Chapter One

Introduction

1.1 Preface

Reduction in the amount of energy consumed in a process or system, or by an organization or society, through economy, elimination of waste, and rational use. Power consumption become one of the problems in Sudan due to the high rate of Kw that vary in price depending on the usage, in universities and educational institutes the consumption of power become a problem due to the high power usage daily within the working hours or on the break time , that affect the overall budget. Energy monitoring and targeting (M and T) is an energy efficiency technique based on the standard management axiom stating that “you cannot manage what you cannot measure”. M and T techniques provide energy managers with feedback on operating practices, results of energy management projects, and guidance on the level of energy use that is expected in a certain period. Importantly, they also give early warning of unexpected excess consumption caused by equipment malfunctions, operator error, unwanted user behaviors, lack of effective maintenance and the like.

Power measurement is the first step to compile the data from the different meters. Low-cost energy feedback displays have become available. The frequency at which the data is compiled varies according to the desired reporting interval. Some measurements can be taken directly from the meters, others must be calculated. These different measurements are often called streams or channels. Driving factors such as production or degree days also constitute streams and must be collected at intervals to match. The next step is to monitor the difference between the expected consumption and the actual measured consumption. One of the tools most commonly used for this is the cumulative sum control chart (CUSUM), which is the CU mutative SUM of differences.

This consists in first calculating the difference between the expected and actual performances (the best fit line previously identified and the points themselves). The CUSUM can then be plotted against time on a new graph, which then yields more information for the energy efficiency specialist. Variances scattered around zero usually mean that the process is operating normally. Marked variations, increasing or decreasing steadily usually reflect a modification in the conditions of the process. Setting targets once the base line has been established, and causes for variations in energy consumption have been identified, it is time to set targets for the future. Now with all this information in hand, the targets are more realistic, as they are based on the building's actual consumption. Targeting consists in two main parts: the measure to which the consumption can be reduced, and the timeframe during which the compression will be achieved. A good initial target is the best fit line identified during step two. This line represents the average historical performance. Therefore, keeping all consumption below or equal to the historical average is an achievable target, yet remains a challenge as it involves eliminating high consumption peaks. Some companies, as they improve their energy consumption, might even decide to bring their average performance down to their historical best. This is considered a much more challenging target. Monitoring results this brings us back to step one: measure consumption. One of the specificities of M and T is that it is an ongoing process, requiring constant feedback in order to consistently improve performance. Once the targets are set and the desired measures are implemented, repeating the procedure from the start ensures that the managers are aware of the success or failure of the measures, and can then decide on further action [1].

1.2 Problem Statement

Power consumption is high in the lecture room and it usually works the whole day.

1.3 Objectives

The main objectives of this thesis are listed as:

1. To understand the radio frequency identification.
2. To study main component to build piratical circuit as microcontroller, uln2804, voltage regulator and crystal oscillator.
3. To know about amplitude shift keying.
4. To understand transmitter and receiver circuits.
5. To evaluate the performance of the practical system.

1.4 Methodology

1. Simulate the power saving system for lecture room using code vision AVR software.
2. Build the transmitter and receiver circuits.
3. Evaluate the performance of power saving system based on practical result.

1.5 Thesis Layout

The thesis consists of five chapters. The each chapter explained as:

Chapter one includes preface, problem statement,objectives and methodology.

Chapter two present background of radio frequency identification. The main component of the practical circuit is discussed such as microcontroller, uln2804, voltage regulator and liquid crystal display (LCD). Finally, the theory of amplitude shift keying is introduced.

Chapter three the main circuit implementation of power saving system is addressed. The transmitter and receiver circuit diagrams using proteous software are presented. Finally the Atmel AVR is discussed.

Chapter four the practical result is presented. The practical results show that the performance of power saving system is good.

Chapter five includes conclusion and recommendations.

Chapter Two

Literature Review

2.1 Radio Frequency Identification

Radio-frequency identification is the use of a wireless non-contact system that uses radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. Some tags require no battery and are powered by the electromagnetic fields used to read them. Others use a local power source and emit radio waves (electromagnetic radiation at radio frequencies). The tag contains electronically stored information which can be read from up to several meters (yards) away. Unlike a bar code, the tag does not need to be within line of sight of the reader and may be embedded in the tracked object.

RFID tags are used in many industries. An RFID tag attached to an automobile during production can be used to track its progress through the assembly line. Pharmaceuticals can be tracked through warehouses. Livestock and pets may have tags injected, allowing positive identification of the animal. Since RFID tags can be attached to clothing, possessions, or even implanted within people, the possibility of reading personally linked information without consent has raised privacy concerns [2].

2.1.1 Design of RFID

A radio-frequency identification system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response. The readers generally transmit their observations to a computer system running RFID software or RFID middleware.

The tag's information is stored electronically in a non-volatile memory. The RFID tag includes a small Radio Frequency (RF) transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. RFID tags can be either passive, active or battery assisted passive. An active tag has an on-board battery and periodically transmits it is identify signal. A Battery Assisted Passive (BAP) has a small battery on board and is activated when in the presence of a RFID reader. A passive tag is cheaper and smaller because it has no battery. Instead, the tag uses the radio energy transmitted by the reader as its energy source. The interrogator must be close for RF field to be strong enough to transfer sufficient power to the tag. Since tags have individual serial numbers, the RFID system design can discriminate several tags that might be within the range of the RFID reader and read them simultaneously. Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write- once, read-multiple; blank tags may be written with an electronic product code by the user [2].

RFID tags contain at least two parts: an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency signal, collecting Direct Current (DC) power from the incident reader signal, and other specialized functions; and an antenna for receiving and transmitting the signal. Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles.

Signaling between the reader and the tag is done in several different incompatible ways, depending on the frequency band used by the tag. Tags operating on low frequency and high frequencies are, in terms of radio wavelength, very close to the reader antenna, only a small percentage of a wavelength away. In this near field region, the tag is closely coupled electrically with the transmitter in the reader. The tag can modulate the field produced by the reader by changing the electrical loading the tag represents. By switching between lower and higher relative loads, the tag produces a change that the reader can detect. At ultra-higher frequencies, the tag is more than one radio wavelength away from the reader, requiring a different approach. The tag can backscatter a signal. Active tags may contain functionally separated transmitters and receivers, and the tag need not respond on a frequency related to the reader's interrogation signal [3]. Figure 2.1 shows the electronic product code type 1:96 bit.

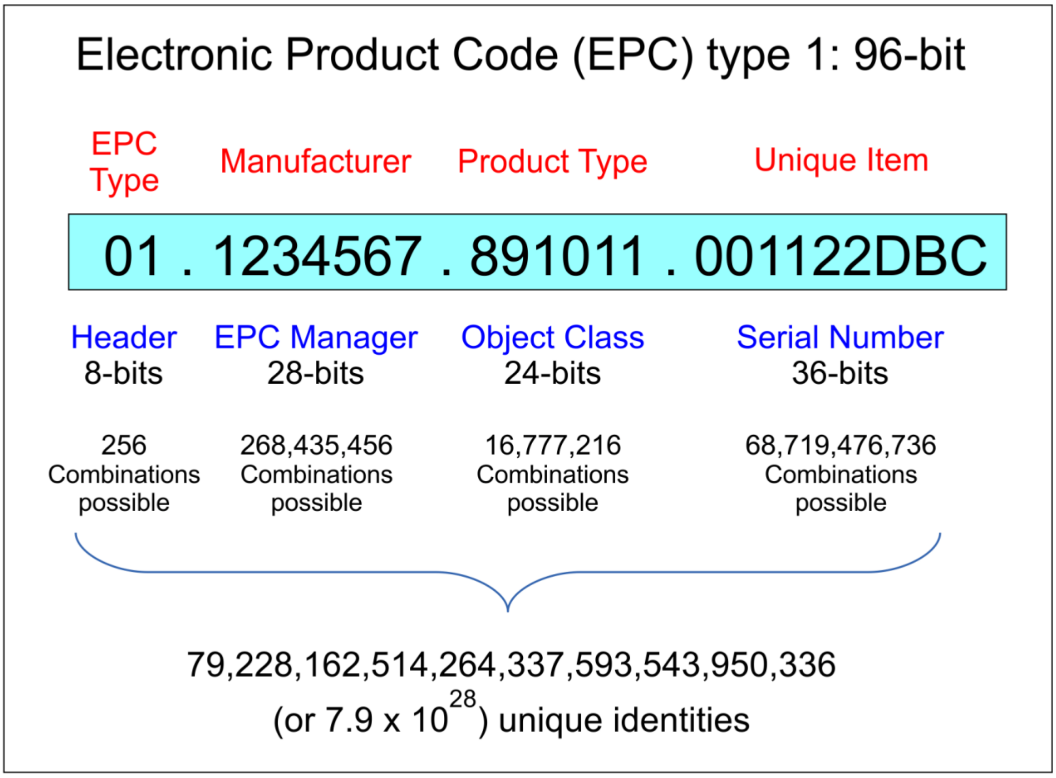

Figure 2.1: Electronic product code

An Electronic Product Code (EPC) is one common type of data stored in a tag. When written into the tag by an RFID printer, the tag contains a 96-bit string of data. The first eight bits are a header which identifies the version of the protocol. The next 28 bits identify the organization that manages the data for this tag; the organization number is assigned by the electronic product code Global consortium. The next 24 bits are an object class, identifying the kind of product; the last 36 bits are a unique serial number for a particular tag. These last two fields are set by the organization that issued the tag. Rather like a URL, the total electronic product code number can be used as a key into a global database to uniquely identify a particular product [3].

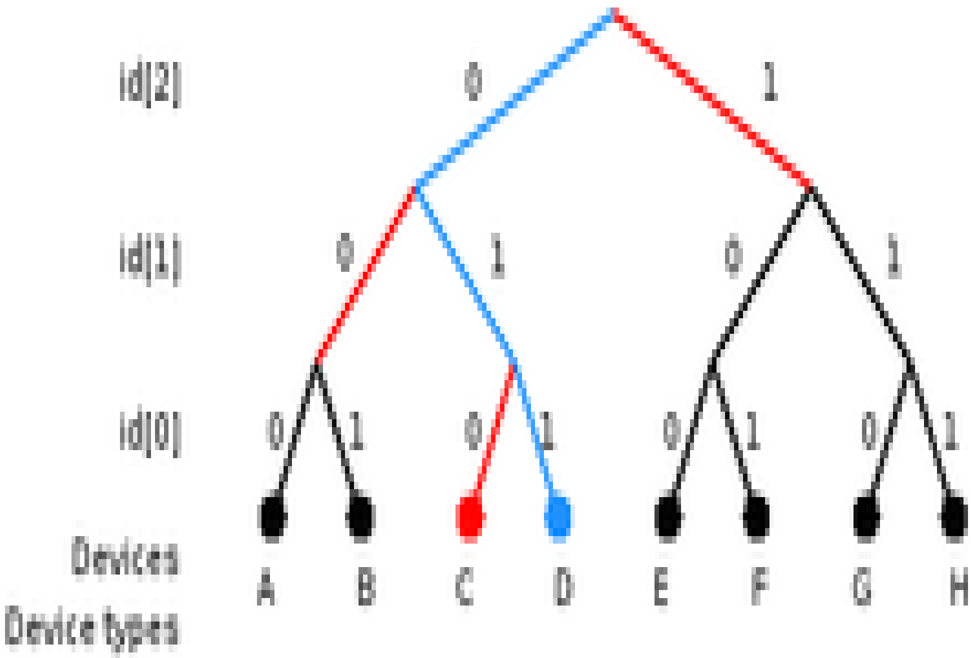

Figure 2.2: Tree Binary Method of Identifying an RFID tag

Often more than one tag will respond to a tag reader, for example, many individual products with tags may be shipped in a common box or on a common pallet. Collision detection is important to allow reading of data. Two different types of protocols are used to "singulate" a particular tag, allowing its data to be read in the midst of many similar tags. In a slotted Aloha system, the reader broadcasts an initialization command and a parameter that the tags individually use to pseudo-randomly delay their responses. Figure 2.2 shows the electronic product code based on binary tree protocol. The reader sends an initialization symbol and then transmits one bit of ID data at a time; only tags with matching bits respond, and eventually only one tag matches the complete ID string [4]. Both methods have drawbacks when used with many tags or with multiple overlapping readers

2.1.2 Uses of RFID

RFID can be used in a variety of applications such as [5, 7]:

- Access management.
- Tracking of goods.
- Tracking of persons and animals.
- Toll collection and contactless payment.
- Machine readable travel documents.
- Smart dust (for massively distributed sensor networks).
- Tracking sports memorabilia to verify authenticity.
- Airport baggage tracking logistics.

2.1.3 RFID working mechanism

Long checkout lines at the grocery store are one of the biggest complaints about the shopping experience. Soon, these lines could disappear when the ubiquitous Universal Product Code (UPC) bar code is replaced by smart labels, also called RFID tags. RFID tags are intelligent bar codes that can talk to a networked system to track every product that you put in your shopping cart. Imagine going to the grocery store, filling up your cart and walking right out the door. No longer will you have to wait as someone rings up each item in your cart one at a time. Instead, these RFID tags will communicate with an electronic reader that will detect every item in the cart and ring each up almost instantly. The reader will be connected to a large network that will send information on your products to the retailer and product manufacturers. Your bank will then be notified and the amount of the bill will be deducted from your account. No lines, no waiting. RFID tags, a technology once limited to tracking cattle, are tracking consumer products worldwide. Many manufacturers use the tags to track the location of each product they make from the time it is made until it is pulled off the shelf and tossed in a shopping cart. Figure 2.3 shows the RFID used to tracking luggage.

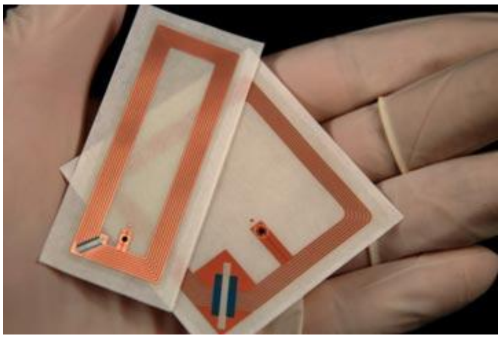

Figure 2.3: RFID tags used for tracking luggage

Outside the realm of retail merchandise, RFID tags are tracking vehicles, airline passengers, Alzheimer's patients and pets. Soon, they may even track your preference for chunky or creamy peanut butter. Some critics say RFID technology is becoming too much a part of our lives that is, if we're even aware of all the parts of our lives that it affects.

2.2 Active, Semi-passive and Passive RFID Tags

Active, semi-passive and passive RFID tags are making RFID technology more accessible and prominent in our world. These tags are less expensive to produce, and they can be made small enough to fit on almost any product. Active and semi-passive RFID tags use internal batteries to power their circuits. An active tag also uses its battery to broadcast radio waves to a reader, whereas a semi-passive tag relies on the reader to supply its power for broadcasting. Because these tags contain more hardware than passive RFID tags, they are more expensive. Active and semi-passive tags are reserved for costly items that are read over greater distances they broadcast high frequencies from 850 to 950 MHz that can be read 100 feet (30.5 meters) or more away. If it is necessary to read the tags from even farther away, additional batteries can boost a tag's range to over 300 feet (100 meters).

Like other wireless devices, RFID tags broadcast over a portion of the electromagnetic spectrum. The exact frequency is variable and can be chosen to avoid interference with other electronics or among RFID tags and readers in the form of tag interference or reader interference**.** RFID systems can use a cellular system called Time Division Multiple Access (TDMA) to make sure the wireless communication is handled properly. Passive RFID tags rely entirely on the reader as their power source. These tags are read up to 20 feet (six meters) away, and they have lower production costs, meaning that they can be applied to less expensive merchandise. These tags are manufactured to be disposable, along with the disposable consumer goods on which they are placed. Whereas a railway car would have an active RFID tag, a bottle of shampoo would have a passive tag. Another factor that influences the cost of RFID tags is data storage. There are three storage types: read-write, read-only and Write Once, Read Many (WORM). A read-write tag's data can be added to or overwritten. Read-only tags cannot be added to or overwritten they contain only the data that is stored in them when they were made. WORM tags can have additional data (like another serial number) added once, but they cannot be overwritten. Most passive RFID tags cost between seven and 20 cents U.S. each. Active and semi-passive tags are more expensive, and RFID manufacturers typically do not quote prices for these tags without first determining their range, storage type and quantity. The RFID industry's goal is to get the cost of a passive RFID tag down to five cents each once more merchandisers adopt it [2].

2.2.1 Advantages

- An RFID smart card-based fare collection system may reduce operation costs in the long run.

- Public transportation authorities will be able to monitor ridership in real-time and will minimize delays by committing extra resources (buses or trains) to specific congested routes.

- RFID does not require line of sight. The reader can communicate with the tag via radio waves. An individual can potentially be identified and charged the right fare by simply carrying the RFID smart-card in his/her pocket.

- RFID equipment damage occurs much less frequently than is the case with magnetic strips or bar codes present on Charlie Tickets.

- The combination of all above mentioned advantages will result in improved convenience and boost public transportation ridership.

2.2.2 Disadvantages

- In the short run, costs of diffusion and implementation for an RFID smart card-based fare collection system can be rather high.

- An RFID-based fare collection system has the potential of seriously invading people's privacy. Check out the potential misurs section of the site to obtain specific examples of this threat.

- RFID technology ultimately involves software that allows each user to be identified by a central database. This infrastructure will certainly be under attack by hackers. Check out the potential misuses section of the site to obtain specific examples of this threat.

- Poor read rate can occur if the reader and receiver are not properly aligned.
- In cases when multiple tags and readers are at work simultaneously, double charges may occur.

2.3 RFID Security

Information collected by readers and passed to the RFID application may have already been tampered with, changed or stolen by unauthorized persons. An RFID reader can also be a target for viruses. In 2006, researchers demonstrated that an RFID virus was possible. A proof-of-concept self-replicating RFID virus was written to demonstrate that a virus could use RFID tags to compromise backend RFID middleware systems via an SQL injection attack. As RFID is increasingly being used in the retailing and manufacturing sectors, the widespread item-level RFID tagging of products such as clothing and electronics raises public concerns regarding personal privacy. People are concerned about how their data is being used, whether they are subject to more direct marketing, or whether they can be physically tracked by RFID chips. If personal identities can be linked to a unique RFID tag, individuals could be profiled and tracked without their knowledge or consent. For instance, washing clothes tagged with RFID does not remove the chips, since they are specially designed to withstand years of wear and tear. It is possible that everything an individual buys and owns is identified, numbered and tracked, even when the individual leaves the store, as far as products are embedded with RFID tags. RFID readers can detect the presence of these RFID tags wherever they are close enough to receive a signal.

Since RFID remains an emerging technology, the development of industry standards for protecting information stored on RFID chips is still being explored and strengthened. Research into the development and adaptation of efficient hardware for cryptographic functions, symmetric encryption, and message authentication codes and random number generators will improve RFID security. In addition, advances in RFID circuit design and manufacturing technology can also lower development costs releasing more resources in tags that can be used for other functions, such as allocating power consumption towards security features. Today, certain public key technologies are also being studied and in some cases deployed by RFID vendors. This helps improve confidentiality, user authentication and privacy of RFID tags and associated applications. RFID vendors are also conducting research into integrity and confidentiality issues around RFID reader infrastructure. Data can now be stored on a token using dynamic re-keying, where specific readers can rewrite a token's credentials/signature, and verify the token's identity. However, the cost and performance issues around using public key technologies in RFID applications have stalled its use for critical security applications [7].

2.4 Block Diagram

The following block diagram illustrate the proposed system that is consist of a transmitter circuit and receiver circuit, in the transmitter circuit a microcontroller was used to read room RFID reader the unique number of the TAG (RFID card) an authentication procedure will be done inside the microcontroller program and the number of detected tag will be displayed on the alphanumeric LCD, moreover through the transmitter parts (encoder and transmitter module) the authentication result will be send to the receiver circuit. Figure 2.4 shows transmitter block diagram.

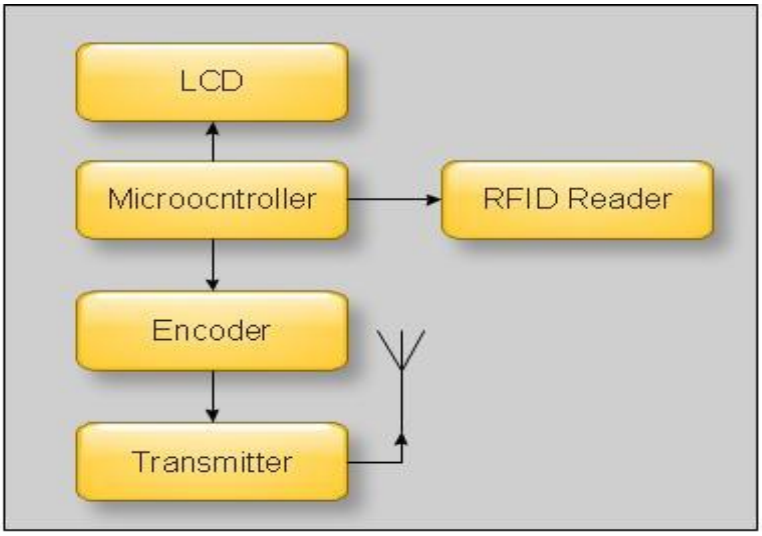

Figure 2.4: Transmitter block diagram

The receiver block diagram consists of many parts as shown in Figure 2.5. The microcontroller in the receiver circuit receive the authentication and prepare the execute subroutine program to switch on the device and start the timer inside the microcontroller.

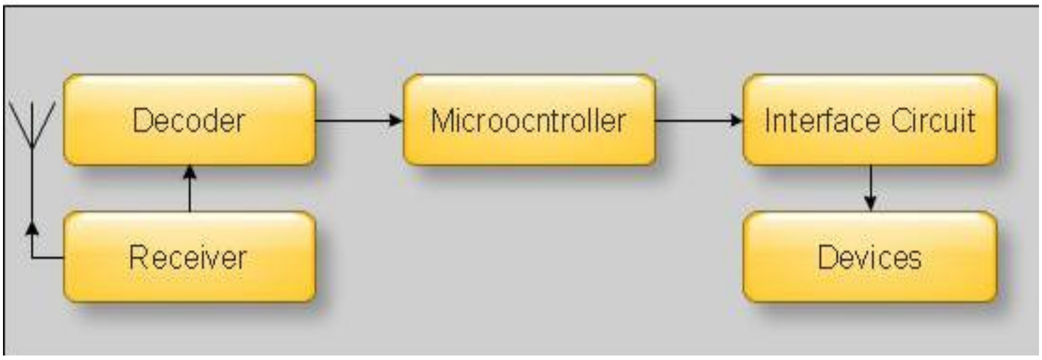

Figure 2.5: Receiver block diagram

2.5 Recruitments and Components

The practical circuit consists of many components as follows:

2.5.1 Microcontrollers

A microcontroller (also MCU or µC) is a functional computer system-on-a-chip. It contains a processor core, memory, and programmable input/output peripherals. Microcontrollers include an integrated Central Process Unit (CPU), memory a small amount of Random Access Memory (RAM), program memory, or both and peripherals capable of input and output. Figure2.6 shows the microcontroller architecture.

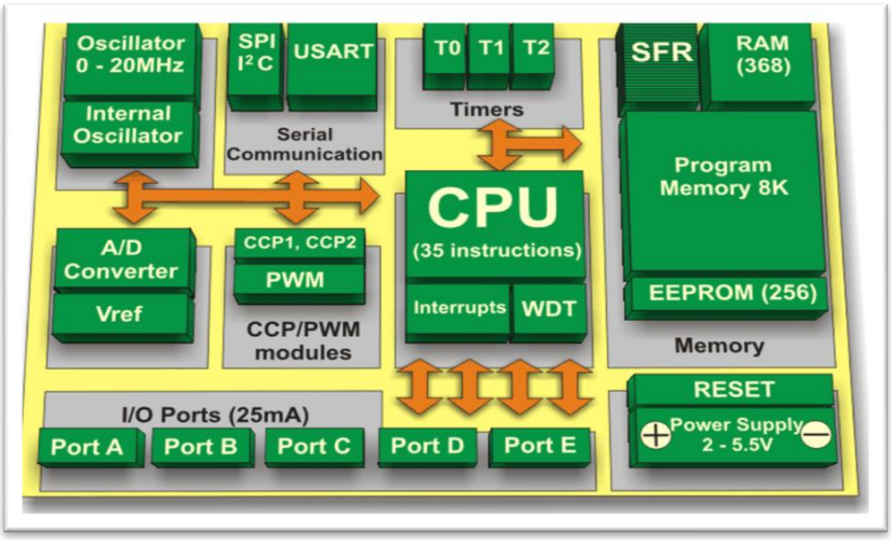

Figure 2.6: Microcontroller architecture

It emphasizes high integration, in contrast to a microprocessor which only contains a CPU. In addition to the usual arithmetic and logic elements of a general purpose microprocessor, the microcontroller integrates additional elements such as read-write memory for data storage, read-only memory for program storage, Flash memory for permanent data storage, peripherals, and input/output interfaces. At clock speeds of as little as 32 KHz, microcontrollers often operate at very low speed compared to microprocessors, but this is adequate for typical applications. They consume relatively little power (mill watts or even microwatts), and will generally have the ability to retain functionality while waiting for an event such as a button press or interrupt. Power consumption while sleeping (CPU clock and peripherals disabled) may be just Nano watts, making them ideal for low power and long lasting battery applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size, cost, and power consumption compared to a design using a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to electronically control many more processes [8, 9].

2.5.2 Programs

Microcontroller programs must fit in the available on-chip program memory, since it would be costly to provide a system with external, expandable, memory. Compilers and assembly language are used to turn high-level language programs into a compact machine code for storage in the microcontroller's memory. Depending on the device, the program memory may be permanent, read-only memory that can only be programmed at the factory, or program memory may be field-alterable flash or erasable read-only memory [8].

2.5.3 RFID reader

The RFID module SL025M supports tags mifare 1K, mifare 4K, and mifare ultra light and has an auto detection tag feature and it was designed with built in antenna. The module support TTL UART communication with a baud rate 9600 to 115,200 bit per second, and has a wide supply range from 4.4 to 12 volt moreover the distance of accurate reading is 70mm [4]. Figure 2.7 shows the RFID reader module.

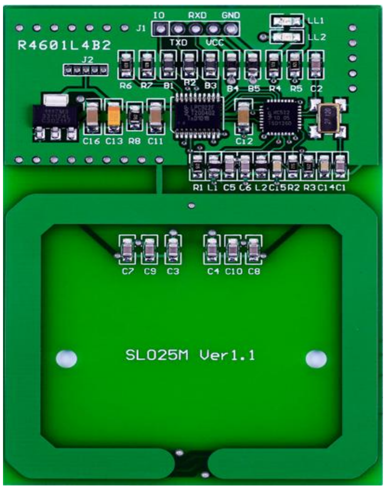

Figure 2.7: RFID reader modules

2.5.4 Capacitor

Just like the resistor, the capacitor, sometimes referred to as a condenser, is a simple passive device that is used to "store electricity". The capacitor is a component which has the ability or "capacity" to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery. There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitors, but they all do the same thing, they store charge. In its basic form, a Capacitor consists of two or more parallel conductive (metal) plates which are not connected or touching each other, but is electrically separated either by air or by some form of a good insulating material such as waxed paper, mica, ceramic, plastic or some form of a liquid gel as used in electrolytic capacitors. The insulating layer between capacitors plates is commonly called the Dielectric. Figure 2.8 shows the electrolyte capacitor.

Figure 2.8: Electrolyte capacitor

2.5.5 Relay

A relay is an electrically operated switch. Many relays use an electromagnetic to mechanically operate a switch, but other operating principles are also used, such as soli-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. Figure 2.9 shows the relay device structure.

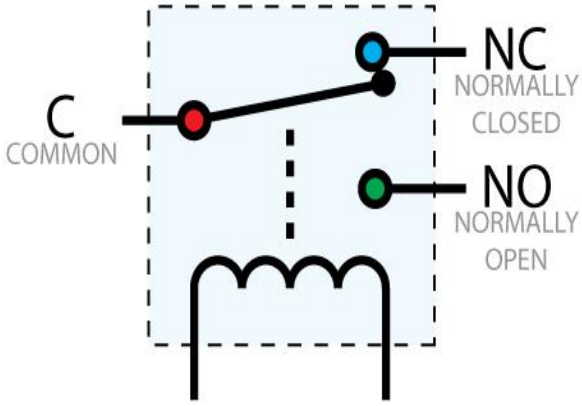

Figure 2.9: Relay device structure

2.5.6 ULN2804

The ULN2804 is a high voltage, high current darlington array comprised of eight NPN darlington pairs. The device features open-collector outputs with suppression diodes for inductive loads and is ideally suited for interfacing between low-level logic circuitry and high power loads. Typical loads including relays DC motors, filament lamps, Light Emitted Diode (LED) displays, printer hammers and high power buffers as show in Figure 2.10. Features of ULN 2804 as:

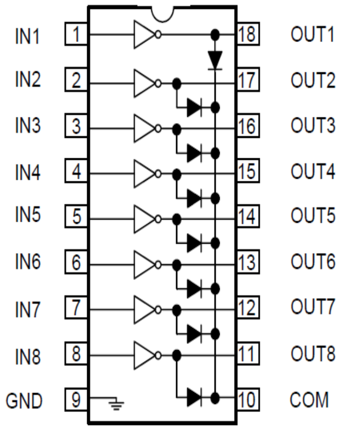

Figure 2.10: Current amplifier integrated circuit (ULN2804)

- Eight darlington with common emitters.
- TTL, PMOS or CMOS compatible inputs.
- Peak output current to 500mA.
- Output voltage to 50V.
- Clamp diodes for transient suppression.

2.5.7 Voltage regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. Figure2.11 shows the voltage regulator.

Figure 2.11: Voltage regulator

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

2.5.8 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. Thus, the ratio of the voltage applied across a resistor's terminals to the intensity of current through the circuit is called resistance. Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

Practical resistors have a series inductance and a small parallel capacitance; these specifications can be important in high-frequency applications. In a low-noise amplifier or pre-amp, the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology. A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and the position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.

2.5.9 Crystal oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits designed around them became known as crystal oscillators. Figure 2.12 shows the crystal oscillator.

Figure 2.12: crystal oscillators

Quartz crystals are manufactured for frequencies from a few tens of kilohertz to tens of megahertz. More than two billion crystals are manufactured annually. Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cell phones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.

2.5.10 Amplitude shift keying

The Amplitude Shift Keying is a technique of digital modulation it vary in amplitude to the maximum whenever digital one input detected and it goes to minimum amplitude whenever the logic 0 detected. Figure 2.13 shows ASK carrier signal**.**

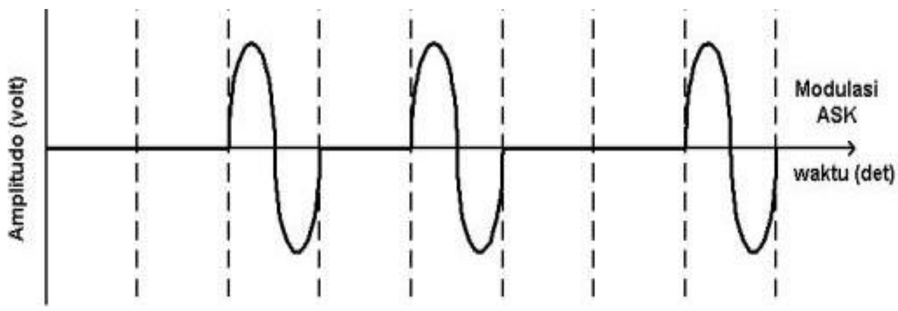

Figure 2.13: ASK carrier signal

The ASK modulator and demodulator is a small device consists of modulation circuit and demodulation circuit with the techniques of digital modulation and ASK modulation type and it is used to transmit and receive a digital data from transmitter to the receiver. Figure 2.14 shows the decoder.

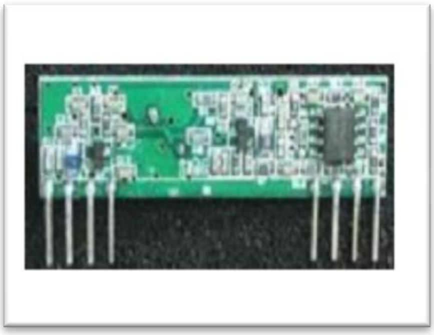

Figure 2.14: Demodulator

- An effective low cost solution for using at 315/433.92 MHZ.
- The circuit shape of ST-RX02-ASK is L/C.
- Receiver Frequency: 315 / 433.92 MHZ
- Typical sensitivity: -105dBm
- Supply Current: 3.5mA
- IF Frequency:1MHz (see appendix F)

The ST-TX01-ASK is an ASK hybrid transmitter module show in Figure2.15. The ASK Modulator.

Figure 2.15: ASK Modulator

ST-TX01-ASK are designed by the Saw Resonator, with an Effective low cost, small size, and simple-to-use for designing. Frequency Range 315 / 433.92 MHZ, Supply Voltage: 3~12V.Circuit Shape: Saw (see appendix G)

2.5.11 Encoders and encoders working mechanism

The radio frequency spectrum is filled with noise and other signals, especially those frequencies where unlicensed transmitter operation under FCC part 15 rules is allowed. When using a wireless remote control system it is desirable to have a way of filtering out or ignoring those unwanted signals to prevent false data from being received. One way to accomplish this is to use microprocessors at the transmitter and receiver that are programmed with error detection and correction algorithms something like those used in modems. A much simpler way is to use an encoder IC at the transmitter and a decoder IC at the receiver. These ICs automatically generate and decode multiple serial codes that must match before data is accepted as valid.

In the early days of ”radio control", before these coding ICs were available, radio controlled garage doors sometimes opened themselves when they received transmissions from a plane passing overhead or a two-way radio operating in the area. Encoding and decoding is now used in most wireless control systems to prevent this type of interference and to provide security.

The 2^{12} encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12 N data bits. Each address/ data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E further enhances the application flexibility of the 2^{12} series of encoders. Figure2.16 shows the Encoder HT12E.

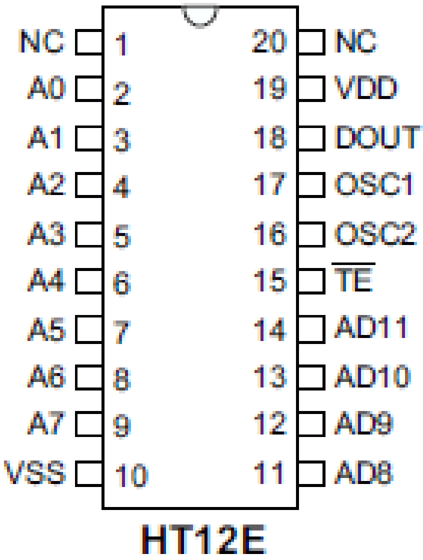

Figure 2.16: Encoder HT12E

The 2^{12} decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek's 2^{12} series of encoders (refer to the encoder/decoder cross reference table). For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen.

The decoders receive serial addresses and data from a programmed 2^{12} series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission.

The 2^{12} series of decoders are capable of decoding information that consists of N bits of address and 12 N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits. Figure 2.17 shows the Decoder HT12D.

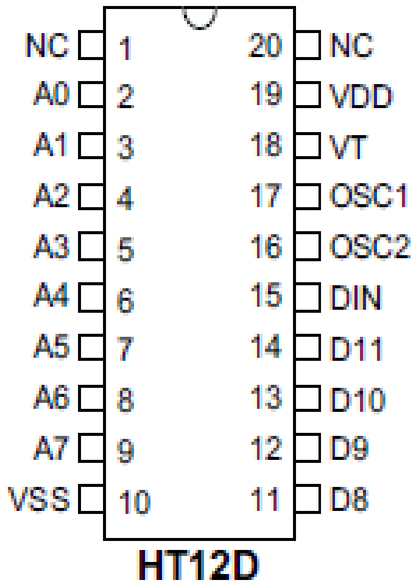

Figure 2.17: Decoder HT12D

2.6 Liquid Crystal Display

Liquid Crystal Display (LCD) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. A comprehensive classification of the various types and electro-optical modes of LCDs is provided in the article LCD classification. Figures 2.18 and 2.19 show the liquid crystal display and LCD Interface to microcontroller.

Figure 2.18: Liquid crystal display

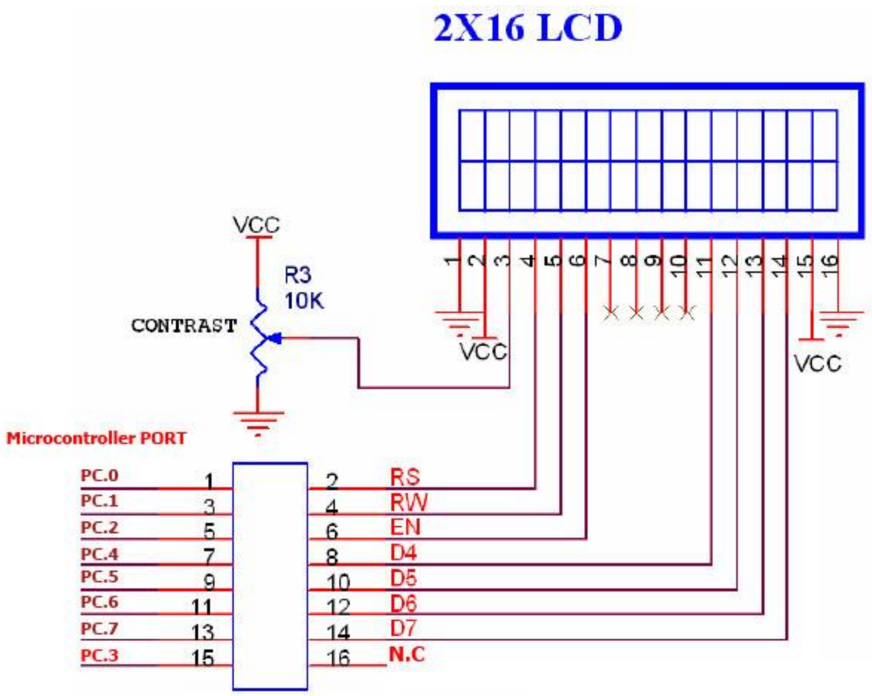

Figure 2.19: LCD Interface to microcontroller

Chapter Three

Main Circuit Implementation

3.1 Transmitter Flowchart

The flowchart represents the transmitter program flow inside the microcontroller as shown in Figure 3.1.

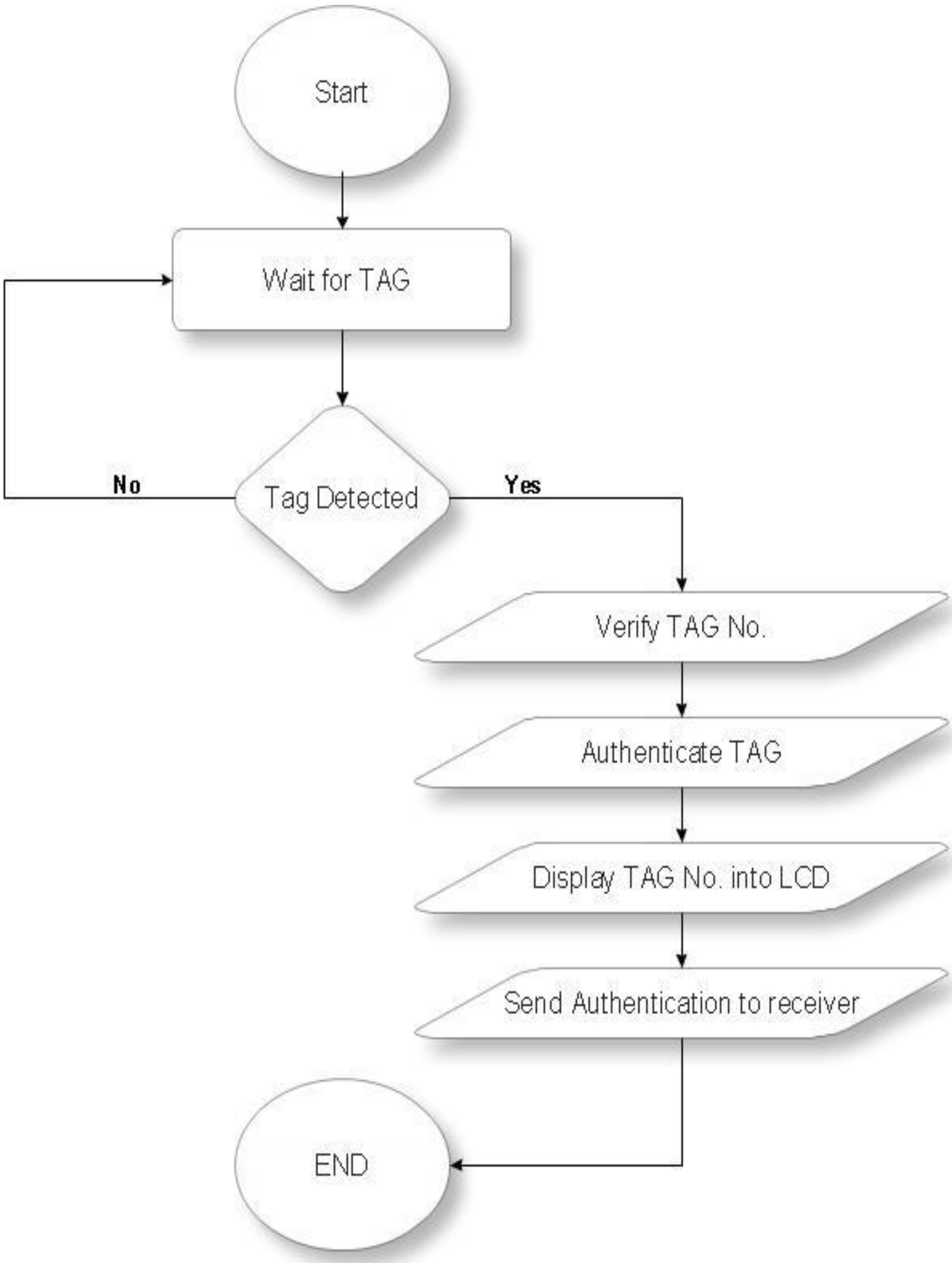

Figure 3.1: Transmitter flowchart

3.2 Receiver Flowchart

The flowchart represents the receiver program flow inside the microcontroller as shown in Figure 3.2.

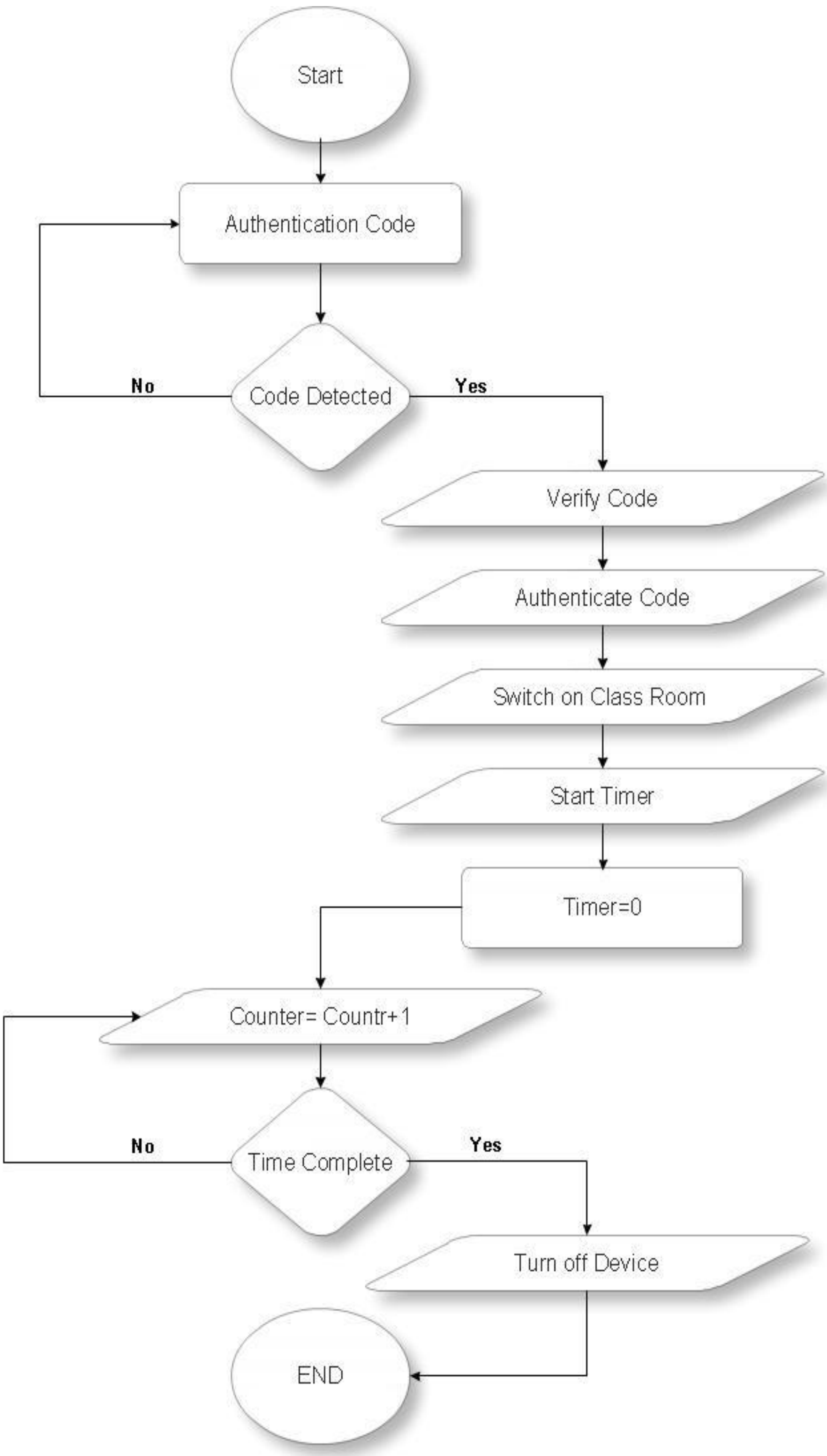

Figure 3.2: Receiver flowchart

3.3 Transmitter Circuit Diagram

Figure 3.3 illustrates the transmitter circuit including the RFID module, LCD display to view the system activities, transmitter circuit used to transmit the authentication to the receiver circuit. A power regulator circuit was used to adjust the power input to the circuit since the regulator input between 6 volt to 36 volt to give an output of 5 volt with a maximum current 1.5A.

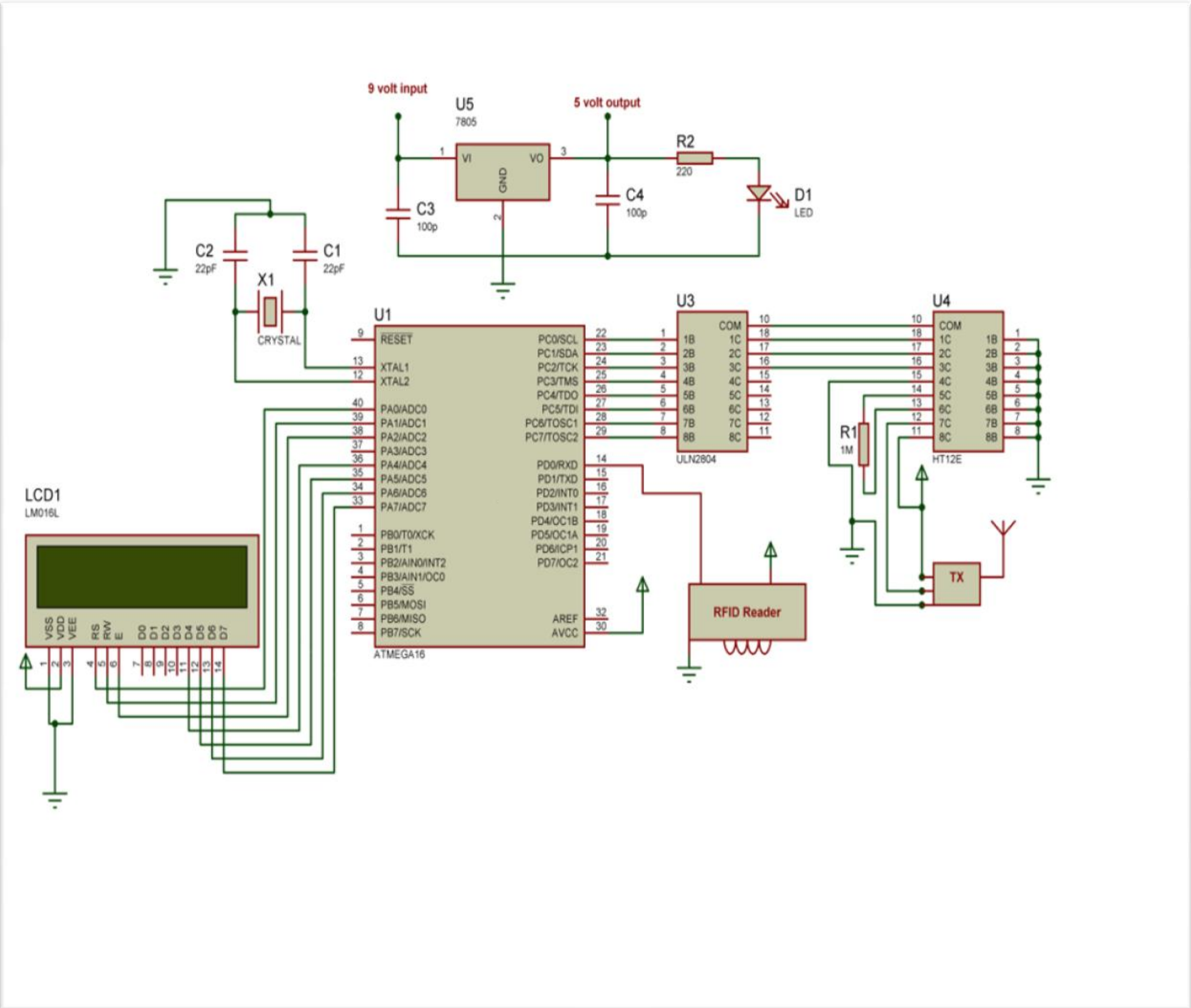

Figure 3.3: Transmitter circuit

A crystal oscillator is used to speed up the processing speed of the microcontroller to 8MHz the ULN2804 or ULN2803 used to convert logic zero to logic one and increase the current to 500mA .

3.4 Receiver Circuit Diagram

The receiver circuit consists of microcontroller atmega16 used to receive the authentication code through decoder and receiver module, the circuit bypass the authentication result as a switching command ON/OFF to the relays that used to switch ON/OFF electronic components inside class room. Also a regulator used to adjust the power input and a crystal oscillator used to speed up the microcontroller. Figure 3.4 shows the receiver circuit diagram.

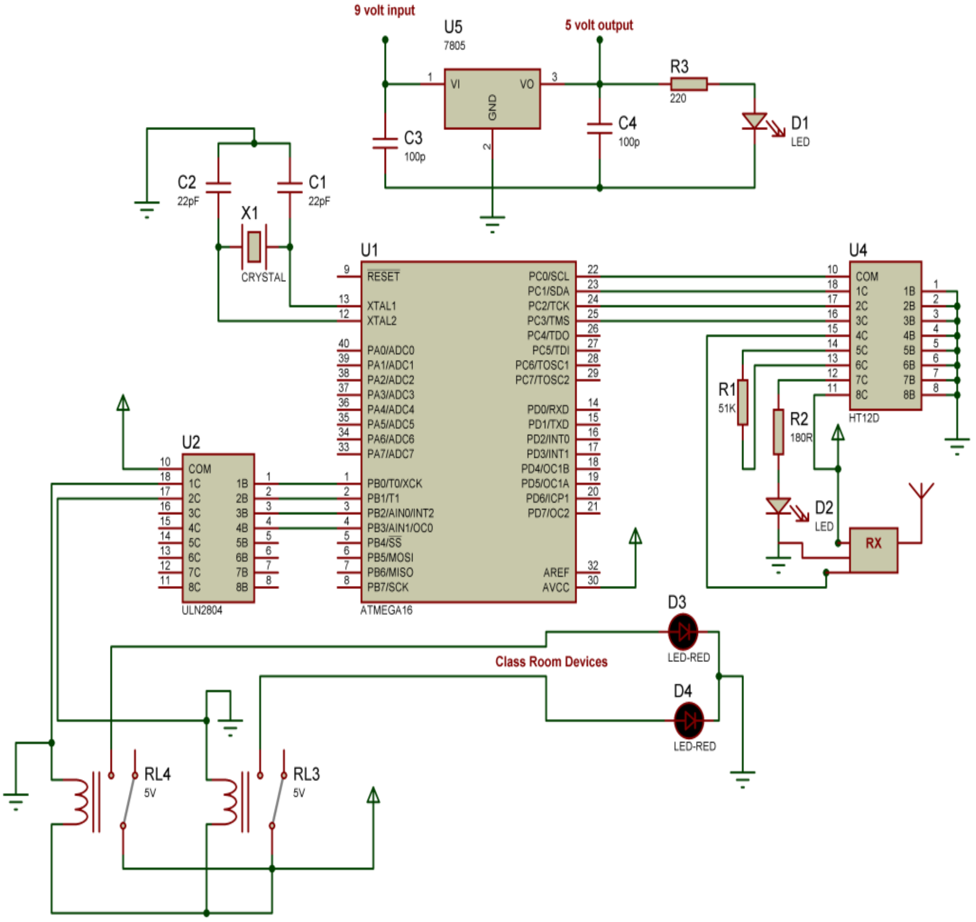

Figure 3.4: Receiver circuit

3.5 Programming Environment

Microcontroller is originally programmed only in assembly language, but various high level programming language are now also in common use to target microcontroller . These language are either designed especially for the purpose or versions of general purpose language such as the C programming language . Compilers for general purpose language will typically have some restriction as well as enhancement to better support the unique characteristics of microcontroller . Some microcontroller have environments to aid developing certain types of applications. Microcontroller vendors often make tools freely available to make it easier to adopt their hardware.

Many microcontrollers quirky that they effectively require their own non-standard dialects of C, such as SDCC for the 8051, which prevent using standard tools (such as code libraries or static analysis tools) even for code unrelated to hardware features. Interpreters are often used to hide such low level quirks. Interpreter firm are is also available for some microcontrollers. Simulators are available for some microcontrollers, such as in Microchip's MPLAB environment. These allow a developer to analyze. What the behavior of the microcontroller and their program should be if they were using the actual part. A simulator will show the internal processor state and also that of the outputs, as well as allowing input signals to be generated. While on the one hand most simulators will be limited from being unable to simulate much other hardware in a system, they can exercise conditions that may otherwise be hard to reproduce at will in the physical implementation, and can be the quickest way to debug and analyze problems.

3.6ATMEL AVR

The AVR is a modified Harvard architecture 8-bit Reduced Instruction Set Computer (RISC) single chip microcontroller (μC) which was developed by Atmel in 1996 . The AVR is one of the first microcontroller families to use on-chip flash memory for program storage, as opposed to one-Time programmable Read Only Memory (ROM), Erasable Programmable Read Only Memory (EPROM) or Electrically Erasable Programmable Read Only Memory (EEPROM) used by other microcontroller at the time. Note that the use of AVR in this article generally refers to the 8-bit RISC line of Atmel AVR microcontroller.

Among the first of the AVR line was the AT90S8515, which in 40-pin DIP package has the same pin out as an 8051 microcontroller, including the external multiplexed address and data bus. The polarity of the RESET line was opposite 8051's having an active-high RESET, while the AVR has an active-low RESET, but other than that, the pin out was identical.

3.6.1 AVR overview

The AVR is a modified Harvard architecture machine with program and data stored in separate physical system that appear in address spaces but having the ability to read data items from program memory using special instruction. Figure 3.5 shows the AVR Atmega 16L microcontroller.

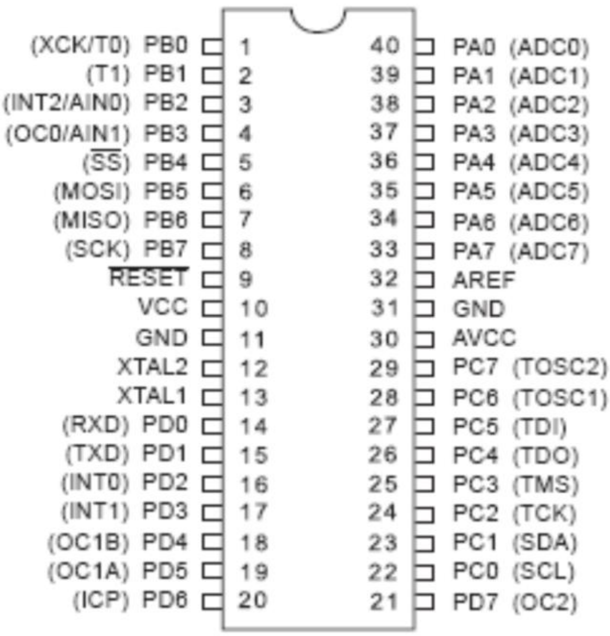

Figure 3.5: AVR Atmega16L microcontrollers

3.6.2 AVR pin descriptions

VCC: Digital supply voltage

GND: Ground.

Port A (PA0- PA7): Port A serves as the analog inputs to the A/D Converter. Also port A serves as an 8-bit bi-directional input/output (I/O) port, if the A/D converter is not used.

Port B (PB0- PB7): Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

Port C (PC0- PC7): Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

Port D (PD0- PD7): Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

RESET: A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

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

XTAL2: Output from the inverting oscillator amplifier.

AVCC: AVCC is the supply voltage pin for port A and the A/D converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: is the analog reference pin for the A/D converter.

Chapter Four

Circuit Testing, Simulation and Results

4.1 Introduction

In this chapter circuit testing and simulation results are presented to evaluate the performance at the power saving system.

4.2 Transmitter Circuit

A simulation of a transmitter circuit was done through ISIS circuit simulation program that used to simulate the circuit with its components shown in figure4.1.

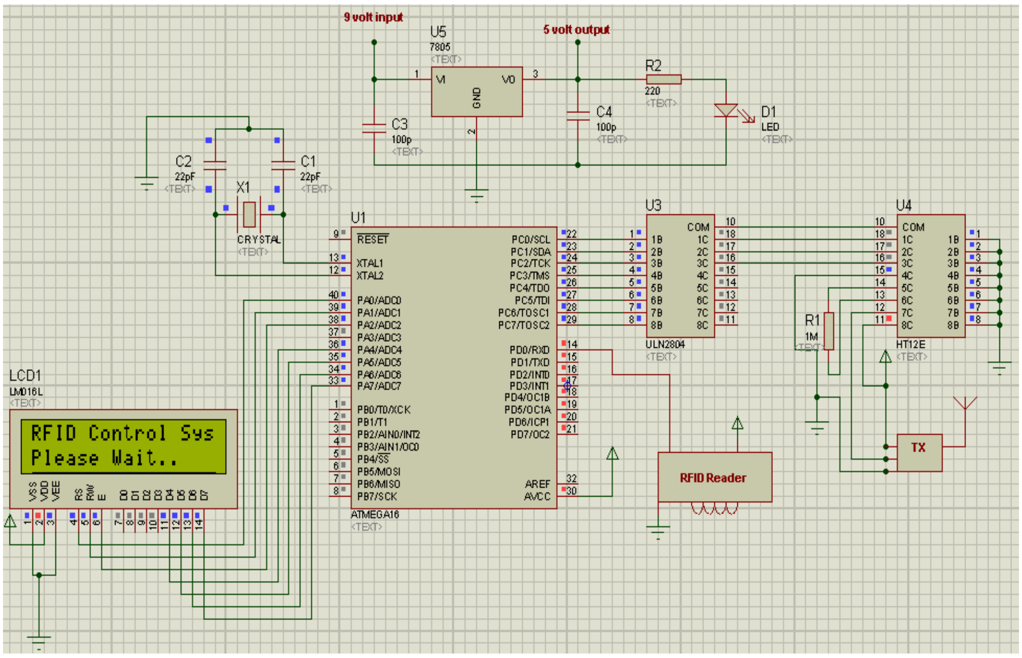

Figure 4.1: Simulation of transmitter circuit

The microcontroller code was written in C language environment using Code Vision AVR compiler, then the output file is located through the simulation program and loaded. Moreover a circuit was design and implemented on printed circuit board identical to simulation as shown in figure 4.2.

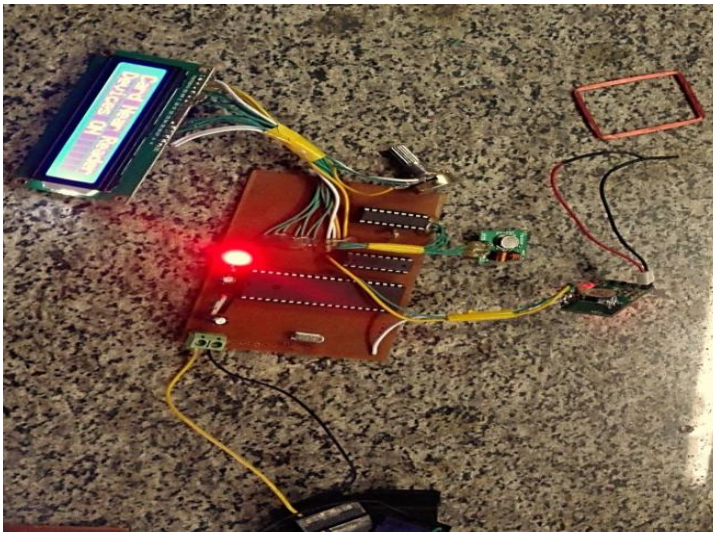

Figure 4.2: Transmitter circuit

4.3 Receiver Circuit

A simulation of a receiver circuit was done through ISIS circuit simulation program that used to simulate the circuit with its components shown in figure4.3.

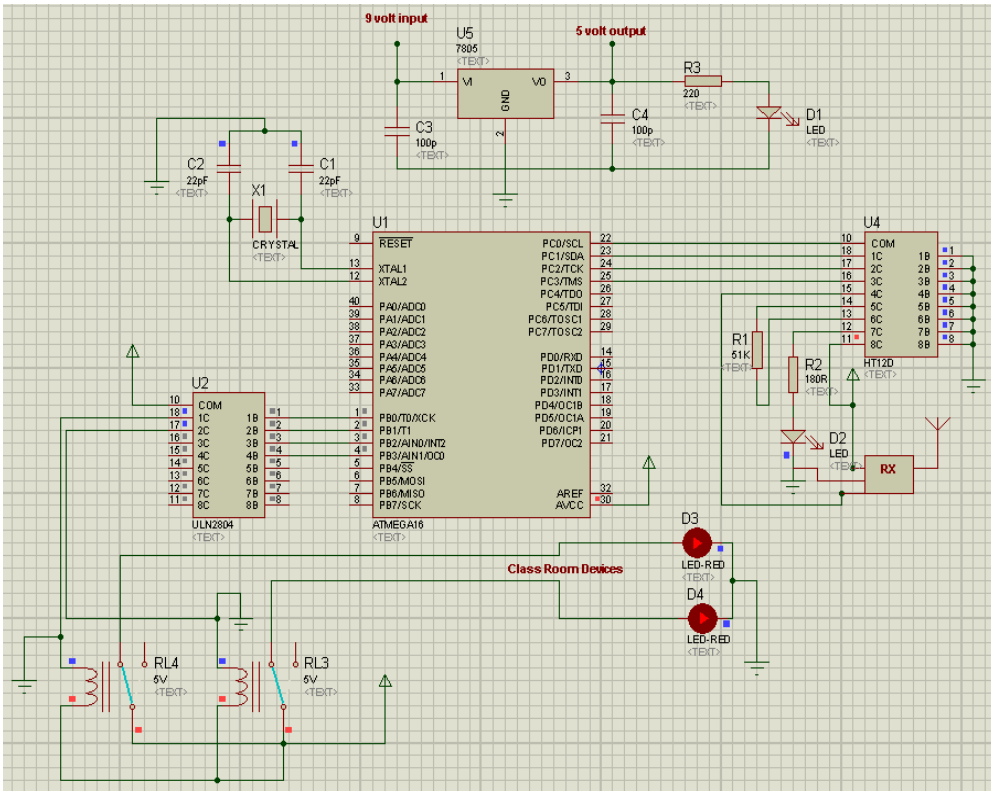

Figure 4.3: Simulation of receiver circuit

The microcontroller code was written in C language environment using Code Vision AVR compiler, then the output file is located through the simulation program and loaded. Moreover a circuit was design and implemented on printed circuit board identical to simulation as shown in figure 4.4.

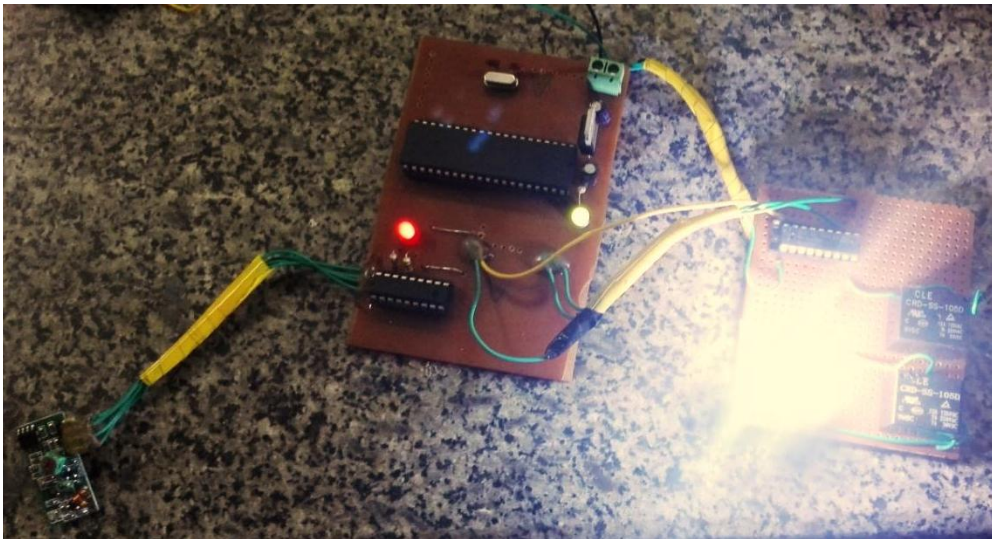

Figure 4.4: Receiver circuit

The following tables illustrate the obtained results from the implementation including TAG Required Distance, optimum time required for reading TAGs, class room time and response time.

The following table 4.3 illustrate the TAG distance from the RFID, six experiments was done to detect optimal distance.

Table 4.3: Distance required for TAG

No.	TAG Number	Distance	Status
1	TAG1	20cm	Not Detected
2	TAG1	15cm	Not Detected
3	TAG1	5cm	Detected
4	TAG2	20cm	Not Detected
5	TAG2	15cm	Not Detected
6	TAG2	5cm	Detected

The following table 4.4 illustrate the TAG required read time, six experiments was done to detect optimum time in seconds.

Table 4.4: Time required to read TAG

No.	TAG Number	Time (s)	Status
1	TAG1	20	Repeated 3 times
2	TAG1	15	Repeated 2 times
3	TAG1	5	Detected Once
4	TAG2	20	Repeated 3 times
5	TAG2	15	Repeated 2 times
6	TAG2	5	Detected Once

The following table 4.5 illustrates experiments done to test latency of the response time.

Table 4.5: Response Time

No.	Tests	Time (h)	Milliseconds Configuration	Response Time
1	TAG	2	7200000	Less than 10 seconds
2	TAG	1	3600000	Less than 10 seconds

Chapter Five

Conclusion and Recommendation

5.1 Conclusion

In this thesis a study of power consumption that is required to power up most of the institutes and educational facilities in Sudan and due to the high rate of KW that vary in price. Moreover this consumption increase the budget of the university or facility which depend on the usage of power in the daily lectures, So consumption of power become a problem due to the high power usage daily within the working hours or on the break time , that affect the overall budget.

In this thesis the usage of electronics and technology in electronic systems give the ability to monitor and control the appliance inside class room using radio frequency identification system RFID in order to reduce power consumption, to high power consumption usage the transmitter and receiver circuits are successfully implemented and tested, and the power was optimized to its optimum values.

5.2 Recommendation

1- Develop the system with attendance monitoring and registering system.
2- Develop an automated detection system to lecturer using face recognition.
3- Develop an estimation and calculation program to calculate the power consumption.
4- Add temperature sensor to detect the room temperature inside lecture room to switch on / off the cooling system automatically.

References

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[9] David Harris and Sarah Harris, "Digital Design and Computer Architecture", Second Edition, p. 515. Morgan Kaufmann, 2012.

Appendix A

Transmitter Code

```
/*****************************************************
This program was produced by the

CodeWizardAVR V2.05.0 Professional

Automatic Program Generator

http://www.hpinfotech.com


Project : power saving (TX code)

Date    : 3/20/2016

Author  : ayman azhari


Chip type               : ATmega16

Program type            : Application

AVR Core Clock frequency: 8.000000 MHz

Memory model            : Small

External RAM size       : 0

Data Stack size         : 256

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


#include <mega16.h>

#include <delay.h>

#include <math.h>

#include <stdio.h>

#include <stdlib.h>

#include <string.h>

// Alphanumeric LCD Module functions

#include <alcd.h>
```

```
// Declare your global variables here
int s;
void main(void)
{
// Declare your local variables here
// Input/Output Ports initialization
// Port A initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTA=0x00;
DDRA=0x00;

// Port B initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTB=0x00;
DDRB=0x00;

// Port C initialization
// Func7=Out Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out Func1=Out Func0=Out
// State7=0 State6=0 State5=0 State4=0 State3=0 State2=0 State1=0 State0=0
PORTC=0x00;
DDRC=0xFF;

// Port D initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTD=0xFF;
```

```
DDRD=0x00;


// Timer/Counter 0 initialization
// Clock source: System Clock
// Clock value: Timer 0 Stopped
// Mode: Normal top=0xFF
// OC0 output: Disconnected
TCCR0=0x00;
TCNT0=0x00;
OCR0=0x00;
// Timer/Counter 1 initialization
// Clock source: System Clock
// Clock value: Timer1 Stopped
// Mode: Normal top=0xFFFF
// OC1A output: Discon.
// OC1B output: Discon.
// Noise Canceler: Off
// Input Capture on Falling Edge
// Timer1 Overflow Interrupt: Off
// Input Capture Interrupt: Off
// Compare A Match Interrupt: Off
// Compare B Match Interrupt: Off
TCCR1A=0x00;
TCCR1B=0x00;
TCNT1H=0x00;
TCNT1L=0x00;
ICR1H=0x00;
ICR1L=0x00;
```

```
OCR1AH=0x00;
OCR1AL=0x00;
OCR1BH=0x00;
OCR1BL=0x00;
// Timer/Counter 2 initialization
// Clock source: System Clock
// Clock value: Timer2 Stopped
// Mode: Normal top=0xFF
// OC2 output: Disconnected
ASSR=0x00;
TCCR2=0x00;
TCNT2=0x00;
OCR2=0x00;
// External Interrupt(s) initialization
// INT0: Off
// INT1: Off
// INT2: Off
MCUCR=0x00;
MCUCSR=0x00;

// Timer(s)/Counter(s) Interrupt(s) initialization
TIMSK=0x00;
// USART initialization
// USART disabled
UCSRB=0x00;
// Analog Comparator initialization
// Analog Comparator: Off
// Analog Comparator Input Capture by Timer/Counter 1: Off
```

```
ACSR=0x80;
SFIOR=0x00;
// ADC initialization
// ADC disabled
ADCSRA=0x00;
// SPI initialization
// SPI disabled
SPCR=0x00;
// TWI initialization
// TWI disabled
TWCR=0x00;
// Alphanumeric LCD initialization
// Connections specified in the
// Project|Configure|C Compiler|Libraries|Alphanumeric LCD menu:
// RS - PORTA Bit 0
// RD - PORTA Bit 1
// EN - PORTA Bit 2
// D4 - PORTA Bit 4
// D5 - PORTA Bit 5
// D6 - PORTA Bit 6
// D7 - PORTA Bit 7
// Characters/line: 16
lcd_init(16);
while (1)
    {
    start:

    lcd_gotoxy(0,0);
```

```
lcd_putsf("RFID Control Sys");
delay_ms(100);
lcd_gotoxy(0,1);
lcd_putsf("Please Wait.    ");
delay_ms(50);
lcd_gotoxy(0,1);
lcd_putsf("Please Wait..   ");
delay_ms(50);
lcd_gotoxy(0,1);
lcd_putsf("Please Wait.... ");
delay_ms(50);
lcd_gotoxy(0,1);
lcd_putsf("Please Wait.....");
delay_ms(50);
lcd_gotoxy(0,0);
lcd_putsf("Card Near Reader");
delay_ms(50);

lcd_gotoxy(0,1);
lcd_putsf("                ");
delay_ms(50);
 goto stage1;

};
while(2)
{
stage1:
   s=PIND.0;
```

```
      if (s==0x00)
{
lcd_gotoxy(0,1);
lcd_putsf("TAG Recognized  ");
delay_ms(100);
lcd_gotoxy(0,1);
lcd_putsf("Devices ON      ");
delay_ms(50);
 PORTC.7=0x01;
 PORTC.6=0x01;
 delay_ms(200);
 PORTC.7=0x00;
 PORTC.6=0x00;
       }
};
}
```

Appendix B

Receiver Code

```
/*****************************************************
This program was produced by theCodeWizardAVR V2.05.0 Professional
Automatic Program Generator
© Copyright 1998-2010 Pavel Haiduc, HP InfoTech s.r.l.
http://www.hpinfotech.com

Project : power saving (RX code)
Date    : 3/20/2016
Author  : ayman azhari

Chip type               : ATmega16
Program type            : Application
AVR Core Clock frequency: 8.000000 MHz
Memory model            : Small
External RAM size       : 0
Data Stack size         : 256
*****************************************************/

#include <mega16.h>
#include <delay.h>
// Declare your global variables here
int s;
void main(void)
{
// Declare your local variables here
// Input/Output Ports initialization
```

```
// Port A initialization
// Func7=Out Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out Func1=Out Func0=Out
// State7=0 State6=0 State5=0 State4=0 State3=0 State2=0 State1=0 State0=0
PORTA=0x00;
DDRA=0xFF;

// Port B initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTB=0x00;
DDRB=0x00;

// Port C initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTC=0xFF;
DDRC=0x00;

// Port D initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTD=0x00;
DDRD=0x00;
// Timer/Counter 0 initialization
// Clock source: System Clock
// Clock value: Timer 0 Stopped
// Mode: Normal top=0xFF
// OC0 output: Disconnected
```

```
TCCR0=0x00;
TCNT0=0x00;
OCR0=0x00;
// Timer/Counter 1 initialization
// Clock source: System Clock
// Clock value: Timer1 Stopped
// Mode: Normal top=0xFFFF
// OC1A output: Discon.
// OC1B output: Discon.
// Noise Canceler: Off
// Input Capture on Falling Edge
// Timer1 Overflow Interrupt: Off
// Input Capture Interrupt: Off
// Compare A Match Interrupt: Off
// Compare B Match Interrupt: Off
TCCR1A=0x00;
TCCR1B=0x00;
TCNT1H=0x00;
TCNT1L=0x00;
ICR1H=0x00;
ICR1L=0x00;
OCR1AH=0x00;
OCR1AL=0x00;
OCR1BH=0x00;
OCR1BL=0x00;
// Timer/Counter 2 initialization
// Clock source: System Clock
// Clock value: Timer2 Stopped
```

```
// Mode: Normal top=0xFF
// OC2 output: Disconnected
ASSR=0x00;
TCCR2=0x00;
TCNT2=0x00;
OCR2=0x00;
// External Interrupt(s) initialization
// INT0: Off
// INT1: Off
// INT2: Off
MCUCR=0x00;
MCUCSR=0x00;
// Timer(s)/Counter(s) Interrupt(s) initialization
TIMSK=0x00;
// USART initialization
// USART disabled
UCSRB=0x00;
// Analog Comparator initialization
// Analog Comparator: Off
// Analog Comparator Input Capture by Timer/Counter 1: Off
ACSR=0x80;
SFIOR=0x00;
// ADC initialization
// ADC disabled
ADCSRA=0x00;
// SPI initialization
// SPI disabled
SPCR=0x00;
```

```
// TWI initialization
// TWI disabled
TWCR=0x00;
delay_ms(600);
while (1)
      {
      s=PINC.7;

      if (s==0x00)
      {
       PORTA=0xFF;
       delay_ms(1000);
       PORTA=0x00;

      }

      };
}
```