INTERNSHIP REPORT

RADEL ELECTRONICS PVT. LTD.

01/05/2019 – 24/06/2019

1. **High Speed Video Signal Amplification.**
2. **Literature Survey on Radio Frequency Identification (RFID).**

Guided by –

Mahendra Prasad SP

Team Leader (R&D)

Radel Electronics Pvt. Ltd.

Submitted by –

Ayush Jain (121601005)

Electrical Engineering

IIT Palakkad

PREFACE

As a part of B.Tech curriculum and in order to gain practical knowledge in the field of engineering, we are required to do an internship in a reputed industry/university. The basic objective behind this internship is to apply the concepts learn during engineering to solve real-world problems and find an optimum solution.

In this report, detailed description of the two projects is given. The first project is based on the high speed video signals and ways to amplify its power. It involves the concepts of analog circuits and transmission lines. The second project is a literature survey on radio frequency identification. It involves the concepts of antennas and communication systems.

I had a successful training period and the experience and knowledge I got will be valuable to my future career.

Ayush Jain (121601005)
Department of Electrical Engineering
Indian Institute of Technology, Palakkad.

ACKNOWLEDGEMENT

I would like to express my gratitude and appreciation to all those who assisted me for the successful completion of my internship. A special thanks to the director of Radel Electronics Pvt. Ltd. **Mr. G Raj Narayan** whose support, stimulating suggestions and encouragement helped me to complete the internship successfully.

I would also like to acknowledge with appreciation, the crucial role of my mentor **Mr. Mahendra Prasad**, who coordinated my project work and provided proper guidance to achieve the goal of the project and encouraged me to maintain my progress on track.

A special thanks to the whole Radel team for their kind cooperation and to my colleagues for coordinating with me and for their comforting support during the internship period.

RADEL ELECTRONICS PRIVATE LIMITED

Radel Electronics Pvt. Ltd. is the pioneer in the field of digital electronic musical instruments for Indian music.

A wide range of Digital Indian musical instruments are invented, designed and manufactured by the only **ISO 9001:2008 certified**, award-winning company for Electronic Indian musical Instruments in the world. Starting as a tiny unit in a garage in 1979, Radel's sophisticated factory today has state-of-the-art facilities for design, manufacture as well as quality assurance. It is situated in the prestigious Electronics City close to Bangalore. The company is professionally managed and employs highly trained manpower.

The electronic musical instruments manufactured by Radel Electronics Pvt. Ltd have been invented by its **founder G Raj Narayan**, an engineer-cum-musician of Bangalore. These products therefore cater to the very precise and artistic needs of a musician. Their excellent tonal quality has earned them the approval of leading musicians. They are suitable for use in concerts as well as practice sessions.

The instruments are extremely simple to operate. Highly sophisticated technology used in their design, continuous research and development besides vigorous tests during manufacture have resulted in the production of sound almost identical to that of the conventional instruments that they simulate.

Awards

Karanataka Kalashree (2001), Govt of India National Award for R&D (2009)

ABSTRACT

Project:1 – High Speed Video Signal Amplification

Aim of this project is to display an RCA analog video signal on multiple televisions simultaneously. For this, the power of the analog video signal is to be amplified through a well-designed circuitry in order to display the same signal on multiple televisions without any distortion in amplitude or phase. For designing the circuit, we need to choose suitable ICs and components that can efficiently operate at high frequencies (~ 4.43 MHz). After amplification, the signal needs to be transmitted using coaxial cables. We need to deal with interference problems while transmission and also to understand the importance of impedance matching while deciding the features of the cable.

Project:2 – Literature Survey on Radio Frequency Identification (RFID)

RFID refers to a technology whereby digital data encoded in RFID tags or smart labels are captured by a reader via radio waves. It uses electromagnetic fields to automatically identify and track tags attached to objects.

Aim of this project is to perform detailed analysis on RFID tags and readers to understand their characteristic features, communication modes between them, ways of collision detection in presence of multiple tags, minimum separation distance between tags, testing of tags before deployment, security issues and privacy mechanisms related to RFID and various types of memories available inside the tags and their significance. A brief research on its application in Real Time Location Tracking (RTLS) is also done. This project also provides an insight in the Radio Frequency (RF) technology, its applications and challenges associated with it.

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LIST OF ABBREVIATIONS

RCA – Radio Corporation of America

NTSC – National Television System Committee

PAL – Phase Alternating Line

SECAM – Sequential Color with Memory

RFID – Radio Frequency Identification

FDX – Full Duplex Mode

HDX – Half Duplex Mode

PROJECT – 1

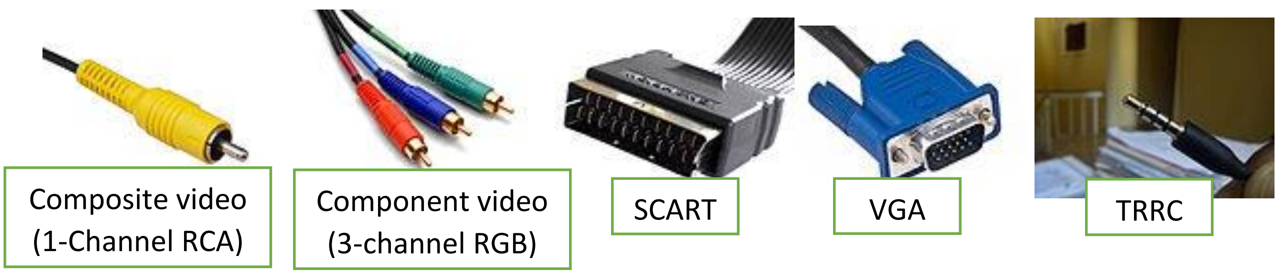
HIGH SPEED VIDEO SIGNAL AMPLIFICATION

INTRODUCTION

Single source signals displayed on multiple screens is often used in multi-screen digital signage and in the high street retailers where the same movie or TV channel might be playing on all televisions to allow the customer to compare pictures. This same technique can also be used in the home environment where, for example, the user might wish to display the same Source (DVD / Blu Ray player, etc.) on 2 or more screens - such as the living room and kitchen. And what they're using is a called a **'Splitter'** (sometimes also known as a **'Distribution Amplifier'**)

On the basis of format there are two video types: Analog & Digital

Analog video:- Analog video is a video signal represented by one or more analog signals. Analog color video signals include luminance, brightness (Y) and chrominance (C). When combined into one channel, as is the case, among others with NTSC, PAL and SECAM it is called composite video. Analog video may be carried in separate channels, as in two channel S-Video (YC) and multi-channel component video formats.



Digital Video:- Digital video signal formats with higher quality have been adopted, including serial digital interface (SDI), Digital Visual Interface (DVI), High-Definition Multimedia Interface (HDMI) and Display Port Interface, though analog video interfaces are still used and widely available. There exist different adaptors and variants.

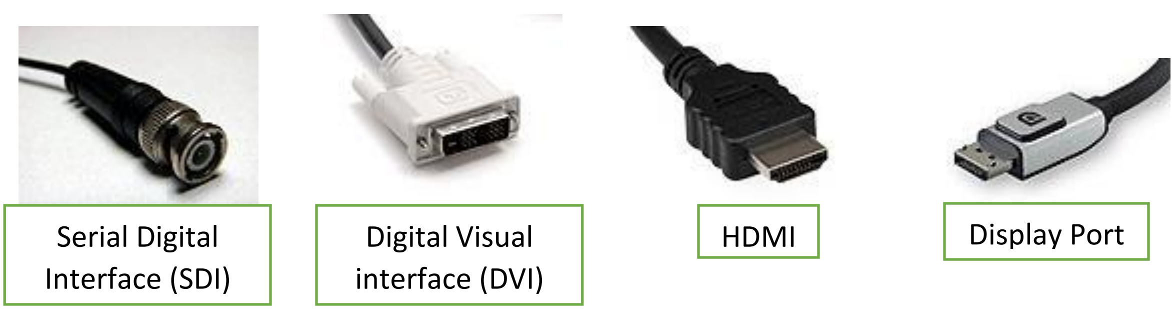


Fig:1.1 – Analog and Digital Ports.

PROBLEM STATEMENT

To display an RCA analog video signal on multiple television screens (approx.~30) simultaneously in a cost-efficient manner.

APPROACH

Current:- RCA analog cable splitters (also called as distribution amplifiers) are used for duplicating the video signals. There are only 8x splitters available in the market and there cost is very high.

Novelty:- I have designed a circuit in which the video signal is first passed through an amplifier circuitry and then delivered to the loads connected.

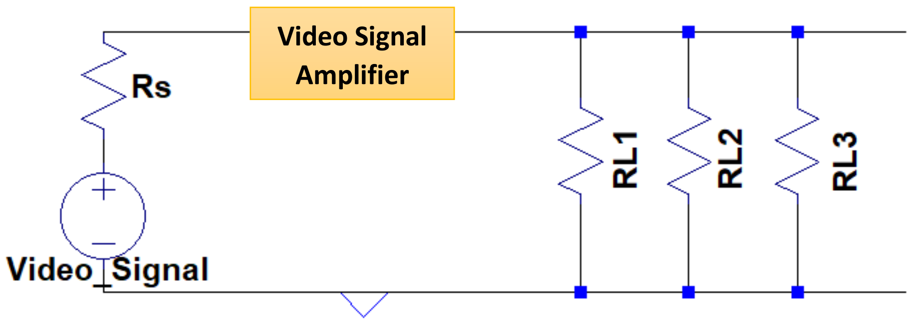


Fig:1.2 – Circuit with video signal amplifier circuitry with large current gain, capable of operating multiple televisions simultaneously.

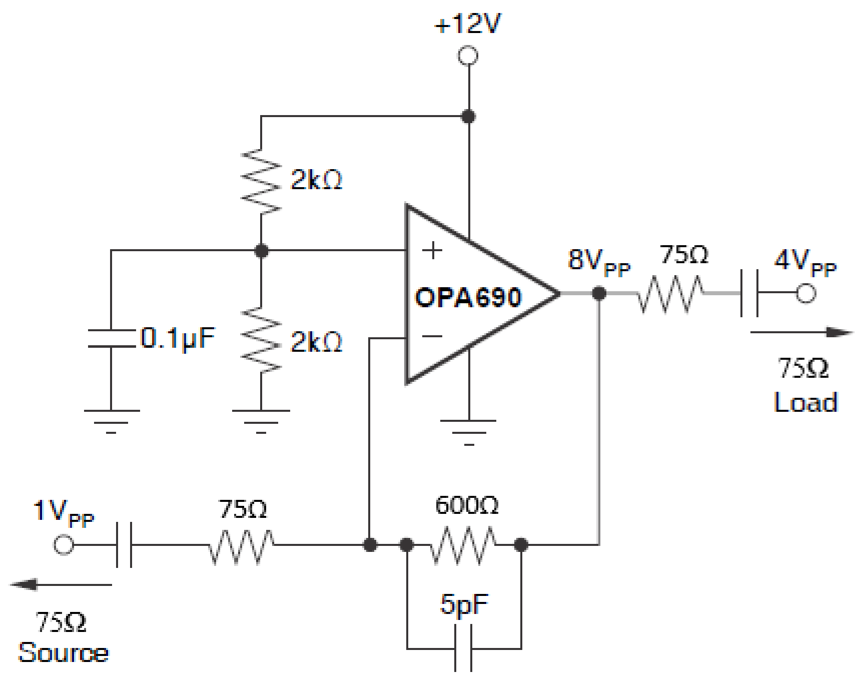


Fig:1.3 – High Power Coaxial Line Driver (Video Signal Amplifier Internal Circuitry)

- Detailed explanation of the High Power Coaxial Line Driver Circuit assuming source and load impedance to be 75 Ω each.

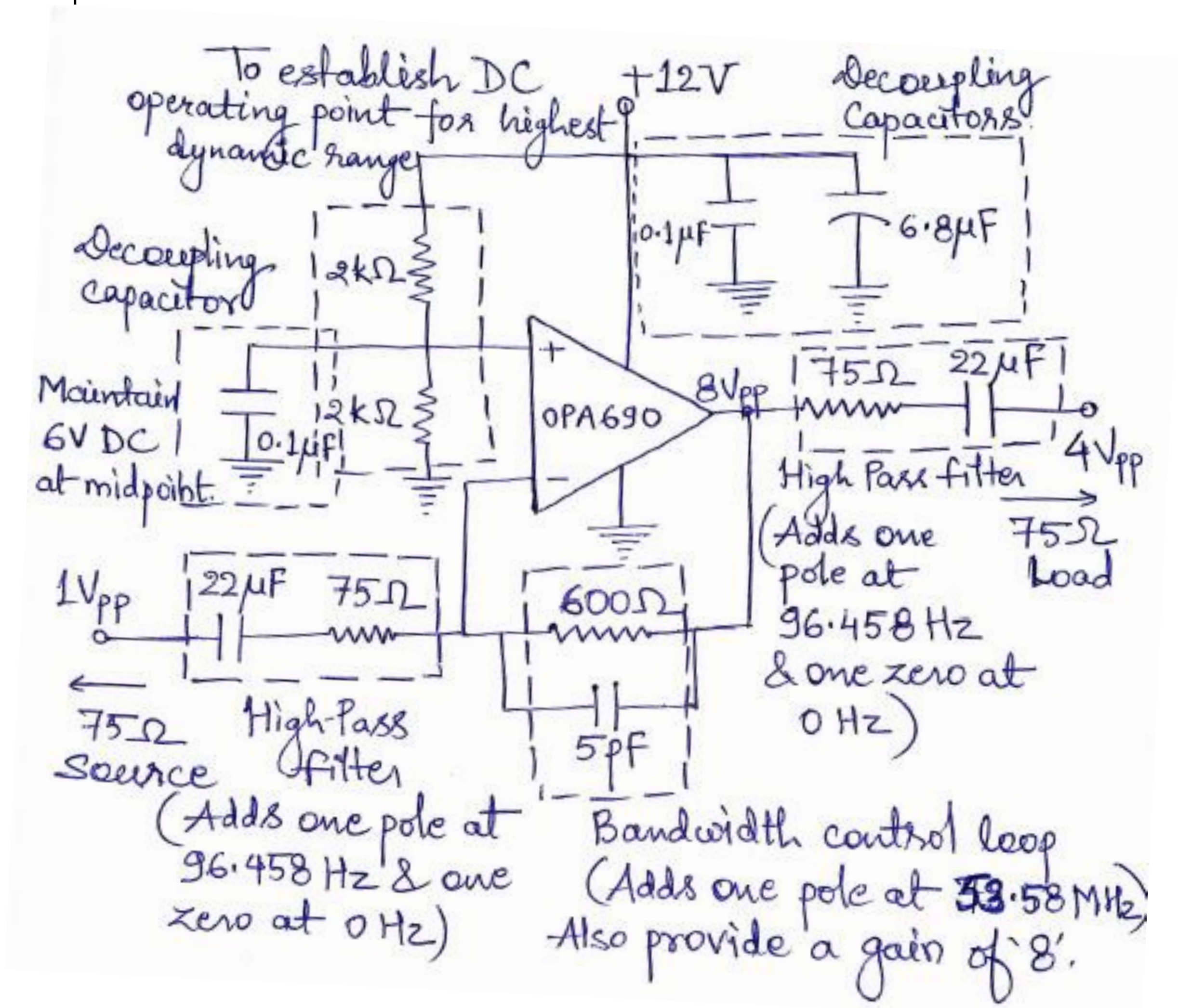


Fig:1.4 – Detailed analysis of High Power Coaxial Line Driver Circuitry.

1. High pass filter capacitor, also called as blocking capacitor, ensures that source and load are ac-coupled.
2. **75 Ω** resistor used in high pass filter is to match with the **75 Ω** source and load impedances.
3. **0.1μF** (ceramic) decoupling capacitor is active at high frequencies, while **6.8μF** (tantalum) decoupling capacitor is active at low frequencies.

Clearly, the two high pass filter at the input and the output terminals produces 2-zeros at **0 Hz** and 2-poles at **96.458 Hz**, thus giving a second order high pass response.
Also, the bandwidth controlling loop, generates a pole at **53.58 MHz**, thus transforming the response to be a bandpass response.

Frequency response of the High Power Coaxial Line Driver circuit will be:

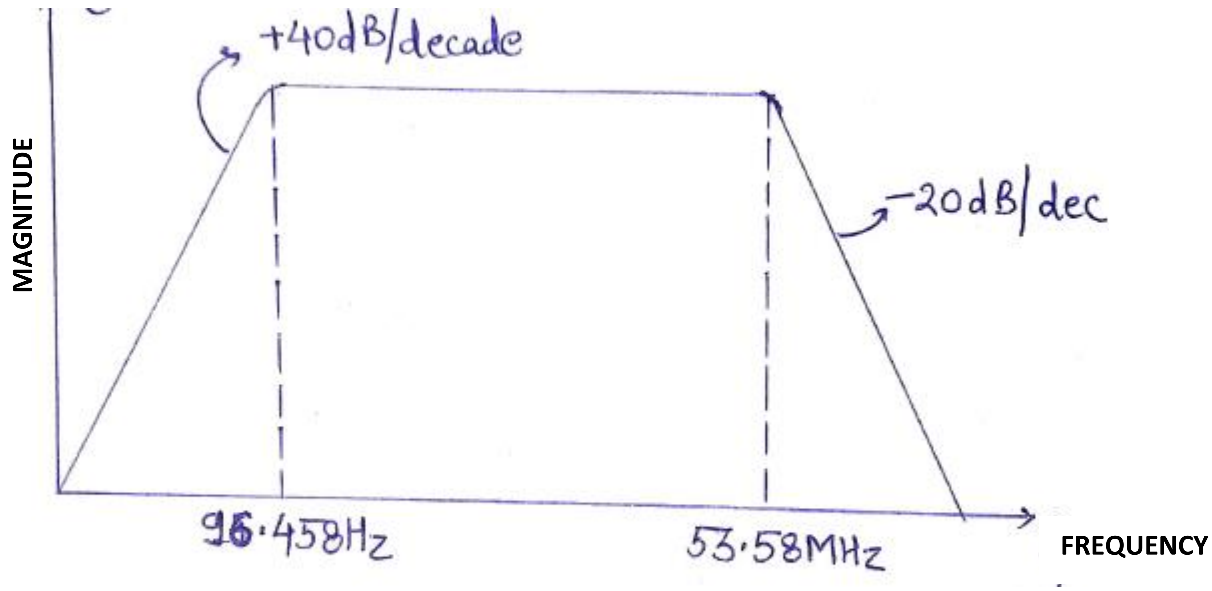


Fig:1.5 – Bode magnitude plot of high power coaxial line driver circuit.

Components Required:-

1. **OPA690 – SOIC-8** package. This is a surface mount IC used in order to avoid parasitic resistances and capacitances.
2. Microwave resistors (buffed metal film rather than laser trimmed spiral-wound) and/or carbon resistors **(75 Ω, 600 Ω & 2 kΩ)** provide good high frequency performance.
3. Ceramic **(0.1µF)**, tantalum **(6.8µF)** and electrolytic **(22µF & 5pF)** capacitors. **CRGO** capacitors are preferred as they have very little tolerance, but **X7R** can also be used.
4. Constant **12V** power supply, properly decoupled in order to improve harmonic distortion performance.
5. A Printed Circuit Board **(PCB)** for soldering all the components before testing.
6. **Coaxial cables (RG-6/U)** having characteristic impedance of **75 Ω** in order to match with the source and load impedance in order to minimize the reflections which can cause distortions in the video signal.

RESULTS & DISCUSSION

- The amplification of high speed signals while preserving fidelity presents a significant design challenge.
- Dynamic range (measured in terms of distortion and noise) and bandwidth are the major driving forces in high speed signal processing systems.
- Video applications require high bandwidths (flat over a wide range of frequencies) and low levels of differential gain and phase.

• Selection of Integrated Chip (IC):-

For video driver applications, I found three suitable ICs namely: OPA693, OPA695 and OPA690.

1. **OPA693:-** The low gain stable **current-feedback** architecture used is particularly suitable for full-power bandwidth cable driving requirements.
2. **OPA695:-** Ultra-wideband **current feedback** op amp for additional flexibility. It offers a voltage gain of '2' or '8' and a bandwidth of 1400 MHz.
3. **OPA690:-** Unity gain stable **voltage feedback** op amp with very high slew rate. High output current of 190mA and a bandwidth of 150 MHz.

Out of these three ICs, I selected **OPA690** because of two major reasons:-

1. Voltage feedback op-amps are generally more favorable for video applications.
2. It has a very high output current of 190mA as well as highest slew rate (1800 µV) among the three.

Table:1.1 – Voltage Feedback vs Current Feedback

PARAMETER	VF	CF
Open loop gain	Voltage $\frac{Vo}{Ve} = a(f)$. Frequency dependant, limits bandwidth.	Transimpedance $\frac{Vo}{ie} = Zt(f)$. Frequency dependant, limits bandwidth.
Closed loop gain	$\frac{Vo}{Vi} = \left(\frac{1}{b}\right)\left[\frac{1}{1+\left(\frac{1}{ab}\right)}\right]$	$\frac{Vo}{Vi} = \left(\frac{1}{b}\right)\left[\frac{1}{1+\left(\frac{R2}{Zt}\right)}\right]$
Ideal closed loop gain	Set by feedback factor $\left(\frac{1}{b}\right)$	Set by feedback factor $\left(\frac{1}{b}\right)$
Gain bandwidth product	Gain and bandwidth interdependent. Constant over most frequencies of operation.	Gain and bandwidth independent of each other.
Stability	Normally unity gain stable.	Minimum impedance in feedback component required for stability
Bandwidth	Set by closed loop gain	Set by impedance of feedback component

- ## Role of Decoupling (Bypass) Capacitors:-

- A decoupling capacitor is a capacitor used to decouple one part of an electrical network (circuit) from another. Noise caused by other circuit elements is shunted through the capacitor, reducing the effect it has on the rest of the circuit.
- A bypass capacitor is often used to decouple a sub-circuit from AC signals or voltage spikes on a power supply or other line. A bypass capacitor can shunt energy from those signals, or transients, past the sub-circuit to be decoupled, right to the return path.
- High frequencies and transient currents can flow through a capacitor to circuit ground instead of to the harder path of the decoupled circuit, but DC cannot go through the capacitor and continues on to the decoupled circuit.
- Another kind of decoupling is stopping a portion of a circuit from being affected by switching that occurs in another portion of the circuit. Switching in sub-circuit A may cause fluctuations in the power supply or other electrical lines, but you do not want sub-circuit B, which has nothing to do with that switching, to be affected. A decoupling capacitor can decouple sub-circuits A and B so that B doesn't see any effects of the switching.

- ## Input and Output impedance of the circuit:-

The input and output impedance of the video amplifier circuit used for our application is designed to be **75 Ω** each in order to match with the source and load impedances to avoid reflections in the system.

- ## Total Harmonic Distortion (THD):-

It is a measurement of the harmonic distortion present in a signal and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.

$$\mathrm{THD_F} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \cdots}}{V_1}$$

$$\mathrm{THD_F} = \frac{\sqrt{12.5^2+7.5^2+4.5^2+6^2+2.5^2+5^2}}{460}$$

$$= \mathbf{3.8\%}$$

THD+N means total harmonic distortion plus noise. This measurement is much more common and more comparable between devices. It is usually measured by inputting a sine wave, notch filtering the output, and comparing the ratio between the output signal with and without the sine wave.

$$\text{THD+N} = \frac{\sum_{n=2}^{\infty} \text{harmonics} + \text{noise}}{\text{fundamental}}$$

$$\text{THD+N} = \frac{12.5+7.5+4.5+6+2.5+5+30}{460}$$

$$= \mathbf{14.8\ \%}$$

Note:- Calculation of THD and THD+N is done for a 12 V single power supply.

- **Ringing in Electrical Signals at High Frequencies.**

Ringing is oscillation of a signal, particularly in the step response. Often ringing is undesirable. It is also known as ripple, particularly in electricity or in frequency domain response.

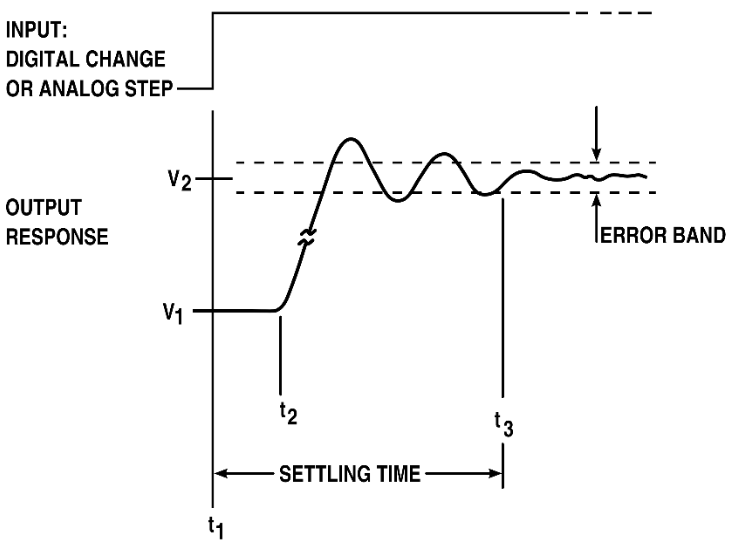


Fig:1.6 – An illustration of overshoot, followed by ringing and settling time.

In video circuits, electrical ringing causes closely spaced repeated ghosts of a vertical or diagonal edge where dark changes to light or vice versa, going from left to right.

- **Layout Guidelines:-**

Achieving optimum performance with a high-frequency amplifier like the OPA690 requires careful attention to board layout parasitic and external component types. Recommendations that optimize performance include:

1. Parasitic capacitance on the output and inverting input pins can cause instability: on the noninverting input, it can react with the source impedance to cause unintentional bandlimiting.

To reduce unwanted capacitance, a window around the signal I/O pins must be opened in all of the ground and power planes around those pins.

2. Socketing a high-speed IC OPA690 is not recommended. The additional lead length and pin-to-pin capacitance introduced by the socket can create an extremely troublesome parasitic network which can make it almost impossible to achieve a smooth, stable frequency response. Best results are obtained by soldering the OPA690 onto the board.
3. Resistors must be a very low reactance type. Surface-mount resistors work best and allow a tighter overall layout. Metal film or carbon composition axially-leaded resistors can also provide good high-frequency performance. Never use wire-wound type resistors in a high-frequency application. Because the output pin and inverting input pin are the most sensitive to parasitic capacitance.

LEARNING & OUTCOME

From this project I learnt to implement the concepts of analog electronics to design the circuitry for high speed signals and of impedance matching in transmission lines to transmit the video signal without any reflections. I also learnt to read a datasheet of any device to get the characteristics of that device.

Finally, I was able to design the circuitry for high speed video signal amplification to drive multiple televisions simultaneously. I successfully tested it over 4 TVs and no distortions were observed.

SUMMARY

This project dealt with high speed RCA analog video signals. The goal was to display the video signal from a single source on multiple televisions. For this, the power of the analog video signal was amplified through a well-designed circuitry in order to display without any distortion in amplitude or phase. For designing the circuit, I chose suitable IC and components that can efficiently operate at high frequencies (~ 4.43 MHz). After amplification, the signal was transmitted using coaxial cables. I also dealt with interference problems while transmission and understood the importance of impedance matching while deciding the features of the cable.

FUTURE SCOPE

This design can be helpful in creating a low cost device for displaying a video signal on multiple screens and can be used during seminars, conferences or workshops in auditoriums. It can also be installed in the buses or in the television shops.

PROJECT – 2

LITERATURE SURVEY ON RADIO FREQUENCY IDENTIFICATION (RFID)

PROBLEM STATEMENT

To perform a literature survey on Radio Frequency Identification (RFID) to analyse and explain the detailed working of RFID tags, communication modes between tag and reader, collision detection and security and privacy concerns. Also to understand the approach of location tracking using RFID.

CONCEPTS LEARNT

- **RFID TAGS:-**

A Radio Frequency Identification Tag (RFID tag) is an electronic tag that exchanges data with a RFID reader through radio waves.

Most RFID tags are made up of at least two main parts. The first is an antenna, which receives radio frequency (RF) waves. The second is an integrated circuit (IC), which is used for processing and storing data, as well as modulating and demodulating the radio waves received/sent by the antenna.

RFID tags can be classified on two grounds:-

1. Based on range of frequencies they use to communicate data:
   - Low Frequencies (LF)
   - High Frequencies (HF)
   - Ultra-High Frequencies (UHF)

Generally lower the frequency of the RFID system, the shorter the read range and slower the data read rate.

2. Depending on how the tag communicates with the reader:
   - Passive
   - Active
   - Semi-Passive

Frequency types:-

- Low Frequency RFID:- **30kHz to 300kHz** (Operating Frequency); Read range upto **10cm.**
  - Perform better in presence of metals and liquids (which can interfere with other types of RFID tag transmissions).
  - Common standards for LF RFID include ISO14223 and ISO/IEC 18000-2.

- High frequency RFID:- **3MHz to 30MHz** (Operating Frequency); Read range is from **10cm to 1m.**
  - Common applications include electronic ticketing and payment and data transfer. Near Field Communication (NFC) technology is based on HF RFID and has been used for payment cards and hotel key card applications. Other types of smart cards and proximity card payment and security systems also use HF Technology.
  - Standards:- ISO15693, ECMA-340, ISO/IEC 18092 (for NFC), ISO/IEC 14443A and ISO/IEC 14443 (for MIFARE and other smart card solutions).
- Ultra-High frequency RFID:- **300MHz to 3GHz** (Operating Frequency); Read range upto **12m.** Faster data transfer.
  - More sensitive to interferences from metals, liquids and electromagnetic signals.
  - Much cheaper to manufacture and as such are commonly used in retail inventory tracking, pharmaceutical anti-counterfeiting and other applications where large volumes of tags are required.
  - EPC global Gen 2/ ISO 18000-6C – a well-known global standard for item level tracking applications.

- **Active RFID:-** Have their own transmitters and power source (battery) on board the tag.
  - Mostly UHF solutions and read range upto 100m in some cases.
  - Larger and more expensive than passive and are used to track large assets (like cargo containers, vehicles and machines).
  - Often equipped with sensors that measure and transmit temperature, humidity, light, shock/vibration data for the objects they are attached to.
  - Are expensive (approximately $15 and up in quantity).
  - Need maintenance such as battery replacement.

There are 2 types of Active RFID tags:-

1. **Transponders:-** Only “wake up” and transmit data when they receive a radio signal from the reader. For eg:- A transponder attached to a vehicle in a toll payment or checkout control location would only be active when passing through a particular gate. This helps conserve battery life.
2. **Beacons:-** Emit signal at a pre-set interval. This type of tag is used in Real Time Location Systems (RTLS) for tracking anything from wheelchair to large cargo containers.

- **<u>Passive RFID</u>:-** The reader and reader antenna sends a signal to the tag and that signal is used to power on the tag and reflect energy back to the reader.
  - There are passive LF, HF, UHF systems. Read ranges are shorter than active tags and are limited by the power of the radio signal reflected back to the reader.
  - Smaller, less expensive and more flexible than active tags.
  - Can be attached or even embedded on wider variety of objects.
  - Commonly used for item-level tracking of consumer goods and pharmaceutical.
  - Need little or no maintenance.
  - Inexpensive (~0.05 dollars)

- **Semi-Passive or Battery Assisted Passive (BAP) RFID**:-
  - Incorporate a power source into a passive tag configuration.
  - Power source ensures that all of the captured energy from the reader can be used to reflect the signal which improves read distance and data transfer rates.
  - They don’t have their own transmitters.
  - Can monitor things in a container, such as climate or security breaches.
  - Range from $10 to $50 in price.

Fig:2.1 – (a) Active and (b) Passive RFID Tags

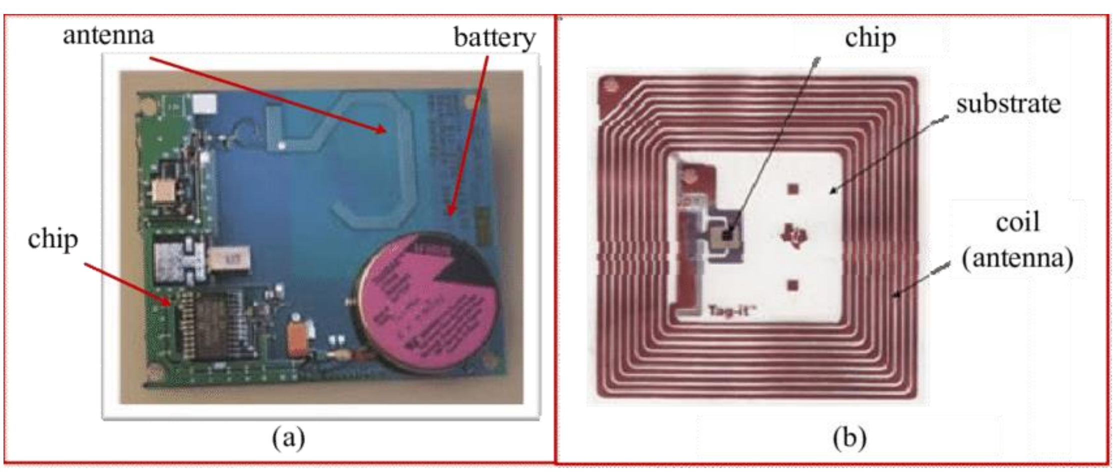


Fig:2.2 – (a) Active and (b) Passive RFID Tag’s internal circuitry.

LF RFID Block Diagram – "Tag Reader"

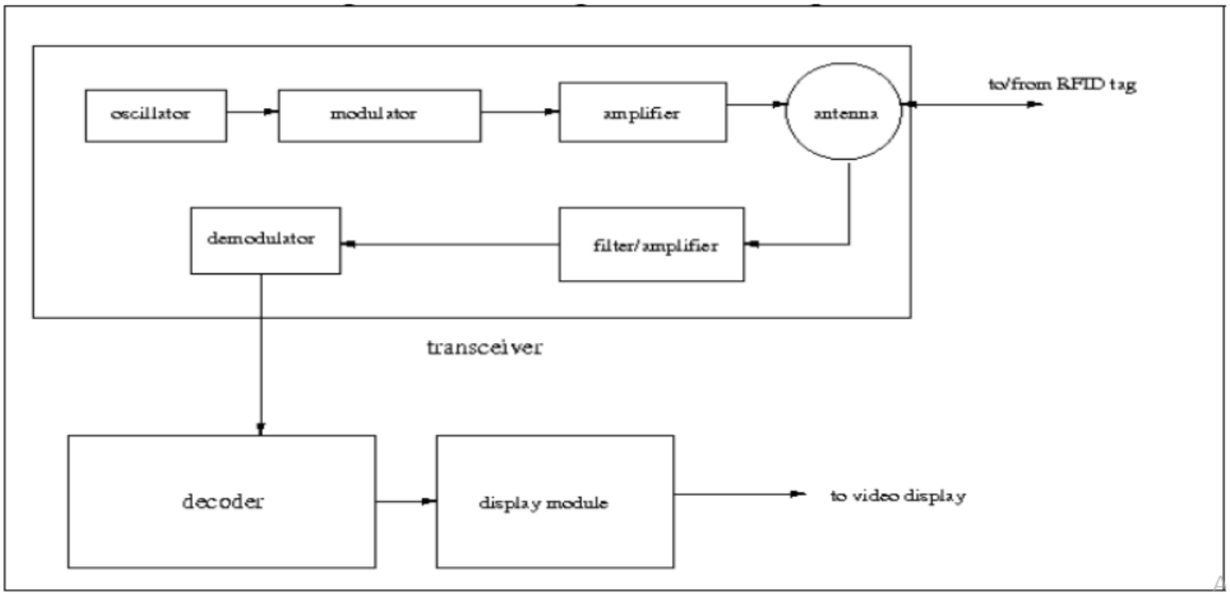


Fig:2.3 – Block diagram of RFID tag reader for low-frequency applications (~125kHz).

There are three main subsystems: a transceiver, a decoder, and a display module. The antenna of the transceiver, which is shown to communicate directly with the tag, includes a 125 kHz transmitter with low distortion for interrogation of the tags, and a 62.5 kHz receiver to get the reply. The RFID tag will send its data as an amplitude modulated (AM) signal, so the reader will filter the signal to select and amplify the 62.5 kHz signal; after this filtering, the reader will demodulate the signal to obtain the signal transmitted by the tag.

- **Communication between Reader and Tag is performed via two basic methods:-**

Load modulation and inductive coupling in the near field

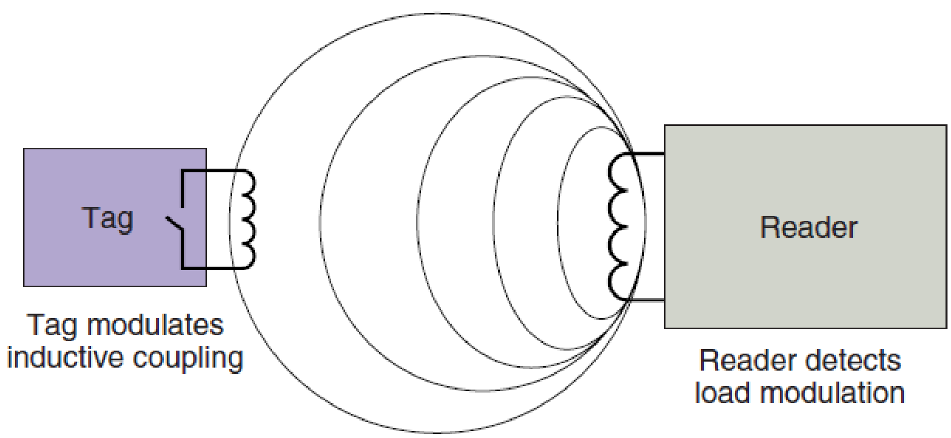


Fig:2.4 – Passive tag load modulation.

In this approach (see Figure 2.4), the RFID reader provides a short-range alternating current magnetic field that the passive RFID tag uses for both power and as a communication medium. Via a technique known as inductive (or near-field) coupling, this magnetic field induces a voltage in the antenna coil of the RFID tag, which in turn powers the tag. The tag transmits its information to the RFID reader by taking advantage of the fact that each time the tag draws energy from the RFID reader's magnetic field, the RFID reader itself can detect a corresponding voltage drop across its antenna leads. Capitalizing on this phenomenon, the tag can communicate binary information to the reader by switching ON and OFF a load resistor to perform load modulation. When the tag performs load modulation, the RFID reader detects this action as amplitude modulation of the signal voltage at the reader's antenna. Load modulation can be found among passive RFID tags using frequencies from 125 to 135 kHz and 13.56 MHz.

Limitations:-

1. Necessity to use larger antennas
2. Low data rate and bandwidth, and
3. Dramatic decay in the strength of the electromagnetic field (1/r6), where 'r' represents the distance between a low frequency interrogator and a passive RFID tag.

Backscatter modulation and electromagnetic coupling in the far field:

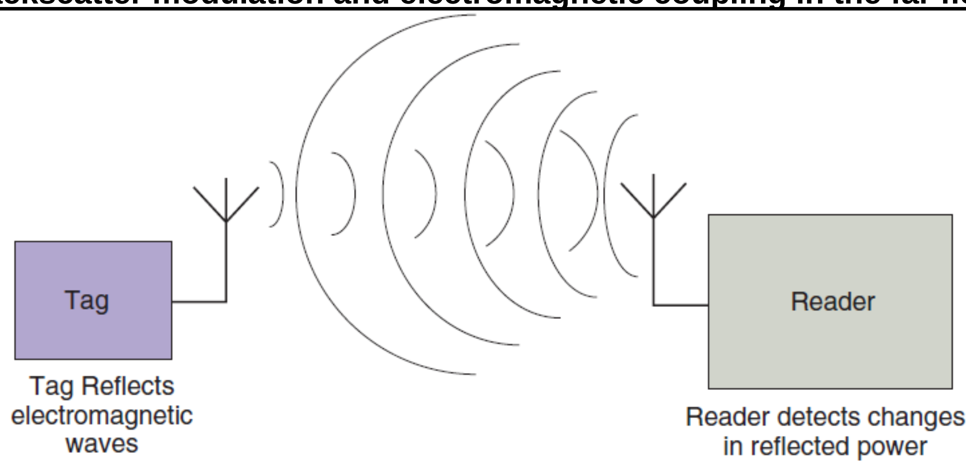


Fig:2.5 – Passive Tag Backscatter Modulation.

In this approach (shown in Figure 2.5), the RFID reader provides a medium-range electromagnetic field that the passive RFID tag uses for both power and a communication medium. Via a technique known as electromagnetic (or far-field) coupling, the passive RFID tag draws energy from the electromagnetic field of the RFID reader. However, the energy contained in the incoming electromagnetic field is partially reflected back to the RFID reader by the passive tag antenna. The precise characteristics of this reflection depend on the load (resistance) connected to the antenna. The tag varies the size of the load that is placed in parallel with the antenna in order to apply amplitude modulation to the reflected electromagnetic waves, thereby enabling it to communicate information payloads back to the RFID reader via backscatter modulation.

Advantages over Inductive Coupling:-

1. Tags operating at higher frequencies (f > 868 MHz).
2. Antenna lengths are smaller.
3. Slower attenuation rate (1/r2).
4. Provide significantly longer range than inductively coupled tags.

Full Duplex (FDX) and Half Duplex (HDX) communication mode

Tags can operate in either Full Duplex (FDX, FDX-B) or Half Duplex (HDX) mode. An FDX-based system has data and energy traveling at the same time. This differentiation is valid for technology in the LF 125 kHz to 135 kHz range but not for HF or UHF passive technologies as not used here.

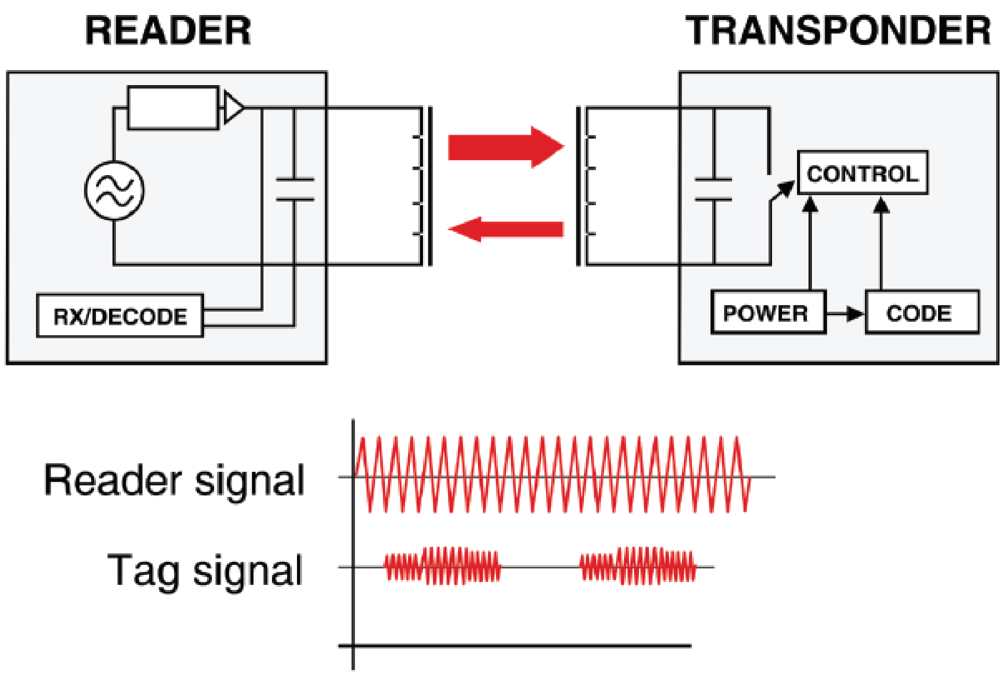


Fig:2.6 – Full Duplex Mode Operation (FDX)

Figure 2.6 shows the reader and tag signals during a transmission. Note that both the reader and tag transmit at the same time. This is because for the tag to be powered so it can transmit data, the reader must be transmitting energy, as well. While a full duplex (FDX) based system can support data traveling in both directions at the same time, the reader must employ complex decoding algorithms to separate the tag signal from the reader signal and ambient noise.

With an HDX-based system, either the reader or tag is transmitting, but not both (see Figure 2.7). TI's HDX-based tags have an integrated charge capacitor in the transponder. When the reader first connects, it charges the capacitor. When the reader stops transmitting, the transponder is then powered by the charged capacitor and is able to transmit the requested data to the reader.

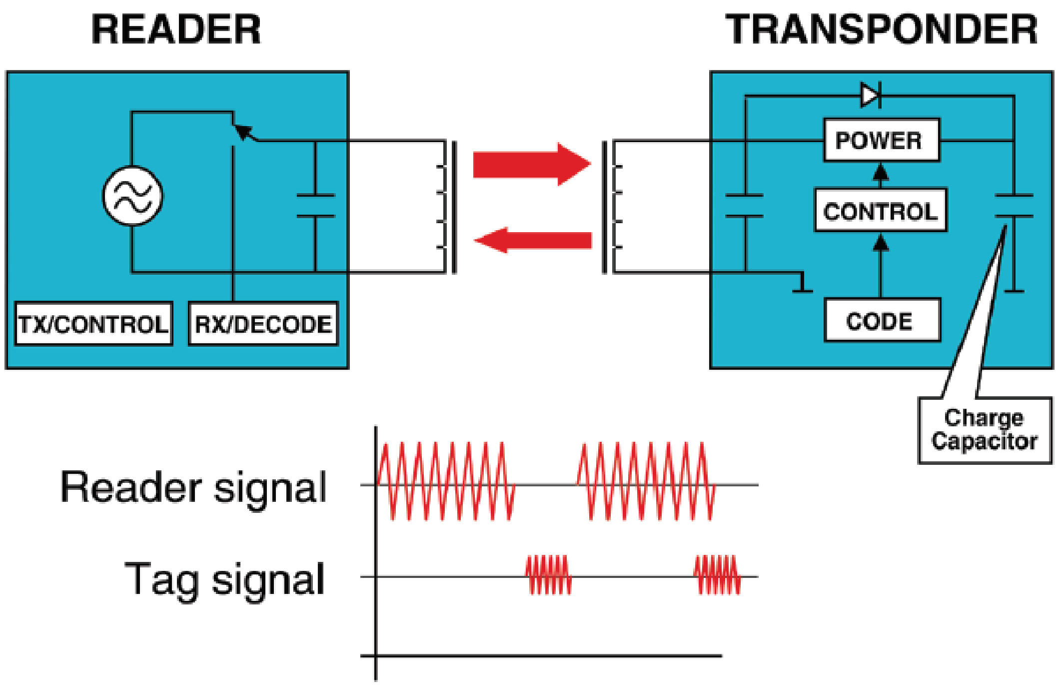


Fig:2.7 – Half Duplex Mode Operation (HDX)

TI's half duplex (HDX) tags integrate a charge capacitor that allows tags to be charged by a reader and then transmit the requested data while the reader is not transmitting. This results in a better: significant improvement in performance (i.e., ~1.5X read range) with higher reliability and lower cost compared to FDX readers since an HDX reader can employ simpler decoding techniques. Consider that during an FDX transmission, the reader must separate the tag signal from its own transmission and any ambient noise. With an HDX-based tag, as the tag does not have to compete with the reader's transmission, the reader can use simpler decoding techniques. The results is higher reliability, greater range, and lower reader cost.

- **<u>Collision Detection</u>**

There is no minimum separation between tags. Using the **SID (anti-collision algorithm),** multiple tags close to the antenna can be readily identified but if they are at the extreme reading range, they will require some separation (5 cm) to prevent mutual de-tuning. If individual tags are passing an antenna, some separation will need to be maintained if the anti-collision algorithm is not being used. The separation is related to the size of the reading zone and should be sufficient that only one tag is in the field at one time.

Several other anti-collision algorithms are:- **ALOHA, Q-algorithm** etc.

- **Security Issues**

1. Unauthorized scanning of tags in order to create user profiles.
2. Scanning the medication a person is carrying to conjecture what illness he/she might suffer.
3. A mugger scanning a crowd of people and singling out a person carrying many valuable items (even money, if tagged as proposed).
4. If tags are replacing credit cards eavesdropping becomes a problem and must be addressed.
5. Authentication is also needed.

- **Privacy**

To ensure privacy the mechanisms that kick in after the customer bought the product are:-

1. **Kill command**: The command will render the tag unusable once received. To prevent an adversary to call those commands they are password protected.
2. **Sleep command**: A tag cannot always be killed. The sleep command works similar to the kill command. Once received the only command accepted is the password protected wakeup command. The sleep command suffers from the same problems as the kill command.
3. **Relabeling**: An approach where the customer can relabel the item tag with a string of user's choice. Some of the old information however remains in a password protected area.
4. **Split approach**: For this approach the information is distributed over two tags and one of the tags is removable by the customer.
5. **Proxy approach**: It assumes that all tags are protected by a PIN that the user can set. Once an item is bought the guardian sets a new PIN.
6. **Distance approach**: Tags use the signal-to-noise ratio (SNR) to get a rough estimate of the readers distance. The closer the reader, the more information is released. However, those tags are more expensive.
7. **Blocking approach**: RFID tags use a special protocol that controls the access to the shared medium (air).

- **Testing before Deployment**

Initially, operation of the reader's transceiver will be tested using an oscilloscope to verify the interrogation frequency. The individual modules of the tag reader, which will be programmed, compiled and run on the FPGA, will be tested for functionality by utilizing test bench simulations in a Verilog programming client. Once successful operation of the reader is verified in terms of generating and transmitting the appropriate data, its proper communication with the tag can then be verified via generating and confirming output from the tag, which will possess known values.

- **Different types of Memory in the tags and their significance**

1. **Reserved Memory:** Stores the kill password and the access password (each are 32 bits). This memory bank is only writable if you want to specify a certain password. It cannot store information besides the two codes.
2. **EPC Memory:** Stores the EPC code, or the Electronic Product Code. It has a minimum of 96 bits of writable memory. The EPC memory is what is typically used in most applications if they only need 96 bits of memory. EPC memory is your first writable memory bank.
3. **TID Memory:** This memory is used only to store the unique tag ID number by the manufacturer when the IC is manufactured. Typically, this memory portion cannot be changed.
4. **User Memory:** If the user needs more memory than the EPC section has available, certain ICs have extended user memory which can store more information. Typically, the extended memory is no more than 512 bits, but there are some high memory tags with up to 4K or 8K bytes of memory. This is the second writable memory bank for Gen 2 ICs.

- **RFID: Location and Tracking**

[Jiang06] presents a study on how to detect movements of an object tagged with a RFID chip. The proposed method works as follows: The reader polls the tag a certain number of times per second and counts the number of responses. The observation is that the number of responses decreases when the distance increases. By further analyzing changes in derived approximations of signal-intensity levels a one antenna system works only within a short radial range and limited angles. By increasing the number of readers and tags the systems accuracy can be improved.

[Haehnel04] is another paper about mapping and localization. In contrast to the other paper they use a robot with 2 antennae located 45 degree to the left and right with respect to the robot, also the robot (reader) is mobile. By comparing the signal strength received on both antennae they can estimate the position of a tag with the Monte Carlo localization algorithm. They show that their method works also in a highly dynamic environment where tags are attached to moving objects. In addition their method can be used to extract the coordinates of the robot if a map of the environment is available.

[InformationWeek] and [Radar Golf] put RFID location to practical use. An RFID tag is incorporated into a golf ball. The mobile reader carried by the player indicated a balls position on its LCD Screen or via audio feedback. Detection range is 30 - 100 feet. Unfortunately, the method that is used to locate the ball is proprietary and not described.

LEARNING & OUTCOME

Through this project I got introduced to Radio Frequency Identification (RFID) technology. I learnt about RFID tags and readers, their working principle, different modes of communications between them, collision detection, security issues, privacy mechanisms and finally their application in Real Time Location Tracking (RTLS).

SUMMARY

This project aims at performing detailed analysis on RFID tags and readers to understand their characteristic features, communication modes between them such as: Load modulation and Backscatter modulation. Also studied about Full Duplex and Half Duplex modes for transferring data and energy simultaneously, ways of collision detection in presence of multiple tags and minimum separation between the tags, security issues and privacy mechanisms, testing of tags before deployment and different memory types available in the tags. A brief research on its application in Real Time Location Tracking (RTLS) is also done.

FUTURE SCOPE

The world will be different once RFID Readers and Tags are everywhere. In an RFID enhanced features, the benefits would accurate not just to businesses, but also to consumers.
Once various limitations like lack of Global Standard, security concerns, cost factors etc. are overcome and this technology is fully implemented, it can transform the way we live our lives.
It has the potential to revolutionize the domains of health and fitness, education, transportation, public welfare etc.

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INTERNSHIP CERTIFICATE

This is to certify that **Ayush Jain** (121601005) of **IIT-Palakkad** has successfully completed Two month internship at Radel Electronics Pvt Ltd between 01.05.2019 and 24.06.2019.

His Conduct during the internship was good and satisfactory

For Radel Electronics Pvt Ltd

MAHESH AANAGODUMATH
(DM-HR & ADMIN)

RADEL ELECTRONICS PVT. LTD.
FACTORY: 74/D, Electronics City, Hosur Road, Bangalore-560 100. **T:** 91 80 28520720/30. **F:** 91 80 28521071
SALES OFFICE: 217, 8-F Main Road, Jayanagar 3rd Block, Bangalore-560 011. **T:** 91 80 26647991 **E:** info@radel.in
www.radel.in