help of GSM. Mean while we can observe the lcd screen that displays vehicle violation and fine 1000RS.

CHAPTER 6
CONCLUSION:

We have proposed a system for automatic detection and penalty management of signal violation which will in turn help to decrease the number of accidents. The system also analyzes the traffic flow on a given road at a given time according to the circumstances of the road. The proposed architecture is portable, accurate and can be installed at a reasonable cost. The system alleviates the need for traffic police at every signal to manually identify the violations. The system shows promising results on automatic detection, since the detection of the tag identification is more precise, reliable and efficient in active RFID, leading to implement corrective actions. The experiments are done using four test vehicles. The frequency of RFID reader is 125 Hz and the range of the RFID reader is 1 meter. In real time environment, if the average road lane is 3.5m, then approximately two 125 Hz readers are required for one road lane. Many vehicles may be moving nearby and possibly blocking or attenuating some of the RFID signals, especially with large vehicles like trucks. A possible solution is the use of RFID readers of higher frequency range since their reading range is high.

References

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SOURCE CODE

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(13,12,11,10,9,8);

#include <SoftwareSerial.h>

SoftwareSerial mySerial(2,3);  // rx tx

int red = 4;

int yellow = 5;

int green = 6;

int sw = 7;

char res[130];

char buff[130];

void serialFlush();

void serialFlush(){

  while(Serial.available() > 0) {

    char t = Serial.read();

  }

}


void sendmsg(char *num,char *msg)

{
```

```
  mySerial.print("AT+CMGS=\"");

  mySerial.print(num);

  mySerial.println("\"");

  delay(2000);

  mySerial.println(msg);

  delay(1000);

  mySerial.write(0x1a);

  delay(2000);

}

char number[15] = "9542364563\0";

char number1[15] = "8639710275\0";

void setup() {

  pinMode(sw,INPUT_PULLUP);

  pinMode(red,OUTPUT);

  pinMode(yellow,OUTPUT);

  pinMode(green,OUTPUT);

  digitalWrite(red,LOW);

  digitalWrite(yellow,LOW);

  digitalWrite(green,LOW);

delay(1000);
```

```
digitalWrite(red,HIGH);digitalWrite(yellow,LOW);digitalWrite(green,LOW);delay(5
00);

digitalWrite(red,LOW);digitalWrite(yellow,HIGH);digitalWrite(green,LOW);delay(5
00);

digitalWrite(red,LOW);digitalWrite(yellow,LOW);digitalWrite(green,HIGH);delay(5
00);

  Serial.begin(9600);

   mySerial.begin(9600);

  lcd.begin(16,2);

  lcd.clear();lcd.setCursor(0, 0);lcd.print("WELCOME");

   mySerial.println("AT");  delay(500);

  mySerial.println("ATE0");  delay(500);

  mySerial.println("AT+CMGF=1");  delay(500);

  mySerial.println("AT+CNMI=1,2,0,0");  delay(500);

  mySerial.println("AT+CSMP=17,167,0,16");  delay(1000);

                        sendmsg(number,"Welcome");
sendmsg(number1,"Welcome");delay(1000);

  lcd.clear();lcd.setCursor(0, 0);lcd.print("WELCOME TRFIC SGNL");

 delay(500);

}
```

```
 unsigned int dist1 = 0,sr1=0;

 unsigned char rfid[15];

void loop()

{

  int sd = digitalRead(sw);

    lcd.clear();

    lcd.setCursor(0, 0);lcd.print("WELCOME TRFIC SGNL");

       lcd.setCursor(0,1);lcd.print("S:");lcd.print(sd);


//digitalWrite(red,LOW);digitalWrite(yellow,LOW);digitalWrite(green,LOW);delay(
100);
//digitalWrite(red,LOW);digitalWrite(yellow,HIGH);digitalWrite(green,LOW);delay(
500);

  if(sd == HIGH)

  {

     lcd.setCursor(5, 1);lcd.print("RED ON");

     digitalWrite(red,HIGH);digitalWrite(yellow,LOW);digitalWrite(green,LOW);

   delay(500);

    if(Serial.available())

    {

              for(int k=0;k<12;k++)

              {

                while(!Serial.available());
```

```
    rfid[k] = Serial.read();

    Serial.print(rfid[k]);

   }

  if(strncmp(rfid,"4B00C9ABA38A",12)==0 && sd == HIGH)

    {

     lcd.clear(); lcd.setCursor(0,0);lcd.print("Voilation Detected");

   lcd.setCursor(0,1);lcd.print("Vechile1 F:1000/-");

          sendmsg(number,"signal jump voilation fine RS/-1000");

//  sendmsg1(number1,"HIGH Temperature");

     delay(1000);

       }


   if(strncmp(rfid,"4C002122C887",12)==0 && sd == HIGH)

    {

     lcd.clear(); lcd.setCursor(0,0);lcd.print("Voilation Detected");

    lcd.setCursor(0,1);lcd.print("Vechile2 F:1000/-");

    sendmsg(number1,"signal jump voilation fine RS/-1000");

     delay(1000);

       }

 }
```

```
}
if(sd==LOW){
 lcd.setCursor(5, 1);lcd.print("NORMAL");

digitalWrite(red,HIGH);digitalWrite(yellow,LOW);digitalWrite(green,LOW);delay(500);

digitalWrite(red,LOW);digitalWrite(yellow,HIGH);digitalWrite(green,LOW);delay(500);

digitalWrite(red,LOW);digitalWrite(yellow,LOW);digitalWrite(green,HIGH);delay(500);
}
}
```