INTERNSHIP PRESENTATION

RADEL ELECTRONICS PVT. LTD.

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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 signal is to be amplified through a well-designed circuitry to avoid distortions in amplitude or phase. Selection of ICs and components that can efficiently operate at high frequencies (~ 4.43 MHz) is important. Finally, the signal should be transmitted using coaxial cables to remove interference problems while transmission (concept of impedance matching).

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

Aim of this project is to perform detailed analysis on RFID tags to understand their characteristic features, communication modes between tag and reader, collision detection in presence of multiple tags, testing of tags before deployment, security issues and privacy mechanisms. A brief research on its application in Real Time Location Sensing (RTLS) is also done. This project also provides an insight in the Radio Frequency (RF) technology, its applications and challenges associated with it.

PROJECT-1

HIGH SPEED VIDEO SIGNAL AMPLIFICATION

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. Also we need to split more than 8 times.

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.

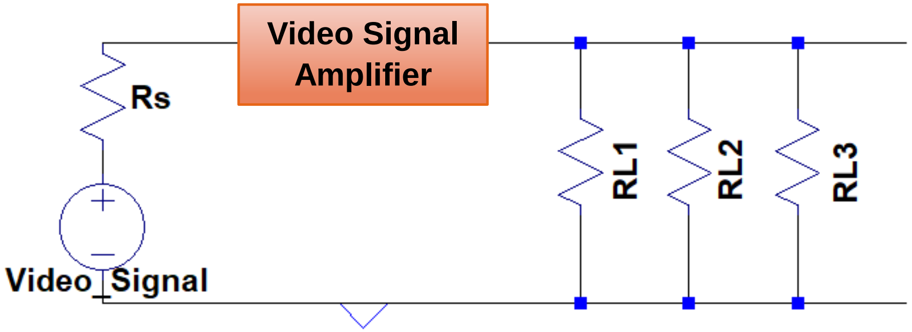


Fig:1.1 – Circuit with video signal amplifier circuitry with large current gain, capable of operating multiple televisions simultaneously.

HIGH POWER COAXIAL LINE DRIVER CIRCUIT

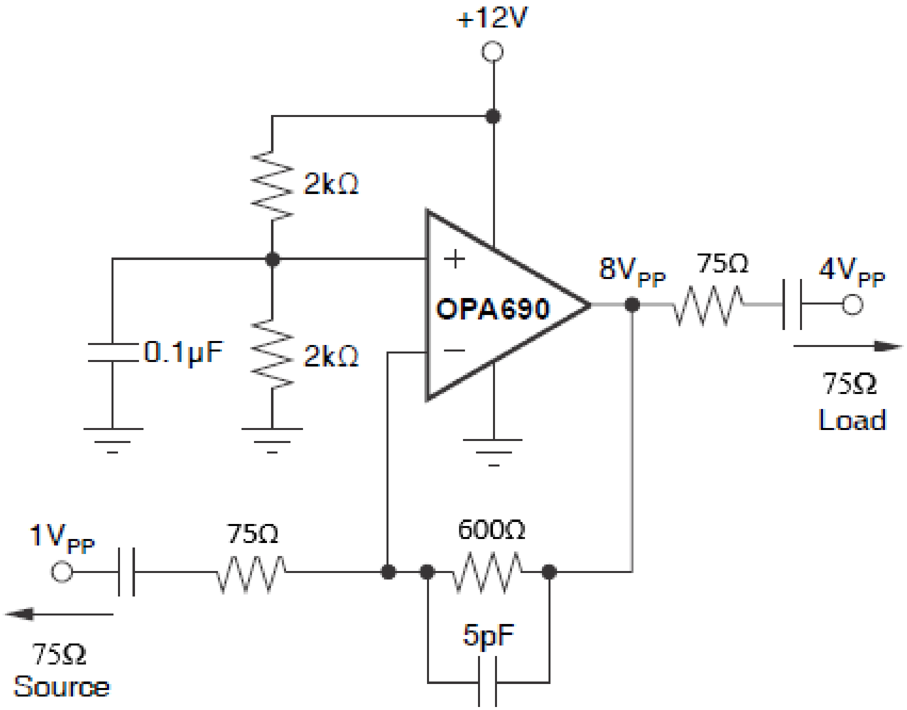
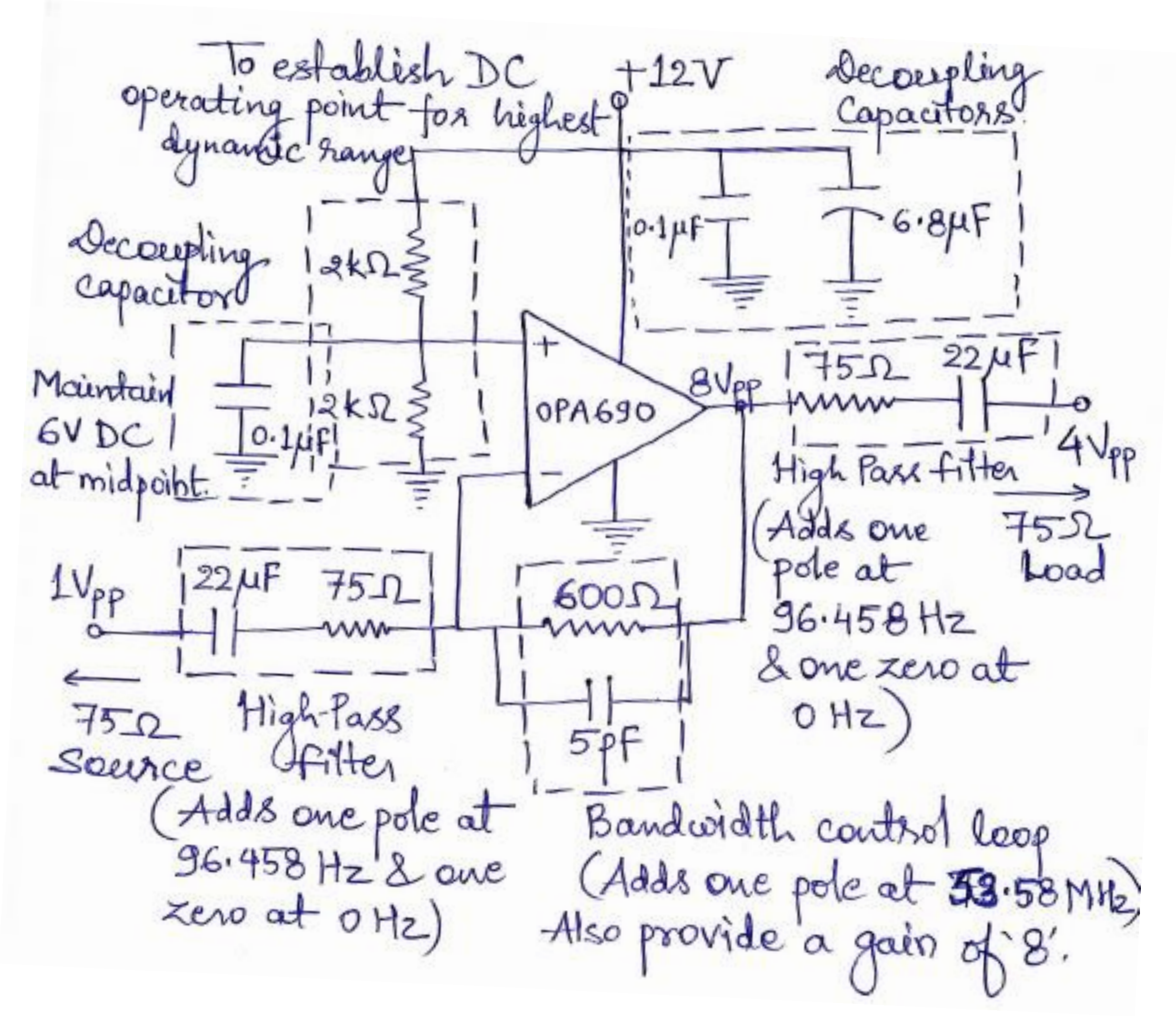


Fig:1.2 – High Power Coaxial Line Driver (Video Signal Amplifier Internal Circuitry)

1. **High pass** filter capacitor, also called as blocking capacitor, ensures that source and load are ac-coupled.
2. **75 Ω** resistor used in 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 **0Hz** and **2-poles** at **96.458 Hz**, thus giving a **second order** high pass response.

FREQUENCY RESPONSE

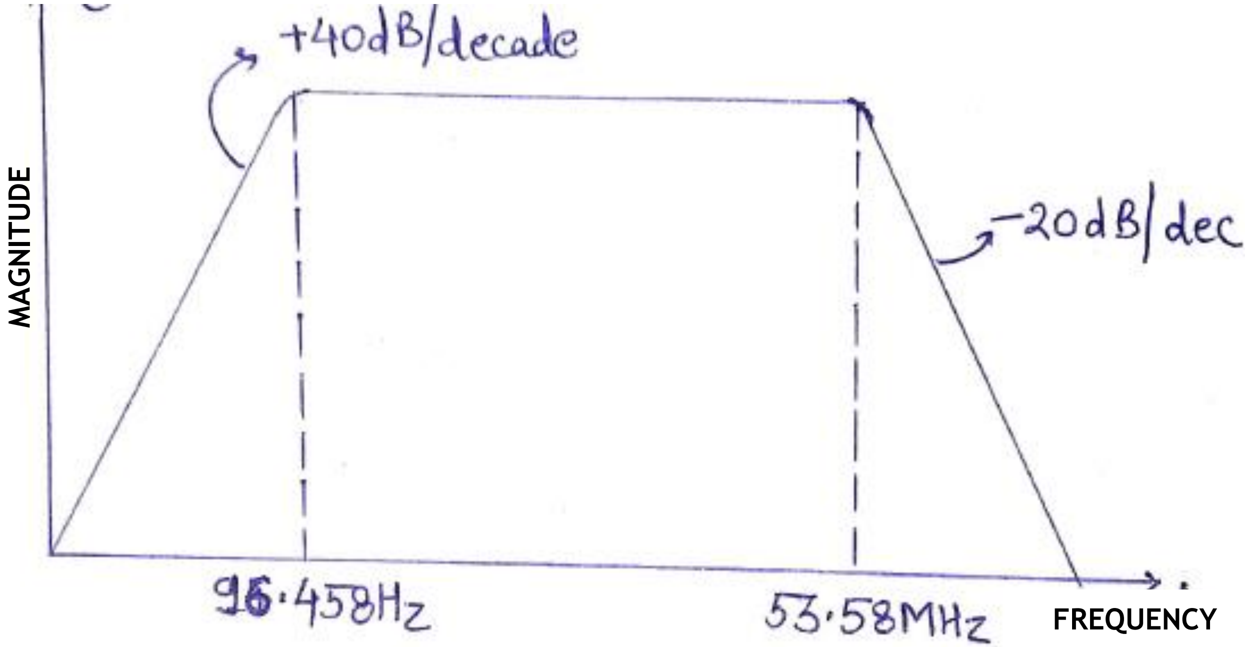


Fig:1.4 – Bode magnitude plot of high power coaxial line driver circuit.

The bandwidth controlling loop, generates **a pole** at **53.58 MHz**, thus transforming the response to be a bandpass response. This loop plays an important role in preventing the circuit from high frequency noise.

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 & 5pF), tantalum (6.8μF)** and **electrolytic (22μF)** capacitors. **COG (NPO)** 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** 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: 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 have selected **OPA690** because of two major reasons:-

1. Voltage feedback op-amps are generally more favorable for video applications.
2. It has the highest output current of **190mA** and slew rate **(1800 μV/s)** among the three.

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.

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

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

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

- **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.

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

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

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

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.

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 in presence of multiple tags, security issues and privacy mechanisms. Also to understand the concept of Real Time Location Sensing (RTLS) 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.

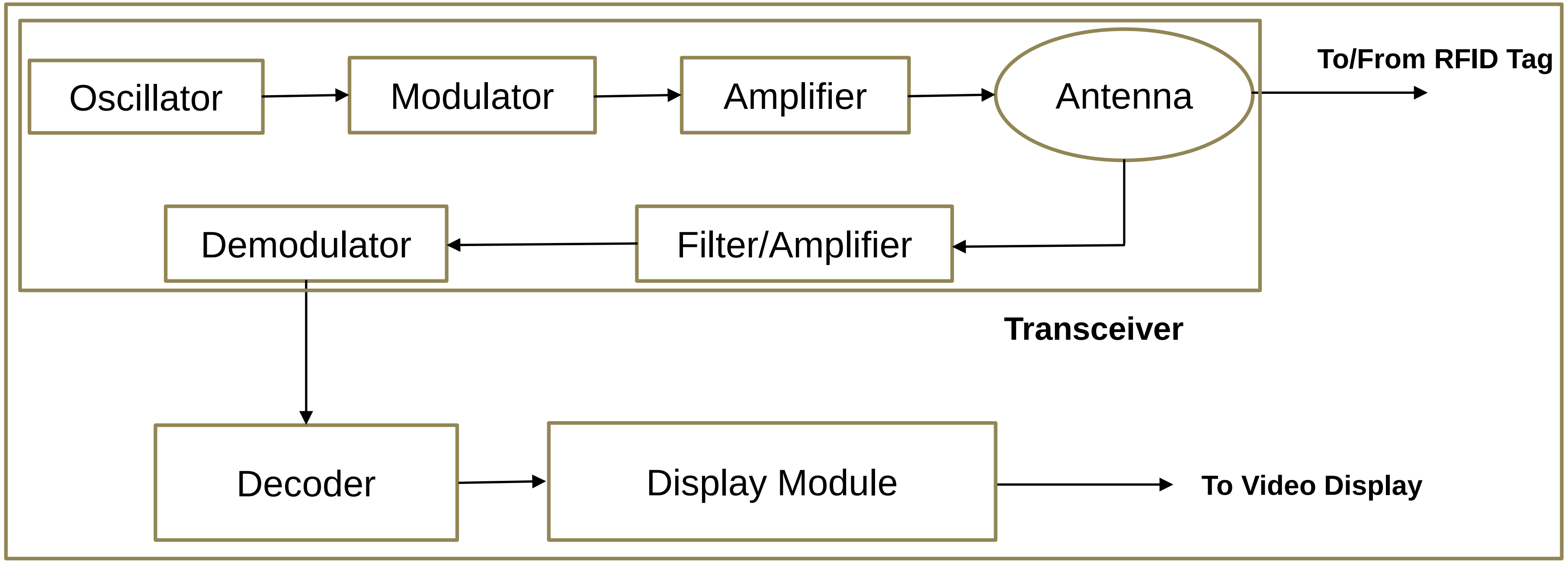
Classification of Tags:-

- Based on range of frequencies they use to communicate data:
- Low Frequencies (LF): **30kHz to 300kHz;** Read range upto **10cm**.
- High Frequencies (HF): **3MHz to 30MHz;** Read range is from **10cm to 1m**.
- Ultra-High Frequencies (UHF): **300MHz to 3GHz;** Read range upto **12m**.

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

- Depending on how the tag communicates with the reader:
- Passive: 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. Inexpensive **(~0.05 dollars).**
- Semi-Passive: Incorporate a power source into a passive tag configuration to improve read distance and data transfer rates. **They don't have their own transmitters**. Range from **$10 to $50** in price.
- Active: Have their own transmitters and power source (battery) on board the tag. Are expensive (**approximately $15** and up in quantity). They are of two types:-
    1. **Transponders:** Only "wake up" and transmit data when they receive a radio signal from the reader.
    2. **Beacons:** Emit signal at pre-set intervals.

Low Frequency RFID Block Diagram – Tag Reader



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

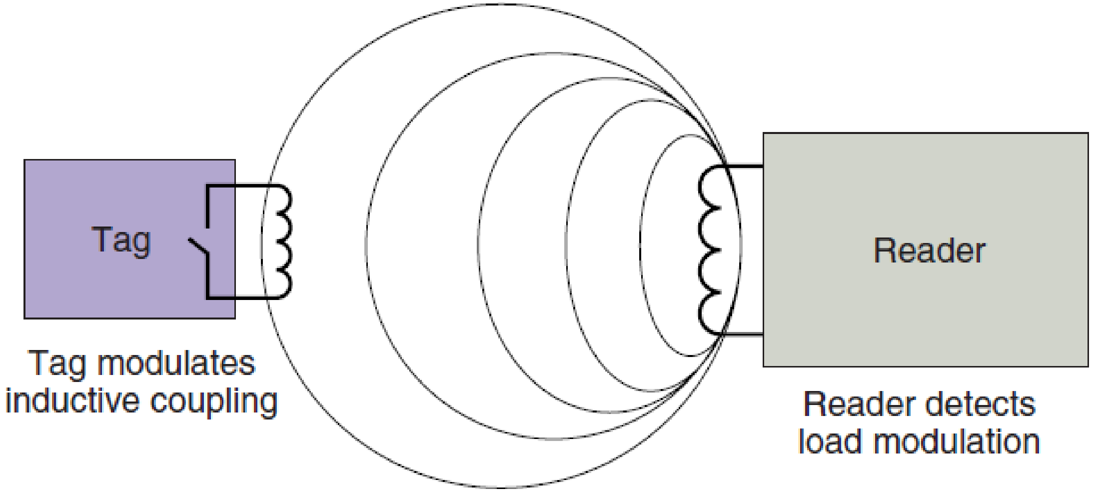


Fig:2.2 – Passive tag Load Modulation.

Limitations:-

- Necessity to use larger antennas
- Low data rate and bandwidth, and
- Dramatic decay in the strength of the electromagnetic field ($1/r^6$), where ‘r’ represents the distance between a low frequency interrogator and a passive RFID tag.

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

Backscatter modulation and electromagnetic coupling in the far field

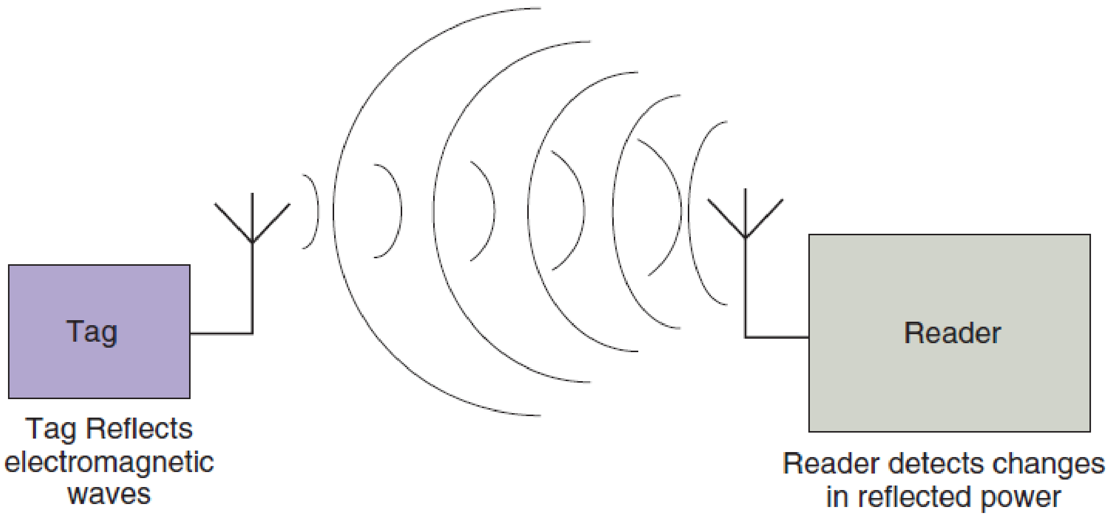


Fig:2.3 – Passive tag Backscatter Modulation.

Advantages over Inductive Coupling:-

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

Full Duplex (FDX) and Half Duplex (HDX) Operation Mode

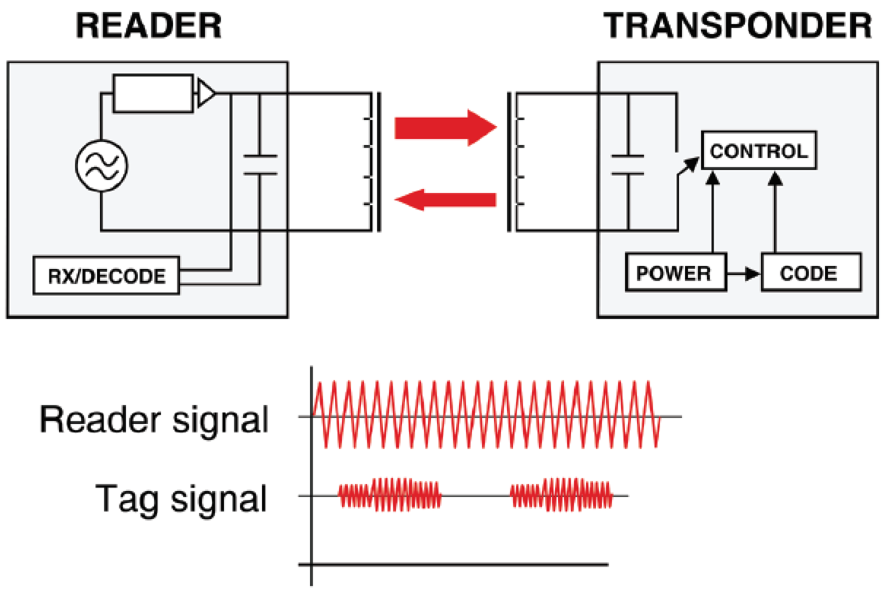


Fig:2.4 – Full Duplex Mode Operation (FDX)

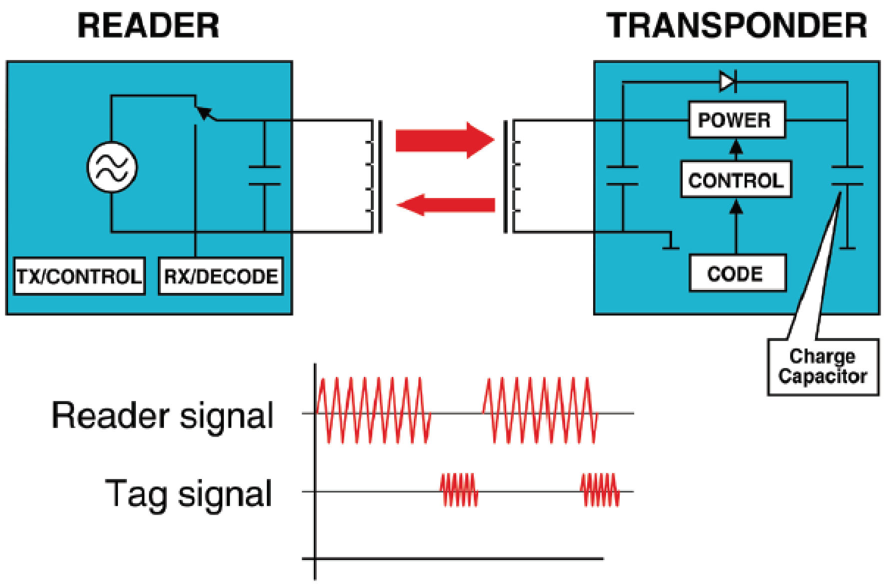


Fig:2.5 – Half Duplex Mode Operation (HDX)

- 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 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.

Security Issues:-

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

Privacy Mechanisms:-

- Kill Command
- Sleep Command
- Relabeling
- Split Approach
- Proxy Approach
- Distance Approach
- Blocking Approach

LEARNING & OUTCOME

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

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.

THANK YOU