RFID BASED ANTI-COLLISION MECHANISM FOR TRAINS

Project report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

in

Electronics and Communication Engineering

By

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Certificate

This is to certify that the project report entitled **"RFID BASED ANTI-COLLISION MECHANISM FOR TRAINS"**, submitted by Anurag Pareek(061030), Daksh Arora(061041) in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

Date : 24/5/2010

Prof.(Dr.) T.S Lamba

(Dean - Academic and Research)

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

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Date: 24th MAY, 2010

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Abstract

The development of computer networks technology and modern communication technology has provided conditions for worldwide high speed and accurate data transmission, also has brought opportunities for RFID technology being widely applied in many applications. This mission uses the same for developing the anti collision mechanism for trains.

This project covers techniques for circuit analysis, simulation and layout designing using PCB Wizard 3.0 of receiver, transmitter and various other stages. Here transmitter and receiver communicate at high frequency of 13.56MHz using different topology with an efficiency of the 80% for an output power. It can work with minimum of 15-18 volts power supply. The design includes Amplitude Shift Keying (ASK) modulation, power control, and multistage power amplifier (PA) configurations to enhance the range of RFID reader, Encoder and Decoder, Transmitter and Receiver module for transmitting and receiving the coded information.

To communicate our hardware with the host computer, we used parallel port programming where our database is installed for comparing the received data and take appropriate actions.

In this project we have systematically studied, the need for anti-collision system, RF spectrum, RFID system and its working, computer networking, advantages of this system, comparison with the existing system, other potential applications and hardware implementation.

In result to this we achieved the communicating pairs of transmitter and receiver, which send the four bit EP code to the server where database is already updated, and checks the route of the train, if it is following wrong path then necessary actions will be taken.

This will lead to better Anti Collision System in terms of efficiency and accuracy for Railways, that too inexpensive as compared to existing system.

Project Proposal

Our project proposal was to make a mechanism for avoiding collisions using RFID technology. Initially, we started with studying the basics of RFID and overview of all its existing applications which gives us the information how to design and install our system. The we planned to equip train with the RFID reader placed at the bottom of train which will communicate with the RFID tags placed between the tracks through RF signal sending information in form of electronic product code (EPC) to RFID reader which will be transferred to host computer (ONS) further, forwarding to main server, activating breaking system automatically and will blow horn as well to acknowledge the drivers if two trains found to be on the same track. In the middle of our project, we faced problems related to generation of high frequency signal in hardware implementation in order to overcome this trouble we removed the wiring which induces the noise by modelling our circuit on PCB through fabrication.

Till now we are able to communicate between the tag (Transmitter stage) and reader (Receiver stage) at the frequency of 13.56MHz. Using ASK modulation, tag sending a four bit information to the reader as our Electronic Product Code which will be sent to the computer database for knowing the location and track. Now comparing the similar information with some other tag, if the train found to be at same track with certain minimum distance and the distance decreasing continuously will leads to acknowledge the guards and drivers by blowing alarm, still if no actions are taken then breaking system gets actuated automatically.

In case of derailment, the reader automatically sends the information to the server regarding its malfunctioning which will further be circulated to the needful trains as danger zones by internet and necessary actions will be taken accordingly.

Chapter 1

INTRODUCTION

Though in use since World War II, RFID technology is seeing renewed interest and development due, in part, to the upcoming RFID tagging requirements from the Department of Defence and various industries.

RFID, or Radio Frequency Identification, is the term used for technologies that leverage radio waves to identify items automatically. Typically, this happens through a stored serial number on the tag that identifies a product. The tag may also have other information, such as where the item was made, manufacture date, serial number, where it is placed and other items that could be relevant for that item. The term EPC, or Electronic Product Code, is sometimes used interchangeably for RFID, but in fact, the EPC refers to the information that is on the tag – the unique item number that identifies that individual item and scanned by the reader for processing the information with the help of host computer.

1.1 Need For Anti Collision Systems For Trains

Safety violations due to 'human errors or limitations' and 'equipment failures' occasionally result in Train collisions. As we all know safety is highly demanded, the growing possibility of train collisions need the special means of safety and efficient anti collision systems. Till now efforts have been made to design more efficient and secure system still the limitations have not been removed completely. Recent miss-happenings due to non efficient system and human error are:

(a.)Trains (Gorakhdhaam and Prayagraaj express) collided due to critical weather conditions near Kanpur recently.

(b.) August 1999, Head-on Collision at 'Gaisal' causing 300 people dead.

1.2 Existing Anti Collision Systems and it's Drawbacks

1. **Anti-Collision Device (ACD)**
   It is based on 'Radio communication', 'Microprocessors' and 'Global Positioning System (GPS)' technology, this prototype when mounted on two approaching trains, would enable them to assess accurately each other's course and initiate an 'automatic' braking action, in case they were perceived to be on 'collision risk'.

   ACDs that work on the principle of 'Distributed Control Systems' which interact en-route with each other through radio communication within a radial range of 3 Kms it takes input from GPS system for determination of Train location, Speed, Course of travel and Time and if found to be at risk of collision, the ACD system activates automatic braking operation to prevent collisions.

   Drawbacks of the ACD System

   - If other train is a not equipped with ACD system then it is not detectable with the other train because ACD functions by reacting to another ACD, as such if one of the two trains is a non-ACD train, the protection against collision will be missing.
   - It's difficult to avoid collisions, if adequate braking distance at a particular speed is not available.
   - If the other train derails and its wagons/coaches dash with Train on adjacent track, then this ACD is not useful.

2. **Manual Operation**
   Train collisions is even avoided manually, by keeping an eye on the traffic signal by the respective drivers of the train, till the time it shows Green signal train continues to run indicating the track ahead is clear, but if the signal observed is Red then the driver apply breaks and stop the train indicating that there is no clearance for the same.

   Drawbacks of this system:

   - Human error: In spite of Red signal, it is often observed that driver continues to run train without paying much attention.
   - Foggy weather: Due to foggy weather driver is unable to observe the signal properly, which causes accidents.
   - When signalling is not proper.

1.3 Practical Use of RFID in Anti Collision System

As the name RF signifies, it is the kind of identification system, which uses radio frequencies. RFID uses wireless technology operating with 50 KHz to 2.5 GHz (in our project 13.56 MHz) frequency range. It does not require any physical connection for identification between the unit to be identified(called Tag) which in this case is placed on tracks and the identifier unit(called Reader), which in this case is present in train. For automatic identification purposes, each piece of equipment (which is to be identified) shall be fitted with small tag containing unique identification code which is retreived from the tag, and giving current status of the train, if found on same track it will automatically applies break, Hence avoiding collision .

1.4 History of RFID Technology

1935: RADAR (radio detection and ranging) invented by Sir Robert Alexander Watson-Watt. WW II: IFF (identify-friend-or-foe) system, signal sent to transponder on plane which either reflects back (passive) or broadcasts (active) a signal.

1960s: anti-theft electronic surveillance tags (1-bit), turned off at Point-of-sale, else alarm sounds when going past reader at exit.

1973: Mario Cardullo obtained first US patent for active RFID tag with rewritable memory, Charles Walton obtained patent for card/reader for unlocking doors (E-lock card!)

1970s-80s: Los Alamos National Lab project for tracking nuclear materials; placed transponders on trucks and readers at gate. Commercialised in mid-80s to automated toll payment systems (Auto-toll!)

1980-90s: 13.56 MHz RFID systems used for access control, payment systems, contactless smart cards, car anti-theft device

1990s: UHF RFID systems developed by IBM and sold to Intermec, but cost a deterrent.

1.5 The RF Spectrum

The RF spectrum is regulated by government regulatory agencies, such as the FCC, who establish guidelines for its use. Depending on the region and country where you are installing your RFID system, you must follow that agencies' guidelines. Typically, the guidelines specify how you can use these features:

- Frequency and bandwidth size
- Channel use (primary or secondary)
- Power level (in milliwatts or watts)
- Duty cycle (percent of time allowed to output power)

1.6 Frequencies System and Bandwidth

All RFID systems must operate within national and international laws and regulatory guidelines with respect to frequency and bandwidth use. Depending on the country, several frequency bands may be available. However, operating outside the more common bands has disadvantages. RFID systems can be classified according to the frequency band in which they operate:

- low frequency (10 to 500 kHz), near-field system using modulated backscatter, inductively-coupled tags.
- high frequency (10 to 15 MHz), near-field system using modulated backscatter, inductively-coupled tags.
- ultra-high frequency (860-960 MHz), far-field system using modulated backscatter, capacitively-coupled tags or active tags.
- microwave frequency (2.4-5.0 GHz), far-field system using modulated backscatter, capacitively-coupled tags or active tags.

Each frequency band has advantages and disadvantages that you need to understand when designing your RFID system. Depending on which frequency band your RFID system uses, certain characteristics of the RFID system can be affected, such as reading range.

Different frequency systems are characterized on the basis of frequency bands

- **Low Frequency System**
  Low frequency systems usually operate in the 125 to 135 kHz range. They use modulated backscatter, inductively-coupled tags. In this frequency range, you get small amounts of data at slow speeds, short reading ranges, and large tags due to large looping antennas. Typically, the reading range

is half the longest dimension of the antenna loop. However, the tags are inexpensive. This frequency range is relatively free from regulatory limitations. Although it does not penetrate metals very well, it does penetrate other materials, such as tissue, wood, and water. It is often used for animal identification and access control.

- **High Frequency System**
  High frequency systems usually operate at 13.56 MHz. They also use modulated backscatter, inductively-coupled tags. Since these tags have a simpler antenna design, they are even more inexpensive than the tags used in low frequency systems. Like the low frequency systems, this system is good at reading small amounts of data at slow speeds. However, it transmits data at slightly higher speeds than low frequency systems and has a slightly larger reading range (0.7 m or 2.3 ft). it penetrate tissue and water but not in metals. It is typically used for access control, inventory control, and smart cards.

- **UHF System**
  Ultra-high frequency (UHF) systems usually operate in the 865 to 928MHz range. They use modulated backscatter, capacitively-coupled tags or active tags and have antennas that allow them to have reading ranges much larger than the antenna dimensions. They are good at reading large amounts of data at high speeds. The 865 to 928 MHz range is the best range for distances between 1 m (3.3 ft) and 10 m (33 ft). UHF frequency ranges are government-regulated. They are not very effective frequencies in environments that have a lot of tissue or water. However, they are effective around metals. This system is best for supply chain management applications.

- **Microwave System**
  Microwave systems usually operate at the 2.4 GHz range. They use modulated backscatter, capacitively-coupled tags or active tags. Microwave systems have a longer reading range than low or high frequency systems, but a much shorter range than UHF systems. 2.4 GHz has a reading range of about 1 m (3.28 ft). However, if you are not concerned about reading range, this frequency has a lot of bandwidth available to it and has more channels to hop between.

1.7 Channel Use

All RFID systems must operate within national and international laws and regulatory guidelines with respect to channel use. Depending on the country, the operating frequency for RFID may be a primary or secondary service. Primary services let you broadcast radio waves however, secondary service or out-of-channel emissions must be kept low to provide efficient use of the overall band. Primary services must not jam or decrease performance for any other devices that use frequencies outside the allowed RFID frequency bands.

1.8 Power Levels and Duty Cycle

All RFID systems must operate within national and international laws and regulatory guidelines with respect to power levels and duty cycle as well. Power levels are defined as the maximum wattage (W) allowed at EIRP (Effective Isotropic Radiated Power). EIRP is the apparent power transmitted towards the antenna, if it is assumed that the signal is radiated equally in all directions. Duty cycle is defined as the percent of time the RFID equipment is outputting power.

1.9 Types of Radio Signals Used in RFID Systems

In RFID systems, the readers and active tags generate the radio signal and broadcast them into the environment through antennas.
Radio signals are sent out as waves. All waves can be described in reference to their amplitude or strength. In RFID systems, there are three main types of radio signals that are used:

- Continuous-wave
- Pulsed
- Swept frequency

1.10 Factors Effecting the Radio Signal

The most significant factors that influences the radio signal are **overall signal strength** and **noise of the signal**.

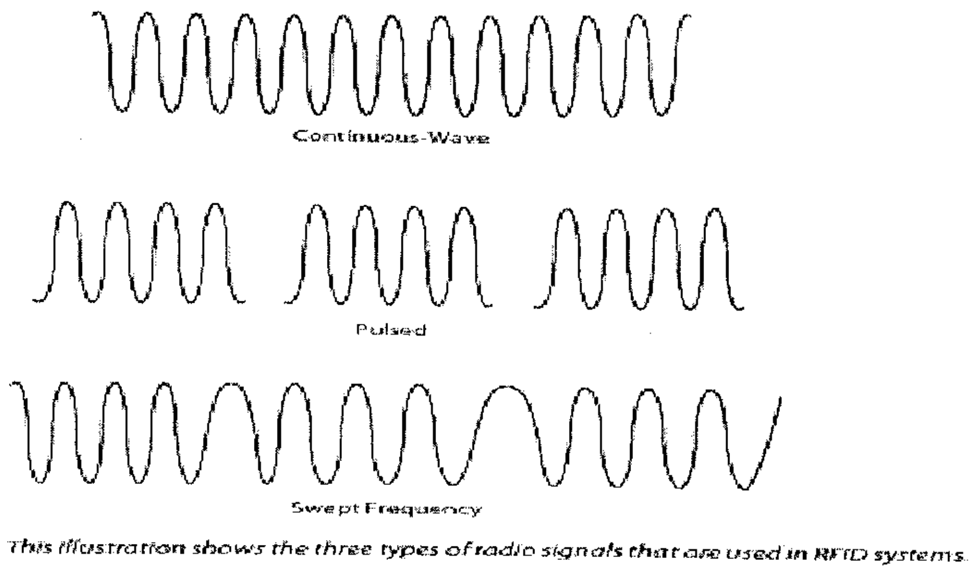


Figure 1.1: Three Types Of Radio Signal Used In RFID System (Ref[1])

1.10.1 Overall Signal Strength

The overall signal strength is influenced by three factors: power density, field strength, and antenna gain. Power density is the amount of energy flowing from an antenna through a unit area that is normal to the direction of propagation in a unit time. It is measured in watts per square meter. Field strength is the intensity of a radio signal measured at a certain distance from the transmitting antenna. Field strength is usually expressed in volts per meter. Antenna gain is the ratio of the signal, usually expressed in dB, received or transmitted by an antenna as compared to an isotropic antenna. You can only achieve antenna gain by making an antenna directional, that is, with better performance in one direction than in others. As a radio signal propagates out from the source (antenna), the total RF energy radiated from the source (antenna gain) remains the same, but the overall signal strength decreases as the distance from the source increases. In other words, as the radio signal (tag) moves away from the source (antenna), the antenna gain remains the same, but its field strength and power density decreases. Doubling the antenna gain will double the field strength. The field strength decreases as the inverse of the distance from the antenna. For example, the field strength at 3 m (10 ft) from the antenna is twice the strength at 6 m (20 ft) from the antenna. The power density of the radio signal follows the inverse square law, which means it decreases as the inverse square of the distance from the antenna.

1.10.2 Noise of the Signal

The electrical noise on the radio signal is influenced by:

- Noise within the reader.
- Noise within the tags.
- Other RF transmitters.
- Other sources that produce low frequency noise (keys jingling).
- Fluorescent lighting.
- Interaction with nearby objects.

1.11 Effects of Multipath in Reading Range

Multipath occurs when two or more favourable radio paths exist between the tag and the antenna. Multipath signals can add at their intersection, creating an area of field enhancement beyond the normally expected reading range, or they can subtract, creating unexpected null regions within the antenna's reading range (i.e. fading).

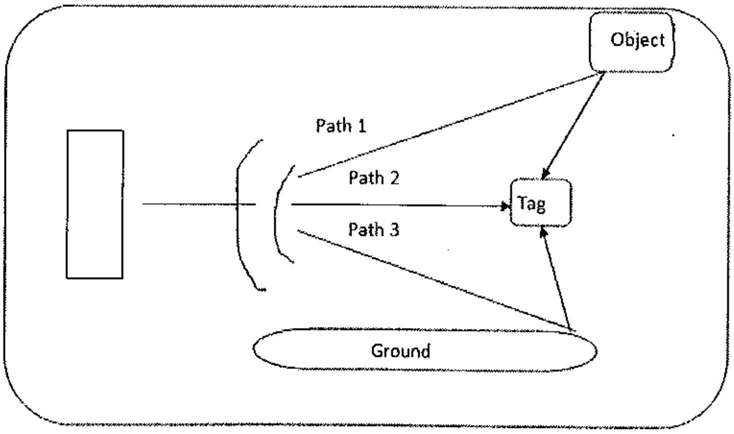


Figure 1.2: When two or more favourable radio paths exist between the tag and the antenna

Extending the Reading Range

Concept of constructive interference of multipath signals can be used to create field enhancement, which extends the reading range. Constructive interference describes the combined, positive effect of a main radio signal intersecting in phase

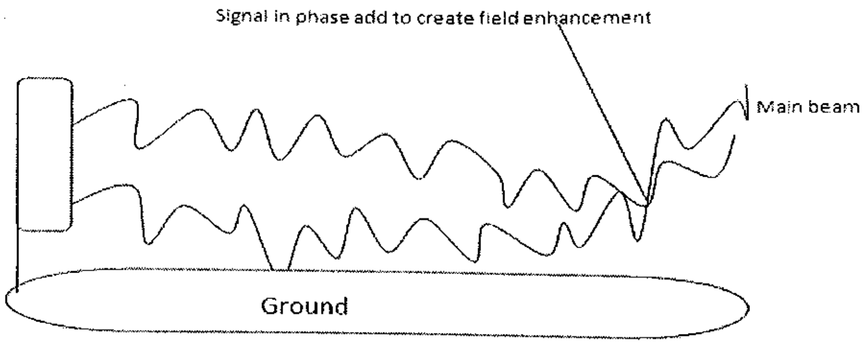


Figure 1.3: An antenna sends out a radio signal as a main beam. It also sends out another portion of the radio signal that is just off axis and is reflected by the ground. Since both radio signal's phases are synchronized when they intersect, the combined effect creates an extended reading range.

with one or more reflected radio signals. In this example, an antenna mounted 1.5 m (5 ft) from the ground sends out a main beam that is a direct radio signal that is strong enough to read a tag as far away as 6 m (19.7 ft). The antenna also sends out another portion of the radio signal that is just off axis (maybe at a 2° to 3° declination), which is reflected by the ground, and then intersects the main beam at a point well beyond the optimal reading range. Under normal circumstances, both radio signals would be too weak to read a tag at this distance. However, because both radio signals' phases are synchronized at the point of their intersection, the combined effect creates an area of extended reading capability. The effect is significant to a distance that is twice the maximum normal reading range, where the enhanced field strength could be twice the field strength of either beam alone. In the case of the above example, the enhanced reading range could extend as far as 12 m (39.3 ft).

Chapter 2

RFID SYSTEM

2.1 RFID System

- One or more RF tags
- Two or more antennas
- One or more interrogators
- One or more host computers

2.2 RFID Tags

RFID tags are attached to objects that you want to track. The tag transfers data to the reader using radio waves that are tuned to the same frequency as the reader and within the reading range of the reader. Tags come in many different form factors for different applications and for different environments. A tag can be mounted inside a carton or it can be embedded in plastic for mounting in a damp environment. A tag may be as small as a grain of rice or as large as a brick. It may be adhered under a label. Some examples of the types of tags are: container tags, windshield sticker tags, tire tag inserts, metal mount tags, and inserts. Tag data is typically contained in an electrically-erasable, programmable, read-only memory circuit, or EEPROM. Tags can be programmed by the manufacturer or customer to match information on the object to be tagged, such as train number(used in our project), part number, serial number, destination, purchase order, SSCC, and so forth. Besides form factors, tags vary by their performance. They can be read-only, write-once/read-many (WORM), or read/write. Tags also vary by their technologies. They can use active, active backscatter, or modulated backscatter to power their circuitry and communicate with the reader.

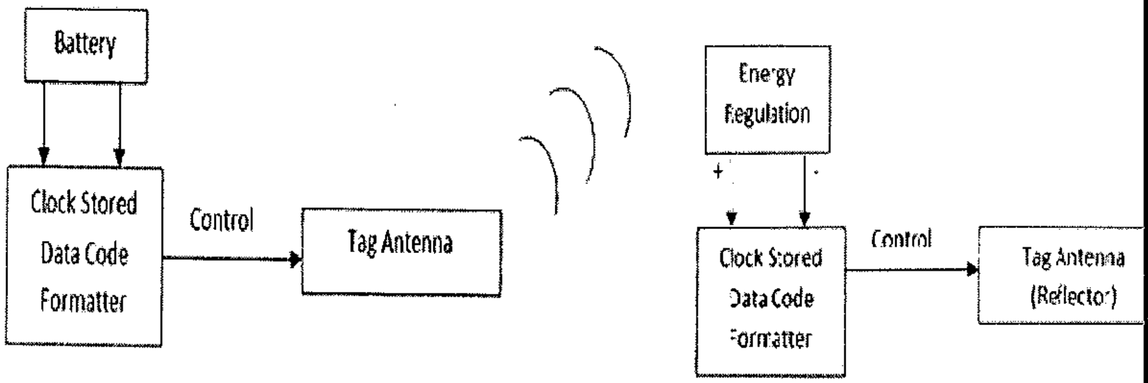


Figure 2.1: active tags are also called battery-powered tags because the are powered by a small lithium battery. Modulated backscatter tags are also called beam-powered tags because they are powered by reflecting the RFID reader's radio signal.

2.2.1 Types of Tags

1. **Active Tags** An RFID tag is an active tag when it is equipped with the battery that can be used as a partial or complete source of power for the tags circuitry and antenna.

   Salient features of Active RFID tags are:

   - Longest communication range of any tag.
   - The capability to perform independent monitoring and control.
   - The capability of initiating communication.
   - The highest data bandwidth.

   Advantages of an active RFID tags are:

   - It can be read at a distance of 100 feet or more greatly improving the utility of the device.
   - It can store large amount of information.

   Disadvantages of an active RFID tags are:

   - The tag cannot function without batter power, which limits the lifetime of tag.
   - The tag is typically more expensive.
   - The tag is physically larger, which may limit applications.

- The long term maintenance cost is more.

2. **Passive Tags:** A passive tag is an RFID tag that does not contain a battery, the power is supplied by the reader. When radio waves from the reader are encountered by a passive RFID tag, the coiled antenna within the tag forms the magnetic field the tag draws power from it, energizing the circuits in the tag. The tag then send the information coded in the tags memory.

   The major advantages of passive tags are:

   - The tag functions without a battery, these tags have a useful life of 20 years or more.
   - The tag is typically much less expensive to manufacture.
   - The tag is much smaller.

   The disadvantages of a passive RFID tags are:

   - The tags can be read at a very short distance typically a few feet at most.
   - It may not be possible to include sensors that can use electricity for power.
   - The tags remain readable for a very long time

3. **Active Backscatter Tags**

   Active backscatter tags, also called battery-assisted tags, are less expensive than active tags. The tag has a medium reading range, which is between 3 and 15.2 m (10 to 50 ft). The battery in the tag powers the tag's internal circuitry, but it does not power its radio. The reader (through its antennas) transmits RF energy. When a tag enters the reader's reading range, it reflects the reader-generated RF energy to transfer data.

4. **Modulated Backscatter Tags**

   Modulated backscatter tags, also called passive tags, are the least expensive, the lightest, and have a virtually unlimited life time. The tag has a shorter reading range than active backscatter—between a few cm (in) to 5.5 m (18 ft). Like active backscatter technology, the reader (through its antennas) transmits RF energy. When a tag enters the reader's reading range, it reflects the reader-generated RF energy, which powers the tag.

Since the tag cannot transmit its own signal (since it has no internally-supplied power), it simply reflects part of this RF energy back through its antenna to the reader's receiver. These tags do not contribute to radio noise background. Modulated backscatter tags require a reader to have much more power than a reader for active tags. They can be inductively-coupled or capacitively coupled.

(a) **Inductively-Coupled Tags**

Inductively-coupled tags (also called radio-wave-coupled tags) are powered by magnetic energy from the reader. That is, a coil in the reader antenna and a coil in the tag antenna form an electromagnetic field. The tag draws power from the magnetic energy in the field and uses it to run its circuitry. Because the tag must be close to the reader, the reading range of inductive tags is very small.

(b) **Capacitively-Coupled Tags**

Capacitively-coupled tags (also called propagation-coupled tags) are powered by the electromagnetic energy generated by the reader. The tag gathers the energy from the reader antenna and reflects back an altered signal. Capacitively-coupled tags are less expensive and more flexible than inductively-coupled tags. They also have a longer reading range.

2.2.2 Effect of Tags on Reading Range

The RFID tags used in any installation significantly affect the dimensions and performance of the reading range. Among the primary tag characteristics that influence the reading range are:

- **Tag Power Source (battery or beam)**

  Tags may be either active or modulated backscatter. The active tag's performance (signal strength) declines gradually with distance, returning a progressively weaker signal. The modulated backscatter tag's reading range is limited by the need to receive adequate RF energy to energize its circuits. Its performance declines gradually until the received radio signal is insufficient to energize its circuits; beyond that point, no signal is returned.

- **Tag Orientation**

  Tags are polarized just as are antennas. For optimal RFID system performance and reading range, tag polarization must be parallel with the applicable antenna's polarization. Ideal alignment of the antenna and tag is with the tag directly in front of the antenna and the tag's longer side oriented parallel with the antenna polarization. The orientation of the tag in direct phase with the antenna pattern returns optimal results. However as a general rule, you may misorient the tag by 15° in any direction with negligible degradation in performance. Proper system configuration can permit even greater tolerance. This tolerance to misorientation allows the system to read tags whose orientation and angle of presentation change as a function of their trajectory through the reading range.

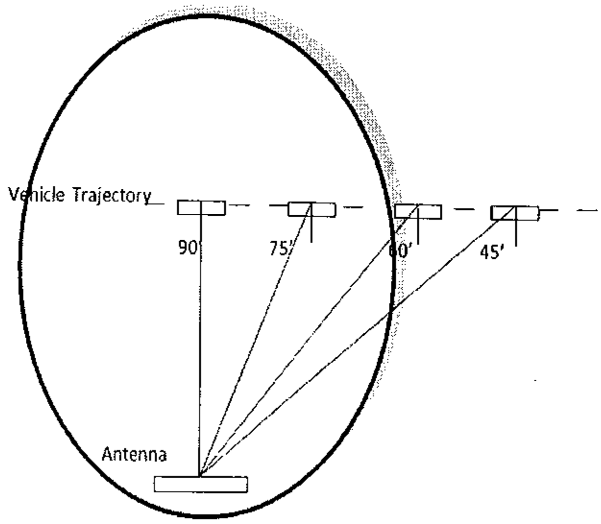


Figure 2.2: This illustration shows a tag passing through the system antenna reading range. Note how the reading range is weaker when the tag is at greater angles to the antenna.

- **Tag Speed**
  The speed at which a moving tag can be read is limited by the need to receive a little more than one complete code frame while the tag is within reading range. In general, in order for the tag to move faster, you need to have a "cleaner" environment, which means stronger signals and fewer sources of noise.

- **Tag Mounting Surface**
  The surface upon which a tag is mounted affects the tag's performance, to a greater or lesser degree dependent on the tag type. You may have a tag that is designed to perform best when it is mounted on a non-conducting surface, such as a cardboard box. Therefore, any metal or other conducting materials in the immediate vicinity of the tag affects its performance as they may create radio signal reflections, refractions, or shadows. The nearness of the box contents, especially metal contents, to the tag or a hand held

behind the tag will also affect its performance as these factors can change the impedance of the tag's internal antenna. Another tag may be designed to perform best when mounted against a metal surface. The metal serves as a ground plane for the tag antenna, thus increasing the reading range.

- **Tag Sensitivity**
  Tag sensitivity is defined as the ability of a tag to decode commands within the radio frequency stream, discerning data from electrical noise. This ability varies slightly among tags of the same type. The net effect of this variability is that a reader can read more sensitive tags at a greater distance than less sensitive tags. An environment that has only one reader is virtually noise-free and the reader may easily be able to power up the tag within a certain reading range. If several readers are added to this environment, they also add a lot of noise. The reading range for each reader may become significantly smaller.

- **Tag Reflectivity**
  Tag reflectivity is defined as how effectively a modulated backscatter tag's antenna-switching circuit reflects energy back to the RFID reader. This ability is affected by materials used, pattern, and size. For example, if you want a tag with great reflectivity, make it using pure silver and make it (relatively) large.

2.2.3 Steps to Select the Tag

While selecting a tag for application following factors nead to be considered:

- **Frequencies and Bandwidth**
  Depending on the country, several frequency bands may be available. Choose a frequency for your RFID equipment, including the tags, that matches your application and performance requirements. The actual frequency of operation for a particular tag is determined by the tag's antenna design, but the same circuitry can be used regardless of which frequency is desired.

- **Tag Type**
  RFID systems that use read/write tags and modulated backscatter technology (class 2 tags). Read/write tags are much more flexible than read-only tags or WORM tags and modulated backscatter tags are less expensive than active or active backscatter tags.

- **Reading Range Performance**
  For any application, a tag's reading range is usually the primary gauge of

its suitability.

- **Environment**
  The tag location and how the tag is used can play a significant role in determining the right tag for your application. The reading range performance will differ depending on what materials are adjacent to the tag. Other environmental conditions such as temperature and humidity may also affect performance.

- **RFID Standards Compliance**
  Compliance to industry standards should play an important role when you are choosing RFID equipment. Manufacturers makes RFID equipment that supports both ISO 18000-6B and EPCglobal Gen 2 class 2. Any equipment that supports either of the standards are technically interoperable.

2.3 RFID Antenna:

The antenna in an RFID tag is a conductive element that permits the tags to exchange the data with the reader. Passive RFID tags make use of coiled antenna that can create a magnetic field using the energy provided by the readers carrier signal.

Every RFID tag has an antenna and every RFID reader has either an integrated antenna or an external system antenna. An RFID antenna has two functions:

- Transmit the radio signal.

- Receive the coded signal transmitted or reflected by the tag.

Antennas come in many different forms and can be used for many different applications in many different environments. **Understanding the Antenna Radiation Pattern Graphs** The antenna radiation pattern graph is part of each antenna's specification. It represents two-dimensional, horizontal or vertical "slices" of the antenna's three-dimensional field of broadcast relative to field intensity. It does not illustrate the absolute value of the relative field strength, but it displays the field strength at a given angle. These graphs show the RF field strength for any direction measured at a fixed distance from the antenna. The outer concentric circles in the antenna pattern graphs show field strength changes in 5 dB increments, indicated by the numbers on the horizontal scale. Each dB corresponds to an attenuation ratio of approximately 1.12. The antenna radiation pattern graphs apply only to the antenna's "far field."

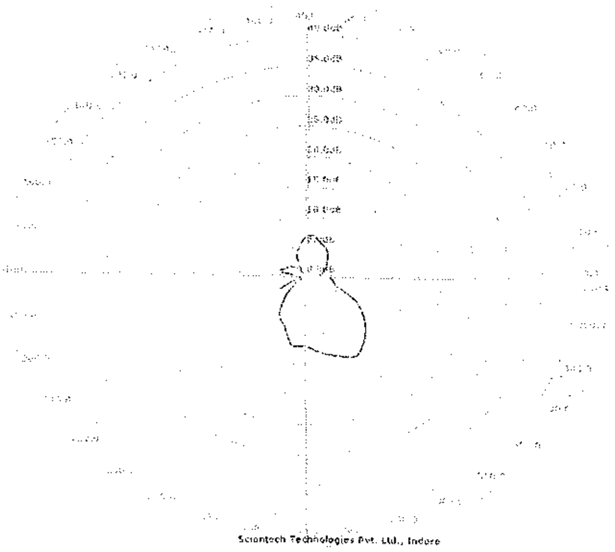


Figure 2.3: Radiation Pattern of Antenna

2.4 RFID Transponder:

An RFID transponder is a special kind of radio transmitter and receiver. It is activated when it receive signal of specific kind. RFID transponder is present in RFID smartcards and RFID Tags.

2.5 RFID Reader:

An RFID reader is the device that is used to interrogate an RFID tag. The reader has an antenna that emits radio wave, the tag responds by sending back its data. A number of factor can affect the distance at which the tag can be read. The frequency use for identification, the antennae gain, orientation and polarization of the reader antenna and transponder antenna, as well as placement of the tag on the object to identified will all have an impact on the RFID systems read range.

In the most general terms, RFID readers identify and communicate with RFID tags. The reader, which has one or more system antennas, generates and sends out RF energy, processes data returned by the tags in its reading range, and relays the tag data to a host system. If your RFID system uses modulated backscatter (passive) tags, the reader must generate enough RF energy to energize the tags' circuitry so that the tag can reflect its data back to the reader. The reader may also write to tags. Readers come in many different forms and can be used for many different applications in many different environments. There are fixed readers, portable readers, and vehicle-mount (forklift) readers. You can mount a fixed reader so that it can read tags travelling through dock doors, conveyor belts, loading bays, gates, doorways, and many other areas. You can use portable readers to add RFID capabilities to your existing application without investing in a new mobile computing system. You can also use portable readers to read and write to tags that are in remote locations.

2.5.1 Effects of Reader on RFID System

The reader has both active and passive influence on RFID system performance. Although inevitable, the effect of electrical noise and interference can be mitigated to an extent, through proper installation. The outer boundary of the reading range is marked by the distance from the system antenna at which a tag can no longer be reliably read. This happens when the distance between the reader and a modulated backscatter tag becomes so great that the power of the radio signal is below the tag's sensitivity level. At the outer boundary, tag data will not be read with any degree of certainty.

2.5.2 Reader Sensitivity

The reader's sensitivity is determined primarily by the electrical noise level of its internal circuitry. This noise competes (interferes) with the tag signal, and when sufficiently strong, the noise can overwhelm the tag signal in much the same way static can overwhelm a radio broadcast. Interference can be defined as any undesired electrical energy within the RFID system.

2.5.3 Electrical Noise and Interference

The reader is also vulnerable to electrical noise from external sources, such as:

- **Sources that produce electrical noise when located in the RF field.**
  Sources that produce electrical noise respond in the RF field in the same way a tag responds. When these tag-like signals return through the antenna, they may be strong enough to mask a real tag signal and prevent the reader from decoding the tag ID. Examples of these sources commonly found in the environment are:
  - other readers.
  - fluorescent lights (AC).
  - mercury and sodium vapour lamps (AC-powered street lights).

- camp lanterns (models which convert VDC to high-frequency AC).
- neon lights.

- **Other sources of electrical noise**

  Other sources of electrical noise may also be present in the environment. However, if you configure your RFID system properly, these sources will have little or no effect on system performance. Examples of other sources of electrical noise are:

  - high-speed fans with metal blades.
  - high-speed trains.
  - digital noise.
  - cellular telephones (when switching on and off).
  - micro phonics caused by system vibrations or motions.

Some of these sources of electrical noise are not always easy to locate, since they often generate noise intermittently. The system designer or installer must be aware of such possible sources of noise and be prepared to compensate for them.

Solving Electrical Noise and Interference Problems

The best way to compensate for sources of electrical noise is to remove the source from the RF field. Or, you can remove the source a sufficient distance from the antenna so that its signal level is far below that of the weakest expected tag signal. When it is not practical to move either the source of the noise or the RFID system components, the source must be shielded with wire screen or other suitable material. The type and length of cables used to connect system components can affect noise levels in the system and power output through the antenna. Long cable runs generally require heavier cable and a higher level of EMI (electromagnetic interference) shielding.

2.5.4 Steps to Select the Reader

While selecting a reader for any application following factors need to be considered:

- **Application Type**

  When you are choosing readers for your application, the application itself should be the determining factor. The most common RFID applications are:

- conveyor reading
- portal reading
- stretch wrap station reading
- overhead reading
- mobile reading (using handheld devices)
- forklift reading

- **Frequencies and Bandwidth**

  All RFID systems must operate within national and international laws and regulatory guidelines with respect to frequency and bandwidth use. Depending on the country, several frequency bands may be available. Choose a frequency for your RFID equipment, including the readers, that matches your application and performance requirements.

- **Tag Orientation and Placement**
- **Number of Tags Read at the Same Time**
- **Tag Speed**

2.5.5 Scanners and Smart Readers

Knowing where you want to filter redundant data and where you want to make decisions will help decide if you need a simple scanner or a "smart" reader.

Scanners

Simple scanners rely on a host computer for filtering redundant data and making decisions. This host computer can be a tethered hand held computer (such as the 700 mobile computer) or a vehicle-mounted computer (such as the CV60). It can have a wired or wireless connection to a host computer. Simple scanners combined with a single antenna may offer a cost effective solution in this situation:

- there is already a local host computer (programmable logic controller or edge server) installed
- tags are consistently oriented the same way
- tags are always located in the same place
- few tags travel through the reading range at a time

- tags travel relatively slowly through the reading range.

If you use simple scanners with multiple antennas, it becomes less important to have tags consistently oriented and consistently placed. You can also increase the number of tags that are travelling through the reading range and the speed at which the tags are travelling.

Smart Readers

Smart readers provide real-time decision making based on the tag data. They can evaluate the tag data and respond to it. For example, they can trigger a red light to indicate that manual intervention is required. Since the reader makes the decisions, there is no communications delay because a server is down or busy. Smart readers combined with a single antenna are often mobile and are the best solution for exception reading and subsequent rewriting of tag data. Smart readers combined with multiple antennas can cope with unpredictable tag placement, high tag volume through the reading range and high speed through the reading range. They can also provide local filtering.

2.6 Factors Influncing RFID System Performance

The performance of an RFID system will vary with the principles of the system and the details of its implementation. Since RFID technology is a radio-based technology, its performance is susceptible to interference from other radio transmissions, interference from metals, materials that absorb radio signals, and environmental factors. However, most situations can be handled by using the proper tags, readers, and applications. In general, the operational characteristics of an RFID system are determined primarily by these factors:

- Reading range, or the maximum distance between the system antenna and tag that will allow a successful read or write.

- Reading speed, or the maximum speed of the tag that will allow a successful read or write.

Reading Range

The reading range is the volume of space surrounding the antenna where a tag can be successfully read. For the successful performance of any RFID system, you must have well-defined reading range (also called a capture window) for all readers and antennas (tag and system). The system hardware configuration and the reader firmware commands function together to define the characteristics of the reading range. Other primary factors that shape the reading range are:

- tag speed through the reading range.
- tag power source (battery, reader).
- tag sensitivity and tag reflectivity.
- tag mounting surface.
- presence of other tags in the reading range.
- reader power.
- other sources of electrical noise and interference.

To control extended reading ranges, you need to consider:

- tag separation.
- tag placement.
- antenna placement.
- shielding or absorbing materials.

Reading Speed

The reading speed is measured by the amount of time it takes the reader to receive a complete code frame while the tag is within the reading range. Because signal reception does not always start at the beginning of the tag's message, you must design the system to receive slightly more than two full code frames to ensure that it receives the entire message. Reading speed can be improved by:

- increasing the width of the reading range.
- decreasing the number of characters (length of message) read from the tag.
- decreasing the number of tags to be read simultaneously.
- increasing the clock rate of the tag.

Tag Orientation and Placement

Considered the sensitive of how the tag is oriented and the surface on which the tag is mounted. Ideally, one should orient the tag so that the polarization of its internal antenna is always aligned favorably with the polarization of the system antenna. If you do not properly align the tag and system antennas, you may only end up with problem.

Electrical Noise and Interference

RFID systems are affected by electrical noise and interference that may be present in the environment. The equipment must be able to cope with common sources of electrical noise and interference, such as other communication systems and devices, televisions, cellular phones, two-way radios, radar, and other readers and tags. RFID systems are also affected by noise generated by motors, fans, digital equipment, and automobile ignition systems. Fluorescent lights and neon signs can interfere with the radio signal. RFID systems that use tags that transmit harmonics of the reader signal often encounter "rusty joint" problems. Anywhere radio currents flow in devices with nonlinear effects harmonics of the reader signal are generated. These harmonics can interfere with the coded harmonic signals generated by the tag and may cause poor performance in these types of systems.

Tag Life

Modulated backscatter tags last "forever." That is, they last as long as the life of most normal low-use electrical systems unless they are damaged. Active backscatter (semi-passive) and active tags last until the battery that is used to power them is exhausted from repeated use or loses energy from internal leakage or both.

Reading Error Rate

In order for reading error rates to be useful, they must be fully described and understood. Reading errors may include:

- good tags that were missed.
- good tags providing bad data.
- "ghost" reads, which occur when a reader says it has read a tag, but the tag is not there.

Create a summary of the RFID system's performance, including a report of how many good tags were read. Then, a statistical analysis of these rates may indicate a need for an on-site visit to see what may be wrong. Also, this analysis can be run in a background application that is set to trigger when averages drop below a predetermined level, which may indicate a system fault.

Environmental Capabilities

Radio signals can be degraded by obstructions or materials between the tag and antenna. Radio waves penetrate non-conducting materials (such as snow, ice, dirt, wood, paper, plastic, and cured concrete) with only moderate attenuation. Other, more conductive materials, such as water (especially saltwater), not only attenuate the radio signal, but can also reflect or refract a portion of the radio waves at the surfaces of the material. The amount of refraction produced is related to the dissimilarity in impedances of adjacent materials.

Other Considerations

Many fundamental properties of radio waves (reflection, refraction, diffraction, multipath) influence the RFID system. Multipath can cause high fields (extended reading range areas) and low fields (null regions) that must be taken into account when you design your system. The combined effects of signal diffraction and multipath reflections can allow tags to be read under seemingly impossible circumstances.

Chapter 3

WORKING OF RFID SYSTEM

The reader emits a radio signal that activates the tag and reads and writes data to it. As products are shipped, received or stored, the information (encoded on a bar codelike tag) can be read and received by the reader, which is attached to a computer. RFID has been integrated into the EPCglobal network and uses the EPC (Electronic Product Code). The EPC is a unique number that identifies a specific item in the supply chain. The EPC is stored on a RFID tag, which combines a silicon chip and a reader. Once the EPC is retrieved from the tag, it can be associated with dynamic data such as the origin of an item or the date of its production. Much like a Global Trade Item Number (GTIN) or Vehicle Identification Number (VIN), the EPC is the key that unlocks the power of the information systems that are part of the EPCglobal Network3.

3.1 Electronic Product Code

Electronic Product Code. also called **EPC** is globally unique serial number used to identify the specific object. Basic format of EPC: **Header :** – identifies

HEADER	EPC MANAGER NUMBER	OBJECT CLASS	SERIAL NUMI

Table 3.1: EPC Format

the length, type, structure, version, and generation of the EPC

EPC Manager Number : – entity responsible for maintaining the subsequent partitions

Object Class : – identifies a class of objects

Serial Number : – identifies the instance

NOTE

- Tag forward its EPC to a reader.
- Reader then passes the code to computer or local system Object Name Service (ONS).
- ONS tells the computer system where to locate information on internet about the object carrying EPC

3.2 Computer Networking

Host computer and main server room communicate with each other by using 7 layer of OSI model.

- **The Physical Layer:** The physical layer is concerned with transmitting raw bits over a communication channel. The design issues have to do with making sure that when one side sends a 1 bit, it is received by the other side as a 1 bit, not as a0 bit.
- **The Data Link Layer:** The main task of the data link layer is to transform a raw transmission facility into a line that appears free of undetected transmission errors to the network layer.
- **The Network Layer:** The network layer controls the operation of the subnet. A key design issue is determining how packets are routed from source to destination. Routes can be based on static tables that are "wired into" the network and rarely changed.
- **The Transport Layer:** The basic function of the transport layer is to accept data from above, split it up into smaller units if need be, pass these to the network layer, and ensure that the pieces all arrive correctly at the other end.
- **The Session Layer:** The session layer allows users on different machines to establish sessions between them. Sessions offer various services, including dialog control (keeping track of whose turn it is to transmit), token management(preventing two parties from attempting the same critical operation at the same time), and synchronization(check pointing long transmissions to allow them to continue from where they were after a crash).

- **The Presentation Layer:** Unlike lower layers, which are mostly concerned with moving bits around, the presentation layer is concerned with the syntax and semantics of the information transmitted.

- **The Application Layer:** The application layer contains a variety of protocols that are commonly needed by users. One widely-used application protocol is HTTP (Hyper Text Transfer Protocol), which is the basis for the World Wide Web. When a browser wants a Web page, it sends the name of the page it wants to the server using HTTP. The server then sends the page back.

Channen Use

Many algorithms for allocating a multiple access channel are known, most important and commonly used is **CSMA with Collision Detection.**
It aborts the station transmission transmissions as soon as they detect a collision. In other words, if two stations sense the channel to be idle and begin transmitting simultaneously, they will both detect the collision almost immediately. Rather than finish transmitting their frames, which are irretrievably garbled anyway, they should abruptly stop transmitting as soon as the collision is detected. Quickly terminating damaged frames saves time and bandwidth. This protocol, known as CSMA/CD (CSMA with Collision Detection) is widely used on LANs in the MAC sub layer.

3.3 Modulation in RFID

- Signal in generally RFID is digitally modulated e.g. OOK(On Off Keying).
- Simple switch can be used to create OOK.
- Simple diode can act as demodulator along with capacitor.
- Firstly we code the data and commonly used coding technique is PIE(Pulse Interval Coding).
- Common multiplexing technique used is FDMA and TDMA.

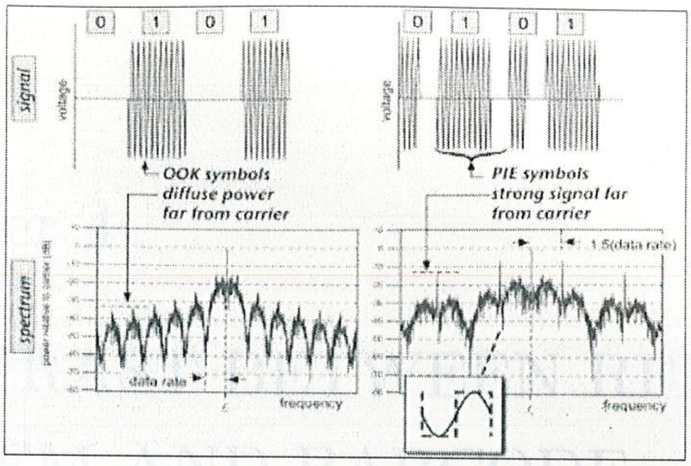


Figure 3.1: Modulation(Ref[9])

3.4 Inductive Coupling

An inductively coupled transponder comprises an electronic data-carrying device, usually a single microchip, and a large area coil that functions as an antenna. Inductively coupled transponders are almost always operated passively. This means that all the energy needed for the operation of the microchip has to be provided by the reader. For this purpose, the reader's antenna coil generates a strong, high frequency electromagnetic field, which penetrates the cross-section of the coil area and the area around the coil. Because the wavelength of the frequency range used is several times greater than the distance between the reader's antenna and the transponder, the electromagnetic field may be treated as a simple magnetic alternating field with regard to the distance between transponder and antenna A capacitor is connected parallel to antenna to form a parallel res-

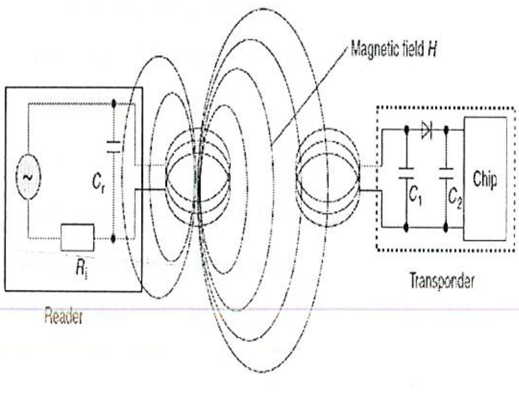


Figure 3.2: Inductive Coupling

onant circuit, with resonance frequency corresponds to transmission frequency which generate a high current generating high field.

Chapter 4

CONTRAST BETWEEN RFID SYSTEM AND BARCODE

RFID tags and barcodes both carry information about products. However, there are important differences between these two technologies:

- Barcode readers require a direct line of sight to the printed barcode; RFID readers do not require a direct line of sight to either active RFID tags or passive RFID tags.

- RFID tags can be read at much greater distances; an RFID reader can pull information from a tag at distances up to 300 feet. The range to read a barcode is much less, typically no more than fifteen feet.

- RFID readers can interrogate, or read, RFID tags much faster; read rates of forty or more tags per second are possible. Reading barcodes is much more time-consuming; due to the fact that a direct line of sight is required, if the items are not properly oriented to the reader it may take seconds to read an individual tag. Barcode readers usually take a half-second or more to successfully complete a read.

- Line of sight requirements also limit the ruggedness of barcodes as well as the reusability of barcodes. RFID tags are typically more rugged, since the electronic components are better protected in a plastic cover. RFID tags can also be implanted within the product itself, guaranteeing greater ruggedness and reusability.

- Barcodes have no read/write capability; that is, you cannot add to the information written on a printed barcode. RFID tags, however, can be read/write devices; the RFID reader can communicate with the tag, and alter as much of the information as the tag design will allow.

- RFID tags are typically more expensive than barcodes, in some cases, much more so.

4.1 Advantages of RFID System

1. Unique identification
2. No manual intervention, no line-of-sight, no moving parts in reader
3. Fast read (300 reads/sec), Reduce effort in data entry
4. Improved data accuracy
5. Information accessible

4.2 Value Proposition

- Reduced info latency
- Decreased labour
- Increased agility
- Increased goods velocity
- Increased security
- Revenue protection

Chapter 5

HARDWARE REQUIREMENTS

5.1 PCB Designing

The main task in designing a PCB is figuring out where all the components are going to go. Normally there is a design or schematic that will be turned in to a PCB. There is no such thing as a standard printed circuit board. Each board is designed for its own use and must be the right size to fit the required space. Board designers use computer-aided design software to layout the circuit designs on the board. The spaces between electrical paths are often 0.04 inches (1.0 mm) or smaller. The location of the holes for component leads or contact points are also laid out. Once the circuit pattern is laid out, a negative image is printed out at exact size on a clear plastic sheet. With a negative image, the areas that are not part of the circuit pattern are shown in black and the circuit pattern is shown as clear. This design is made into instructions for a computer controlled drilling machine or for the automatic solder paster used in the manufacturing process.

5.1.1 PCB Etching

Etching is where the excess copper is removed to leave the individual tracks or traces as they are sometimes called. Buckets, bubble tanks, and spray machines lots of different ways to etch, but most firms currently use high pressure conveyerised spray equipment. Spray etching is fast, ammoniacal etching solutions when sprayed can etch 55 microns of copper a minute. Less than 40 seconds to etch a standard 1 oz, 35 micron circuit board.

Many different chemical solutions can be used to etch circuit boards. Ranging from slow controlled speed etches used for surface preparation to the faster etches used for etching the tracks. Some are best used in horizontal spray process equipment while others are best used in tanks. Etchents for PTH work have to be selective and be non aggressive to tin / tin lead plating, which is used as the etch resist. Copper etching is normally exothermic, where high speed etching is carried out solution cooling is normally required. This is normally done by placing titanium water cooling coil into the etchent. Almost all etching solutions liberate toxic corrosive fumes, extraction is highly recommended. All etchents are corrosive and toxic, mainly due to the high metal content.

1. **PCB Layout**:The PCB layout is a mirrored positive one - black on white. Mirrored as viewed from the silkscreen top (component) side. The PCB layout is printed 1:1 on paper by means of a laser printer or copier machine. The laser printer or copier toner will not run out when it gets wet or oily. The ink of an inkjet paper print does run out and inkjet printers are therefore useless with the described method.

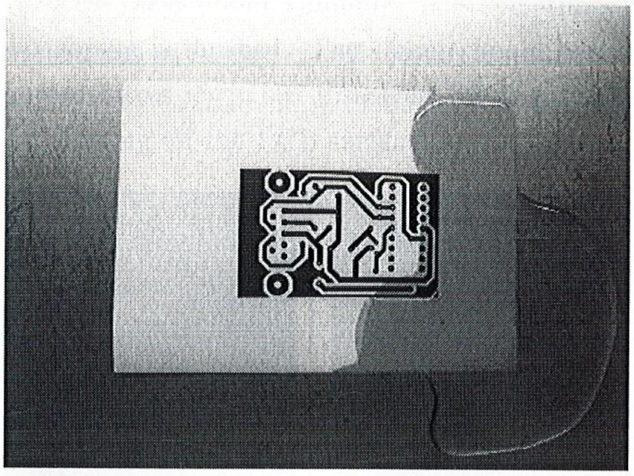


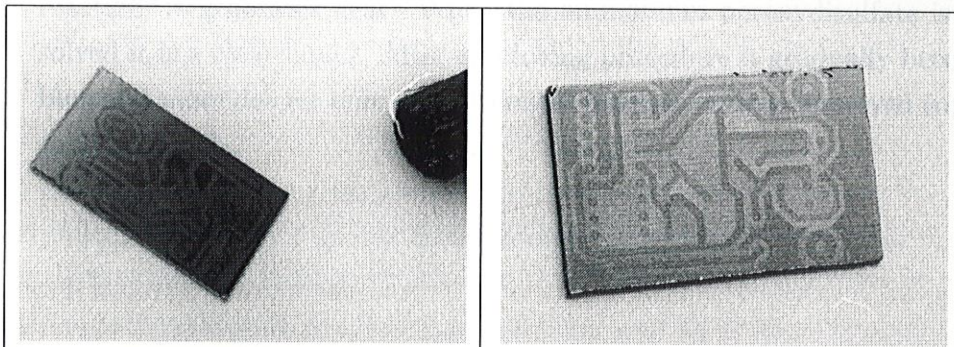
Figure 5.1: Drench Layout with sunflower-seed oil

2. **PCB Preparation**:The PCB layout paper is drenched with sunflower-seed oil. Sunflower-seed oil is common available from your local grocery or wall market. Superfluous oil should be removed carefully with tissue paper. The sunflower-seed oil is used to make the white part of the layout paper transparent for light. If you prefer to use the PCB layout more than once let the drenched PCB layout paper dry at least 48 hours. The layout paper should be carefully dried on forehand as much as possible with tissue paper. Sunflower-seed oil is a 'drying' oil. Exposed to the air over a number of hours, the layout paper becomes rigid again. A kind of polymerization takes place.

3. **PCB UV Exposure**:The protective plastic layer is removed - peeled back - from the photosensitive PCB. The toner side of the greased layout is placed

on the copper of the PCB. Captured air-bubbles are gently pressed away from underneath the layout. The PCB with the layout is now covered with an appropriate sized windowpane and placed on a piece of plain polished tile or marble. The tile or marble absorbs the heat coming from the UV bulb, which is significant. Three to four minutes 300W bulb UV exposure from a distance of 30-40 cm will do the photo process. Take care when finished and removing the PCB, it gets hot.

4. **PCB Development**:The PCB is developed with a 1% solution of sodium hydroxide NaOH. You can make this solvent by adding 10 gram of sodium hydroxide pellets to 1 liter of water and mix it until everything is dissolved. Use a brush to speed up the developing and clean the PCB during this process if the PCB is still greasy due to the applied sunflower-seed oil. The developing process takes about 1 minute. It is sometimes difficult to guess when the developing is finished. The traces should become clear and the exposed photosensitive layer has dissolved (during the brushing you see darker 'cloud' coming off the PCB surface).



(a) Gently brush the PCB

(b) Almost developed, some traces are not clear yet

Figure 5.2: PCB development

5. **PCB Etching**:The developed PCB is etched with a 220 g/l solution of ammonium peroxydisulfate $(NH_4)_2S_2O_8$ a.k.a. ammonium persulfate, 220 gram added to 1 liter of water and mix it until everything is dissolved. Theoretically it should be possible to etch slightly more than 60 grams of copper with 1 liter etching solution. Assume an 50% efficiency, about 30 grams of copper.Etching at ambient temperature might take over an hour, it is better to heat up the etching solvent to about 35-45 degrees Celcius. The etching solution heating up could be done in a magnetron, this takes about 40 to 60 seconds in a 850W magnetron.

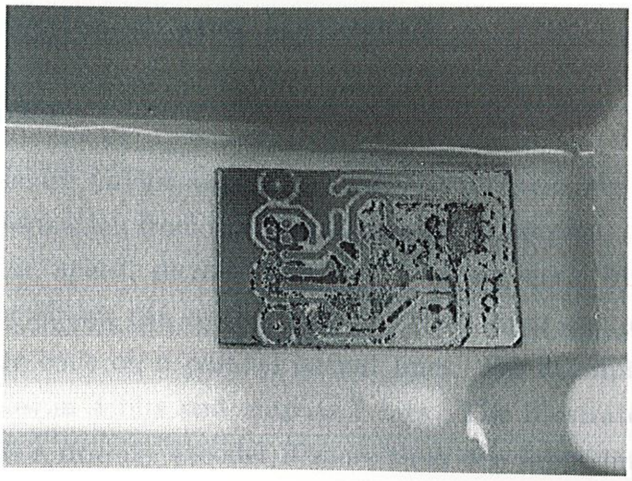


Figure 5.3: PCB Etching

The etching - rocking the etching tray - takes about 15-30 minutes at this temperature. If you have a heated, air-bubble circulated etching fluid tank available, this is probably the fastest way to etch. At higher temperatures the etching performance decreases. The etching process is an exothermic reaction, it generates heat. When the ammonium peroxydisulfate is dissolved it is a clear liquid. After an etching procedure it gradually becomes blue and more deeper blue - the chemical reaction creates dissolved copper sulfate $CuSO_4$.

5.2 Transmitter and Receiver

5.2.1 Encoder

An encoder is a device, circuit, transducer, software program, algorithm or person that converts information from one format or code to another, for the purposes of standardization, speed, secrecy, security, or saving space by shrinking size. A simple encoder circuit can receive a single active input out of 2n input lines generate a binary code on n parallel output lines. For example a single bit 4 to 2 encoder takes in 4 bits and outputs 2 bits. The illustrated example will sometimes fail as a priority encoder if more than one input line is active at a time.

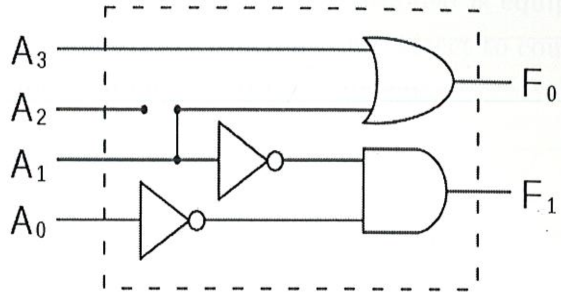


Figure 5.4: Encoder

A priority encoder is a circuit or algorithm that compresses multiple binary inputs into a smaller number of outputs. The output of a priority encoder is the binary representation of the ordinal number starting from zero of the most significant input bit. They are often used to control interrupt requests by acting on the highest priority request. If two or more inputs are given at the same time, the input having the highest priority will take precedence. An example of a single bit 4 to 2 encoder is shown, where highest-priority inputs are to the left and "x" indicates either a 1 or a 0 (i.e., either input value yields the same output when superseded by a higher-priority input). Priority encoders can be easily connected in arrays to make larger encoders, such as a 16 to 4 encoder made from six 4 to 2 priority encoders (four encoders having the signal source connected to their inputs, and two encoders that take the output of the first four as input). The priority encoder is an improvement on a simple encoder circuit, in terms of handling all possible input configurations. There are 7 types of encoder:-

1. Rotary encoder or Shaft encoder: An Electro-Mechanical device which converts the angular position of shaft or axel to an analog or digital code,

making it angular transducer.

2. Incremental Encoder: It is sometimes called a relative encoder.

3. Absolute Position encoder: These are used to generate an electrical signal that indicates absolute mechanical position, or an incremental mechanical movement relative to a reference position.

4. Quadrature Encoder: The most common type of incremental encoder uses 2 output channels (A and B) to sense position.

5. Linear Encoder: It is a sensor, transducer or read head paired with scale that encodes position.

6. Open Collector Encoder: The encoder supplied is equipped with an NPN open collector configuration which if wired direct to counter module would require the counter module to source current.

7. Binary Code Encoder

Here in our project we used HT/12 E encoder which satisfies our project requirements. 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 or a DATA trigger on the HT12A further enhances the application flexibility of the 2^{12} series of encoders. The HT12A additionally provides a 38kHz carrier for infrared systems.

Its Feature

- Operating voltage: 2.4V 5V for the HT12A 2.4V 12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1A (typ.) at VDD=5V
- HT12A with a 38kHz carrier for infrared transmission medium
- Minimum transmission word
- Four words for the HT12E
- One word for the HT12A

- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components
- HT12A/E: 18-pin DIP/20-pin SOP package

Internal block diagram of encoder

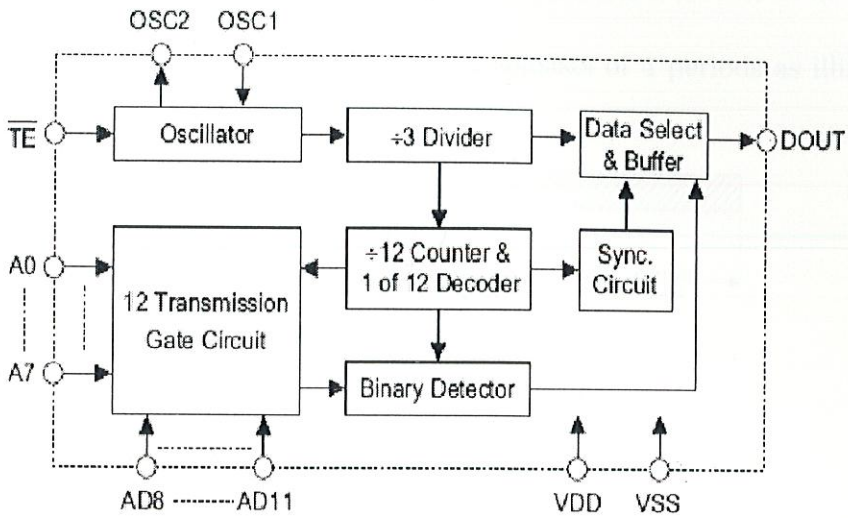


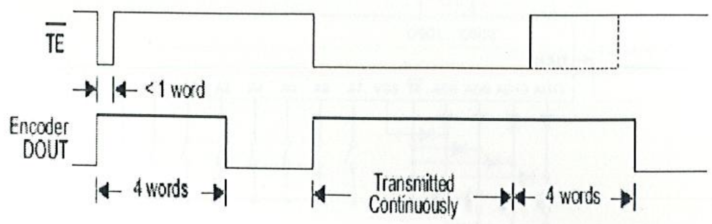
Figure 5.5: Internal block diagram of encoder

Operation

The 2^{12} series of encoders begin a 4-word transmission cycle upon receipt of a transmission enable (TE for the HT12E or D8 D11 for the HT12A, active low). This cycle will repeat itself as long as the transmission enable (TE or D8 D11) is held low. Once the transmission enable returns high the encoder output completes its final cycle and then stops as shown below.

Information word

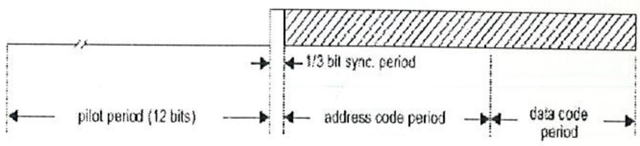
If L/MB=1 the device is in the latch mode (for use with the latch type of data decoders). When the transmission enable is removed during a transmission, the DOUT pin outputs a complete word and then stops. On the other hand, if L/MB=0 the device is in the momentary mode (for use with the momentary type of data decoders). When the transmission enable is removed during a transmission, the DOUT outputs a complete word and then adds 7 words all



Transmission timing for the HT12E

Figure 5.6: Transmission Timing

with the 1 data code. An information word consists of 4 periods as illustrated below.



Composition of information

Figure 5.7: Composition Of Image

Address/data programming (preset)

The status of each address/data pin can be individually pre-set to $logic_{high}$ $logic_{low}$. If a transmission-enable signal is applied, the encoder scans and transmits the status of the 12 bits of address/data serially in the order A0 to AD11 for the HT12E encoder and A0 to D11 for the HT12A encoder. During information transmission these bits are transmitted with a preceding synchronization bit. If the trigger signal is not applied, the chip enters the standby mode and consumes a reduced current of less than 1A for a supply voltage of 5V. Usual applications preset the address pins with individual security codes using DIP switches or PCB wiring, while the data is selected by push buttons or electronic switches. The following figure shows an application using the HT12E:

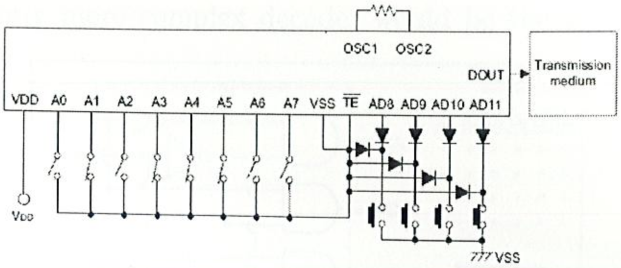


Figure 5.8: How To Use Encoder IC

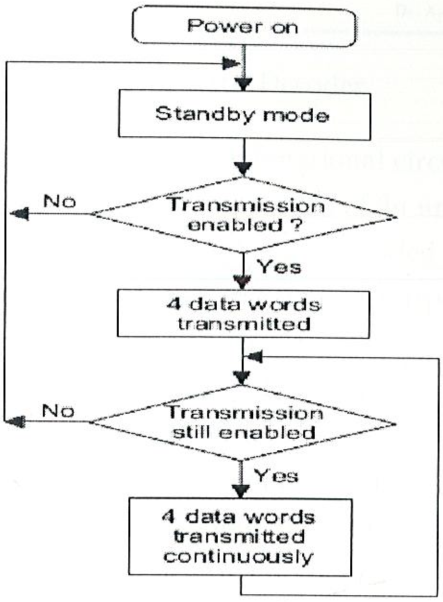


Figure 5.9: Flow Chart

5.2.2 Decoder

A decoder is a device which does the reverse of an encoder, undoing the encoding so that the original information can be retrieved. The same method used to encode is usually just reversed in order to decode. In digital electronics, a decoder can take the form of a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs, where the input and output codes are different. E.g. n-to-2n, binary-coded decimal decoders. Enable inputs must be on for the decoder to function, otherwise its outputs assume a single "disabled" output code word. Decoding is necessary in applications such as data multiplexing, 7 segment display and memory address decoding. The example decoder circuit would be an AND gate because the output of an AND gate is "High" (1) only when all its inputs are "High." Such output is called as "active High output". If instead of AND gate, the NAND gate is connected the output will be "Low" (0) only when all its inputs are "High". Such output is called as "active low output". A slightly more complex decoder would be the n-to-2n type binary

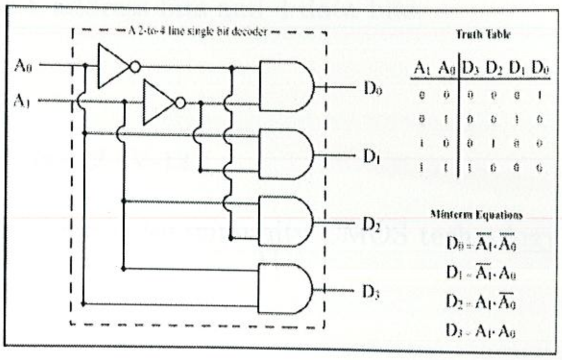


Figure 5.10: Decoder

decoders. These types of decoders are combinational circuits that convert binary information from 'n' coded inputs to a maximum of 2n unique outputs. We say a maximum of 2n outputs because in case the 'n' bit coded information has unused bit combinations, the decoder may have less than 2n outputs. We can have 2-to-4 decoder, 3-to-8 decoder or 4-to-16 decoder. We can form a 3-to-8 decoder from two 2-to-4 decoders (with enable signals). Similarly, we can also form a 4-to-16 decoder by combining two 3-to-8 decoders. In this type of circuit design, the enable inputs of both 3-to-8 decoders originate from a 4th input, which acts as a selector between the two 3-to-8 decoders. This allows the 4th input to enable either the top or bottom decoder, which produces outputs of D (0) through D (7) for the first decoder, and D (8) through D (15) for the second decoder. A decoder that contains enable inputs is also known as a decoder-demultiplexer. Thus, we have a 4-to-16 decoder produced by adding a 4th input shared among both decoders, producing 16 outputs.

Selection of row takes place as: Most kinds of random-access memory use an n-to-2n decoder to convert the selected address on the address bus to one of the row address select lines. Decoder is a circuit that is used to convert an input lines 2n output lines. **In our project we are using HT12/D compatible with the encoder explained above (HT12/E)** The 2^{12} decoders are a series of CMOS LSIs for remote control system applications. They are paired with 2^{12} series of encoders. 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 212 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.

Its features:

- Operating voltage: 2.4V-12V
- Low power and high noise immunity CMOS technology
- Low standby current
- Capable of decoding 12 bits of information
- Binary address setting
- Received codes are checked 3 times
- Address/Data number combination
- HT12D: 8 address bits and 4 data bits
- Built-in oscillator needs only 5% resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external components
- 18-pin DIP, 20-pin SOP package

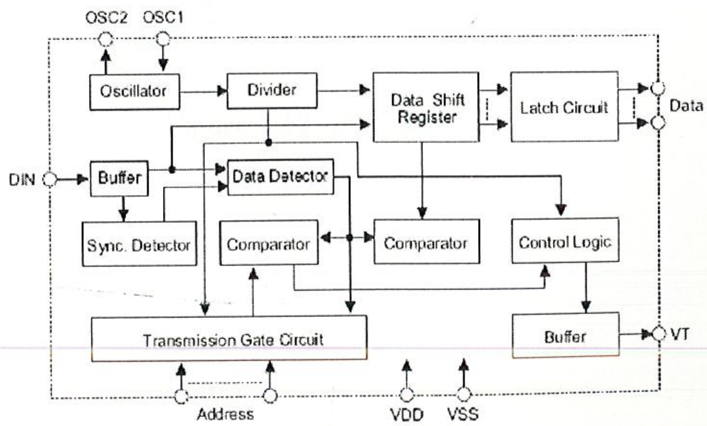


Figure 5.11: Internal Block Diagram

Operation

The 2^{12} series of decoders provides various combinations of addresses and data pins in different packages so as to pair with the 2^{12} series of encoders. The decoders receive data that are transmitted by an encoder and interpret the first N bits of code period as addresses and the last 12-N bits as data, where N is the address code number. A signal on the DIN pin activates the oscillator which in turn decodes the incoming address and data. The decoders will then check the received address three times continuously. If the received address codes all match the contents of the decoder local address, the 12-N bits of data are decoded to activate the output pins and the VT pin is set high to indicate a valid transmission. This will last unless the address code is incorrect or no signal is received. The output of the VT pin is high only when the transmission is valid. Otherwise it is always low.

Output type

Of the 2^{12} series of decoders, the HT12F has no data output pin but its VT pin can be used as a momentary data output. The HT12D, on the other hand, provides 4 latch type data pins whose data remain unchanged until new data are received.

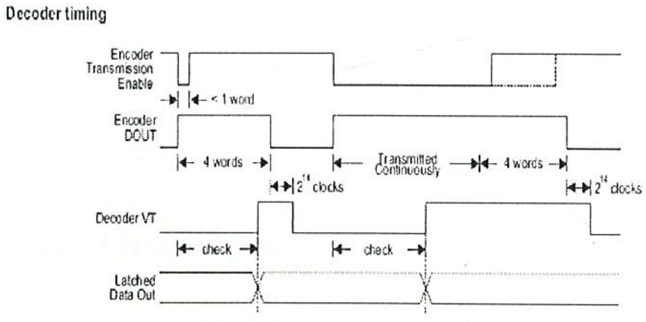


Figure 5.12: Decoder Timing

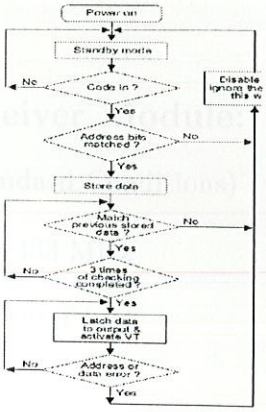


Figure 5.13: Flow Chart

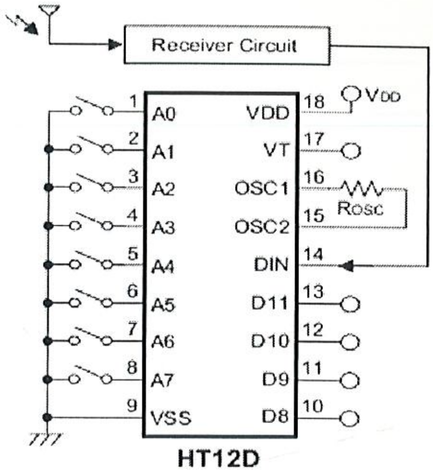


Figure 5.14: Application Of Decoder

5.3 General Description:

We are using radio frequency generator module for transmitting as well as receiving the transmitted information in digital form. At the transmitter stage, four bit information is modulated using Amplitude Shift Keying (ASK) modulation and transmitted. At the receiver end, the modulated signal is received.

5.3.1 Features of Transmitter Module:

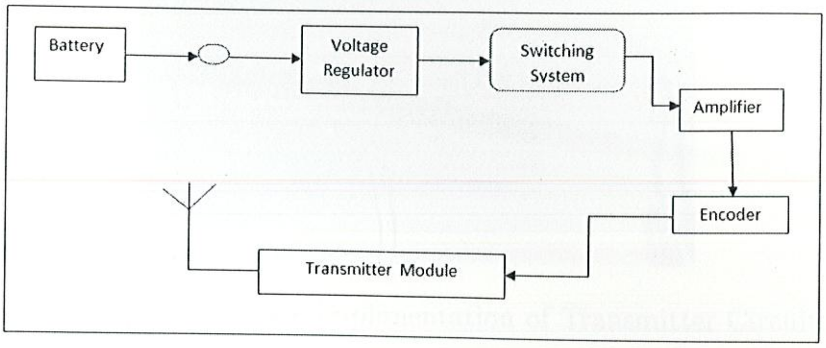
- Effective low cost, small size, and simple-to-use for designing.
- Frequency Range: 433.92 MHZ.
- Supply Voltage: 3 12V.
- Output Power: 4 16dBm

- Circuit Shape: Saw

5.3.2 Features of Receiver Module:

- Range in open space(Standard Conditions) : 100 Meters
- RX Receiver Frequency : 433 MHz
- RX Typical Sensitivity : 105 Dbm
- RX Supply Current : 3.5 mA
- RX IF Frequency : 1MHz
- Low Power Consumption
- Easy For Application
- RX Operating Voltage : 5V
- TX Frequency Range : 433.92 MHz
- TX Supply Voltage : 3V 6V
- TX Out Put Power : 4 12 Dbm

5.4 Block Diagram of Transmitter System



5.4.1 Circuit Analysis:

Battery is the source power to the system, which provides the required energy to drive the system. Then circle represents the switch (On/Off Switch). Voltage regulator circuitry will regulate the power supply to the desired voltage so that to avoid the burning of components in case of excess of power supply voltage, and also to avoid the reverse flow of current in the circuit. Switches are used to transmit the information of tag in terms of binary. Next stage is of amplifier which amplifies the weak signal so that it can be understood by the encoder and then transmitter module will transmits the information after modulation through antenna.

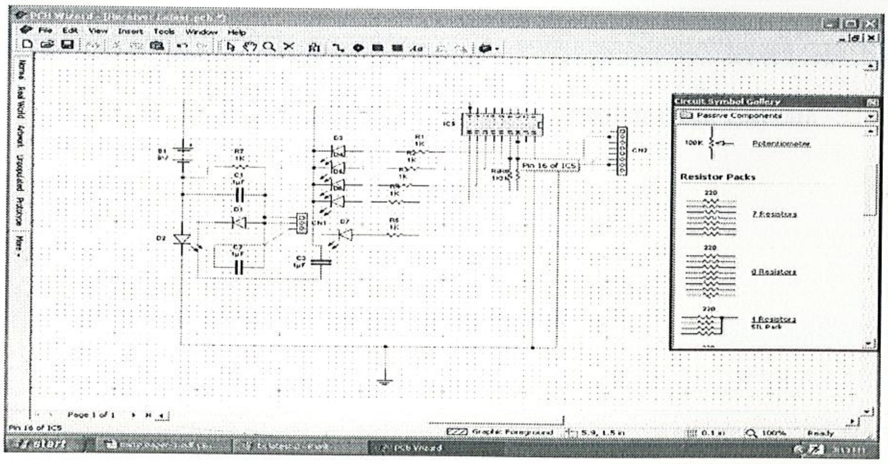


Figure 5.15: PCB Wizard Designed Transmitter Circuit

Result

This module has successfully been implemented and verified on the basis of their accuracy with the theoritical values.

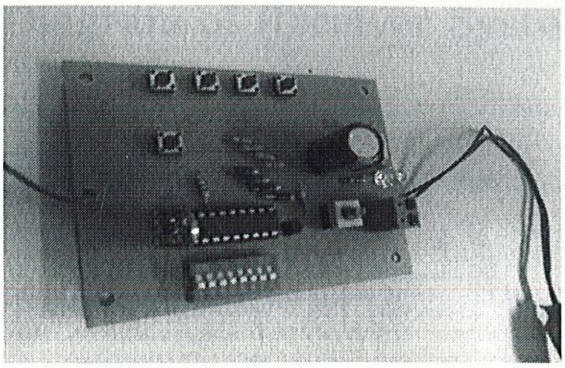


Figure 5.16: Hardware Implimentation of Transmitter Circuit

This module is able to transmit four bit data successfully.

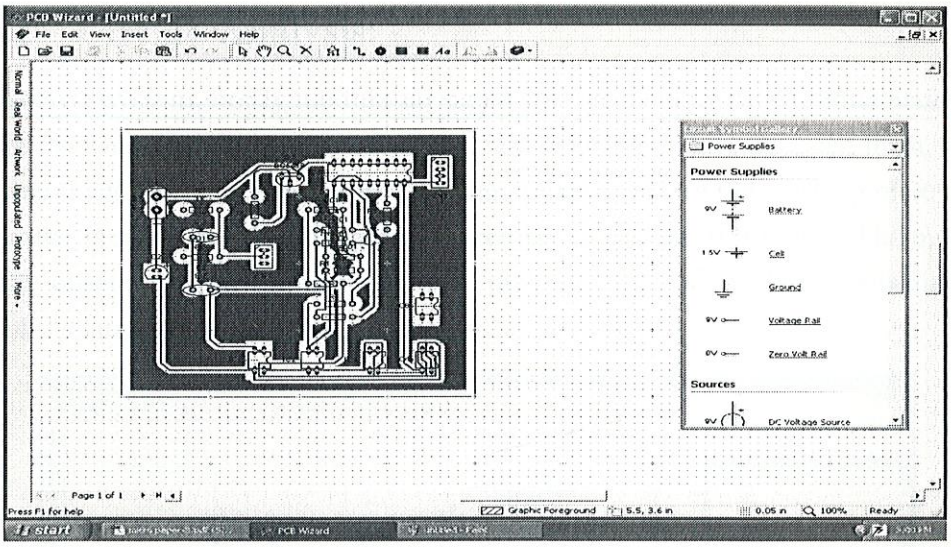
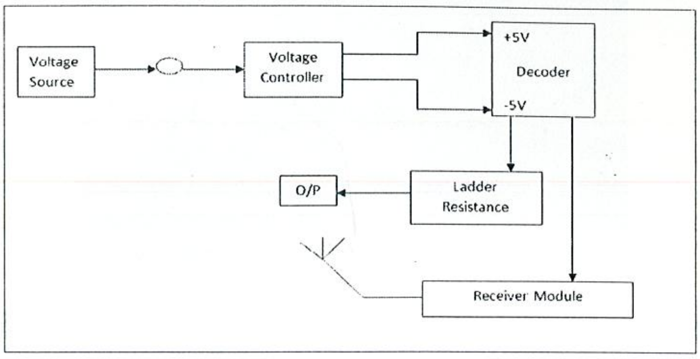


Figure 5.17: PCB Wizard Designed Transmitter Layout

5.5 Block Diagram of Receiver System



5.5.1 Circuit Analysis:

In Receiver system, firstly modulated signal will received by the antenna attached to the receiver module, which will demodulate the signal into encoded form, then the signal will move to decoder for decoding purpose. Here the working of voltage controller is same as voltage regulator circuitry in transmitter stage. The output can be observed from the decoder data pins and LED's will light according to the bits switched at the transmitter end.

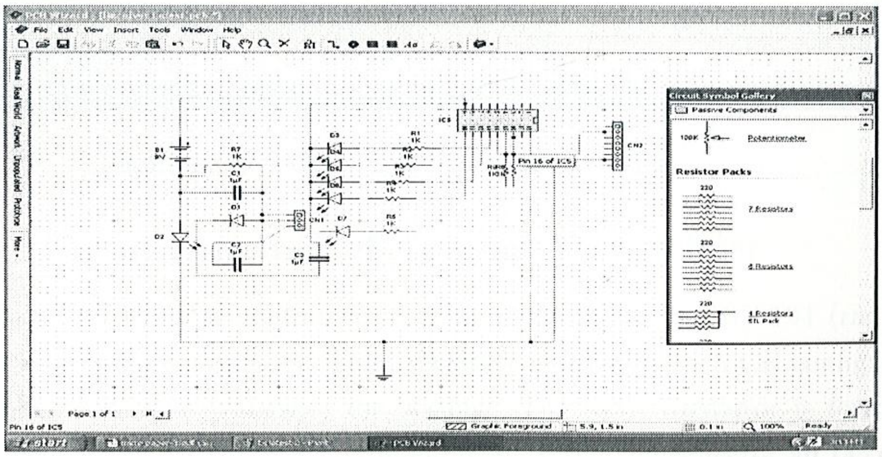


Figure 5.18: PCB Wizard Designed Receiver Circuit

Result

This module has successfully been implemented and verified on the basis of their accuracy with the theoritical values.

This module is able to recieve four bit data successfully and further forwards the decoded information to host computer for further actions.

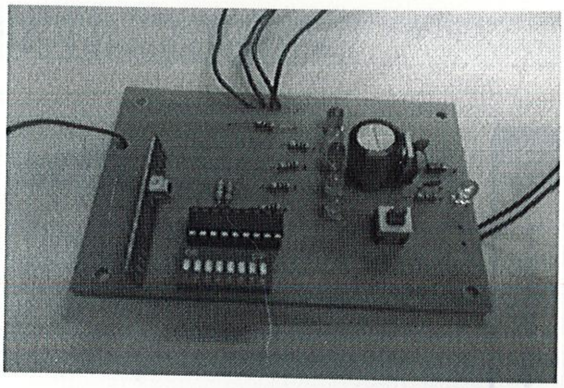


Figure 5.19: Hardware Impimentation of Receiver Circuit

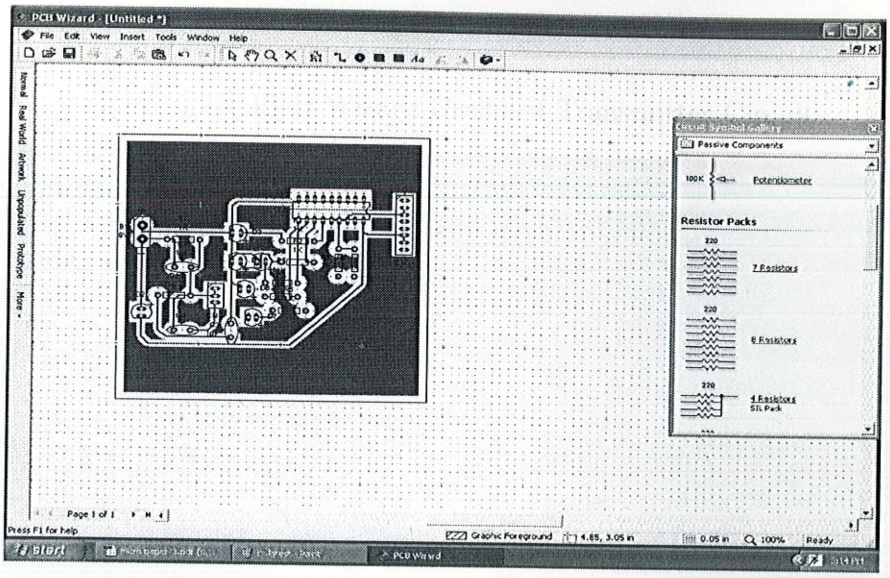


Figure 5.20: PCB Wizard Designed Receiver Layout

5.5.2 Circuit Analysis of Another Transmitter

RF remote transmitter contain an oscillator comprises one BF-194 (radio frequency modulator transistor). This transistor is coupled with CE configuration with other NPN 548 transistor for biasing. The basic oscillator is formed by transistor T3 working under CE configuration. From the collector an LC circuit is generating the source oscillation that super imposes to the T-2 base from its emitter follower circuit. R2 provides biasing Vcc to T3. R1 and LED indicate the power 'on' while pressing the key. The basic modulation circuit comprises T-1, R-6, C-2 and a trimmer variable capacitor. By changing the IFT at the T3 collector (LC circuit) we can change frequency for transmission. Varying trimmer at collector of T-1 can do the range and alignment between transmitter and receiver. A 9V portable battery powers the whole unit.

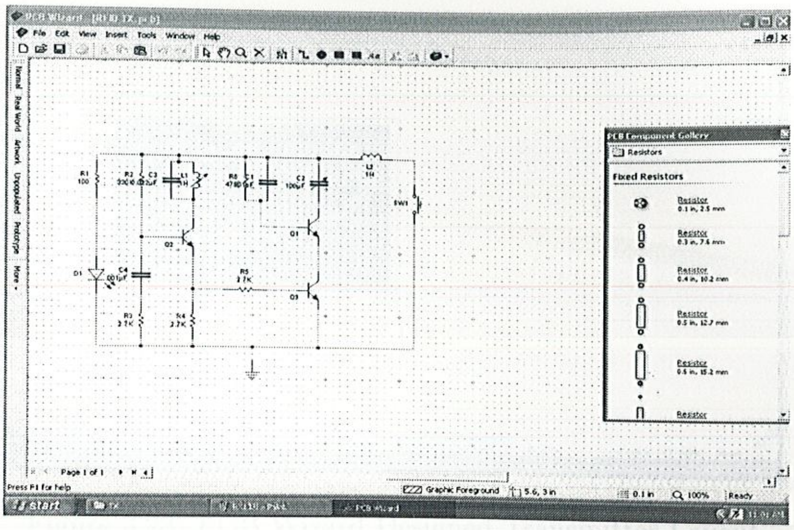


Figure 5.21: PCB Wizard Designed Transmitter Circuit

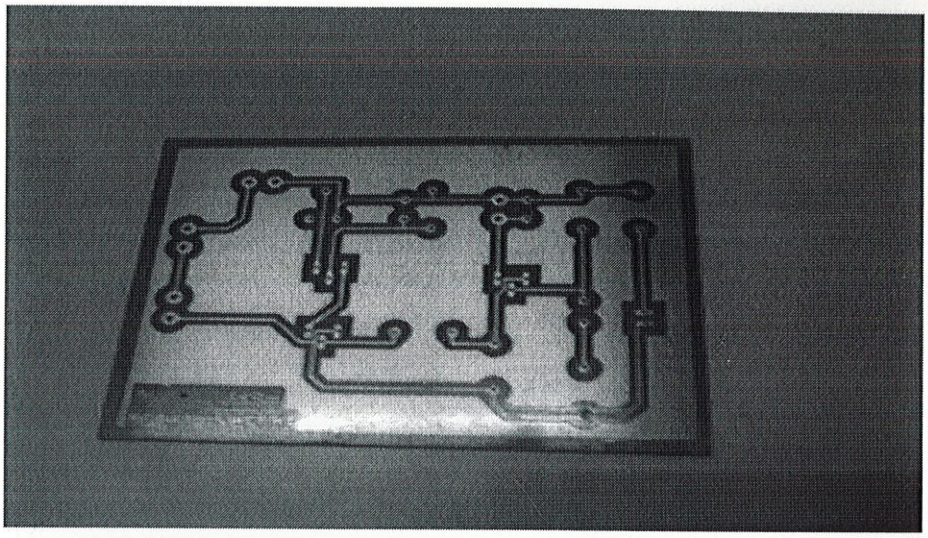


Figure 5.22: PCB Layout of Transmitter Circuit

5.5.3 Circuit Analysis of Another Receiver

In the receiver circuit the transmitter Q1 also working as LC tank circuit basic oscillator that receives the variable frequencies Q2, Q3 are two basic low power amplifier provides amplification to all frequencies. L2 coil (IFT) selects the specific frequency to further amplifiers and fed at the base of Q4 via R-14 resistor. The power amplification is provided by Q5 transistor. In the circuit R2 and R3 provides biasing Vcc to Q1 same as R10 provides biasing Vcc+ to Q2 transistors. C1 and R5 give CE follower circuit for Q1 and same as for Q2 as R8 and C6 doing the same function. Rest other resistor and capacitor provides necessary basing Vc and frequency cut off function at different stages of the circuit. Finally from Q5 the driver unit given output to the buzzer or any other connected device

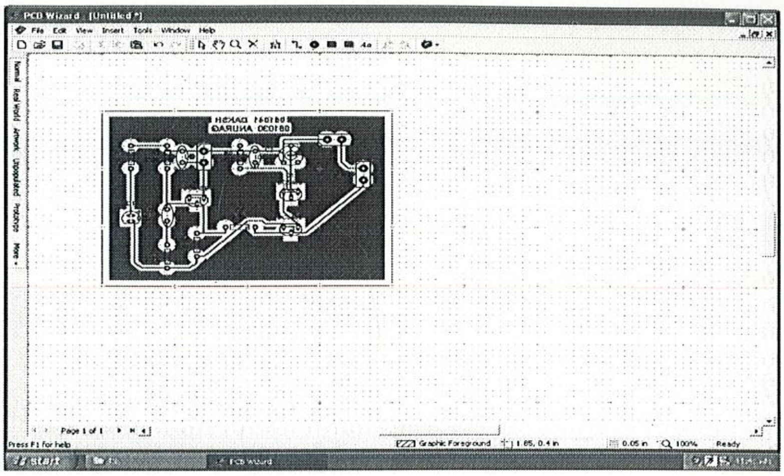


Figure 5.23: PCB Wizard Designed Transmitter Layout

to operate that unit.

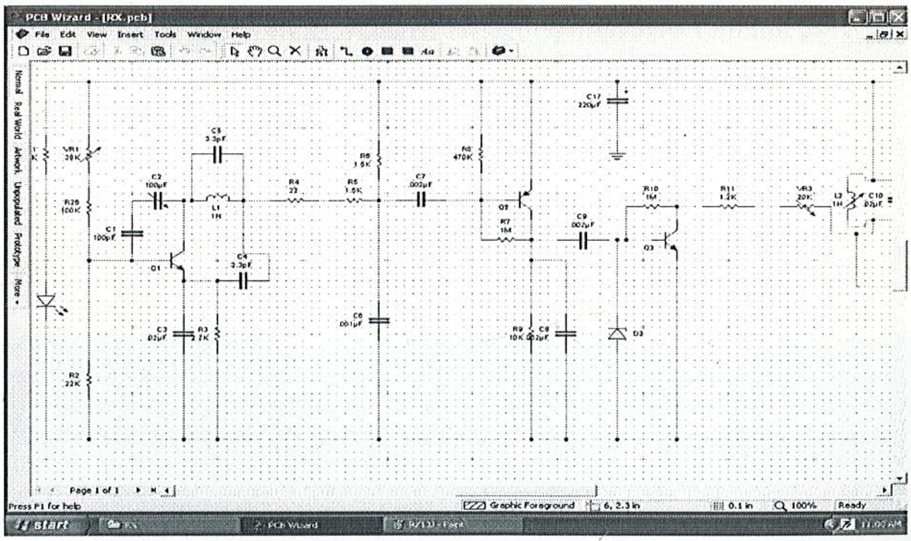


Figure 5.24: PCB Wizard Designed Receiver Circuit.1

Result

Due to inappropraite tunnig of inductor and incorrect value of few circuit elements from the reference and also due to the complexity of the circuitry its bit tedious to generate high frequency for communication. Hence the module is not completed successfully.

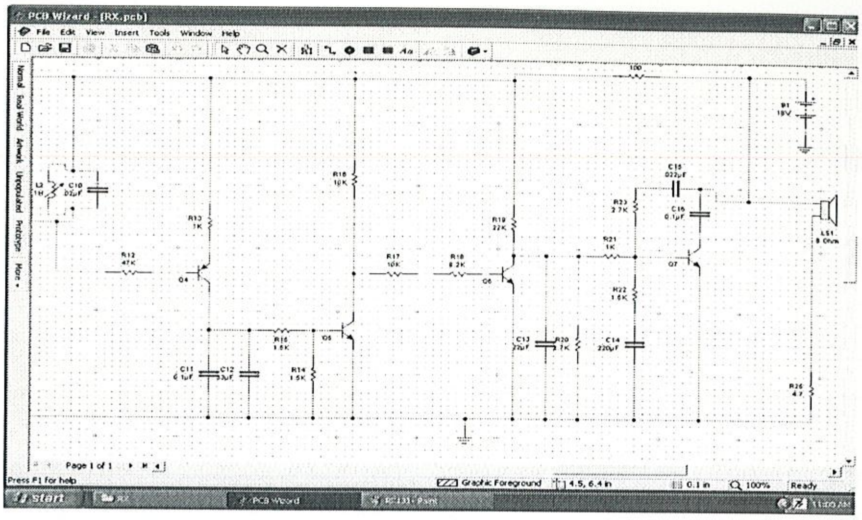


Figure 5.25: PCB Wizard Designed Receiver Circuit.2

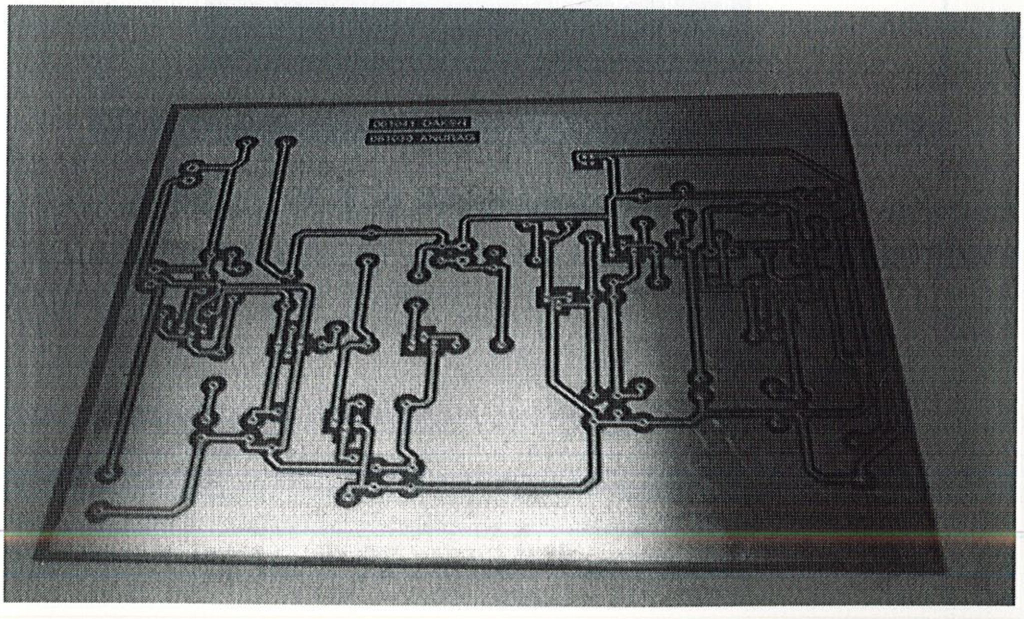


Figure 5.26: PCB Layout of Receiver Circuit

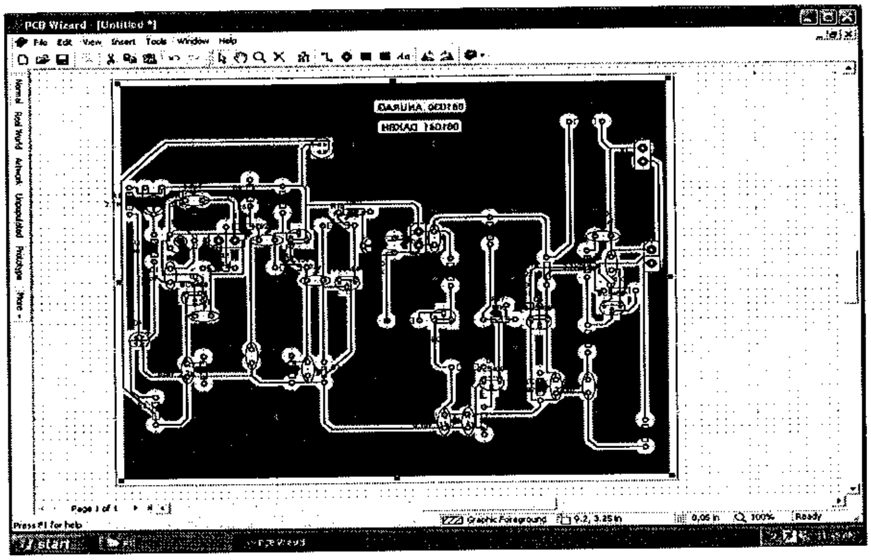


Figure 5.27: PCB Wizard Designed Receiver Layout

Chapter 6

APPLICATIONS OF RFID

Radio Frequency Identification has many applications because of its efficient and cheap service. A lot of research is being done to find better uses of this technology. Some of the applications of RFID are discussed below:

6.1 Asset Tracking:

Static or in-motion assets tracking or locating, like a healthcare facility, wheelchairs or IV pumps in, laptops in a corporation and servers in a data center, was not so easy task.

User can instantly determine the general location of tagged assets anywhere within the facility with the help of active RFID technology. Control point detection zones at strategic locations throughout the facility allow the user to define logical zones and monitor high traffic areas. Tagged assets moving through these control points provide instant location data.

Asset tracking applications will see an almost vertical growth curve in the coming years and the growth rate in this area will be much higher than the growth rate of general RFID market.

6.2 People Tracking:

People tracking system are used just as asset tracking system. Hospitals and jails are most general tracking required places.

Hospital uses RFID tags for tracking their special patients. In emergency patient and other essential equipment can easily track. It will be mainly very useful in mental care hospitals where doctors can track each and every activity of the patient. Hospitals also use these RFID tags for locating and tracking all the activities of the newly born babies.

The best use of the people tracking system will be in jails. It becomes an easy tracking system to track their inmates. Many jails of different US states like Michigan, California, and Arizona are already using RFID-tracking systems to keep a close eye on jail inmates.

6.3 Library:

Many libraries use barcode and electromagnetic strips to track various assets. RFID technology uses for reading these barcodes unlike the self-barcode reader RFID powered barcode reader can read multiple items simultaneously. This reduces queues and increases the number of customers using self-check, which in turn will reduce the staff necessary at the circulation desks.

6.4 Healthcare:

Patient safety is a big challenge of healthcare vertical. Reducing medication errors, meeting new standards, staff shortages, and reducing costs are the plus points of use of RFID solutions. RFID wristbands containing patient records and medication history address several of these concerns.

6.5 Manufacturing and Aerospace:

RFID technology provides an easy way to manage a huge and laborious manufacturing process. It offers all the benefits of small production parts to batch, processes and manufacturing. This type of process helps in better analysis, reduce and eliminate bottlenecks, reduced time in locating parts and products and production process based sensors can be installed to alert any anomalies. Aerospace industry and Department of Defense have a lot to gain from RFID integration into their production and process lines. Boeing and airbus, according to the direction of US Federal Aviation Administration, make it mandatory to put an appropriate tracking mechanism to track the aircraft parts.

All these RFID solutions are available for you in under the roof of Agilesense.com. Choose AgileSense as your default RFID solution provider.

6.6 Other Potential uses:

RFID can be used in various other applications as well:

1. Access management

2. Tracking of goods, persons, animals.
3. Toll collection and contact less payment
4. Location based services.
5. Smart dust (for massively distributed sensor networks)
6. Tracking sports memorabilia to verify authenticity.

Chapter 7

CONCLUSION AND FUTURE SCOPE

7.1 Conclusion

Radio **F**requency **I**dentification **D**evice (RFID) technology is an important and emerging phenomenon in the wireless communication. RFID is the technology that uses radio-frequency waves to transfer data between a reader and a movable item to identify, categorize and track. RFID is fast, reliable, and does not require any physical sight or contact between reader or scanner and the tagged item.

This project has taught us a lot about RF technology, its advantages over other wireless systems and offered us the opportunity to explore and design RF circuits using PSPICS and PCB Wizard 3.0.

Despite the problems encountered such as due to inappropriate tuning of inductor, incorrect values of circuit elements from the reference and complexity of circuitry its bit tedious to generate high frequency system for communication with the preliminary design approaches, still the RF system was successfully completed using an extremely challenging design approach where we are transmitting four bits data as Electronic Product Code (EPC) which when received by the reader is further transferred to the host computer (ONS) for analyzing and fetching the information such as train number, track number and location of tag related to it. Once the information is reached to the server then appropriate actions will be taken such as warning the driver of the train and application of breaking system actuates. Completion of this project is a low powered, high frequency, less expensive system that is capable of detecting RF tag from a greater distance.

As an alternative to storing all the information in the tag, we have used host computer database linked with tag ID and the server.

7.2 Future Scope

This work can be extended in some other dimensions as:

1. We can also read the speed of the train which helps in improving the anti collision system.
2. We can get the exact situation of the delay or right time of the train from certain distance of the station.
3. The RFID system can be used for the following applications on Railways:
    - Automatic Vehicle Identification
    - Parcel Tracking
    - Inventory Monitoring
    - Tracking of wheel sets
    - Schedule dates of Locomotives/Coaches can be stored - using larger memory tags
    - Monitoring of critical subassemblies in locomotives- using larger memory tags

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[23] http://www.epcglobalinc.com/about/faqs.html7

Coding

```
#include<iostream.h>
#include<fstream.h>
#include<conio.h>
void main()
{
clrscr();
int i,j;
float a[2],b[2],epc,d;
char location1[2][50],location2[2][50];
int track1[2],track2[2];
char route1[2][50],route2[2][50];
float dfps1[2],dfps2[2];
printf("/n enter the distance");
scanf("%f",&d);
//for train 1
for(i=0;i<=2;i++)
{
   printf("\n enter the epc code");
   scanf("%f",&a[i]);
}
//for train 2
for(i=0;i<=2;i++)
{
   printf("\n enter epc code for train 2");
   scanf("%f",&b[i]);
}
ifstream infile [U+0093]project.txt[U+0094];
for(i=0;i<2;i++)
{
  while(infile!=EOF)
   {
    infile<<epc;
    if(a[i]==epc)
      {
infile.getline(location1[i],50);
```

```
 infile<<track1[i];
 infile<<dfps1[i];
 infile.getline(route1[i],50);
        }
         if(b[i]==epc)
        {
 infile.getline(location2[i],50);
 infile<<track2[i];
 infile<<dfps2[i];
 infile.getline(route2[i],50);
        }
 if(track1[i]==track2[i])
        {
  if((dfps1[i]-dfps2[i])<d)
        {
  if((dfps1[i+1]-dfps2[i+1])<d)
      {
   printf("\n application of breaks");
   printf("\n alarm");
      }
        }
        }
    }
}
getch();
}
```