DEVELOP AND TEST A METHOD TO CONVERT WIRED SYSTEMS INTO WIRELESS SYSTEMS
(WIRELESS COMMUNICATION)

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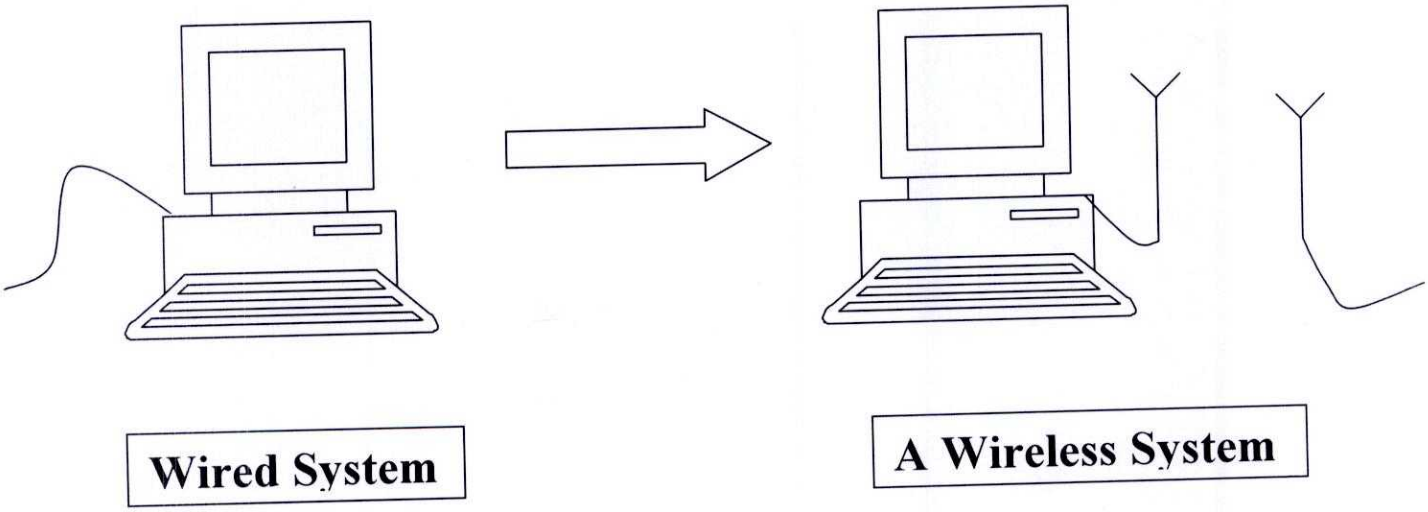
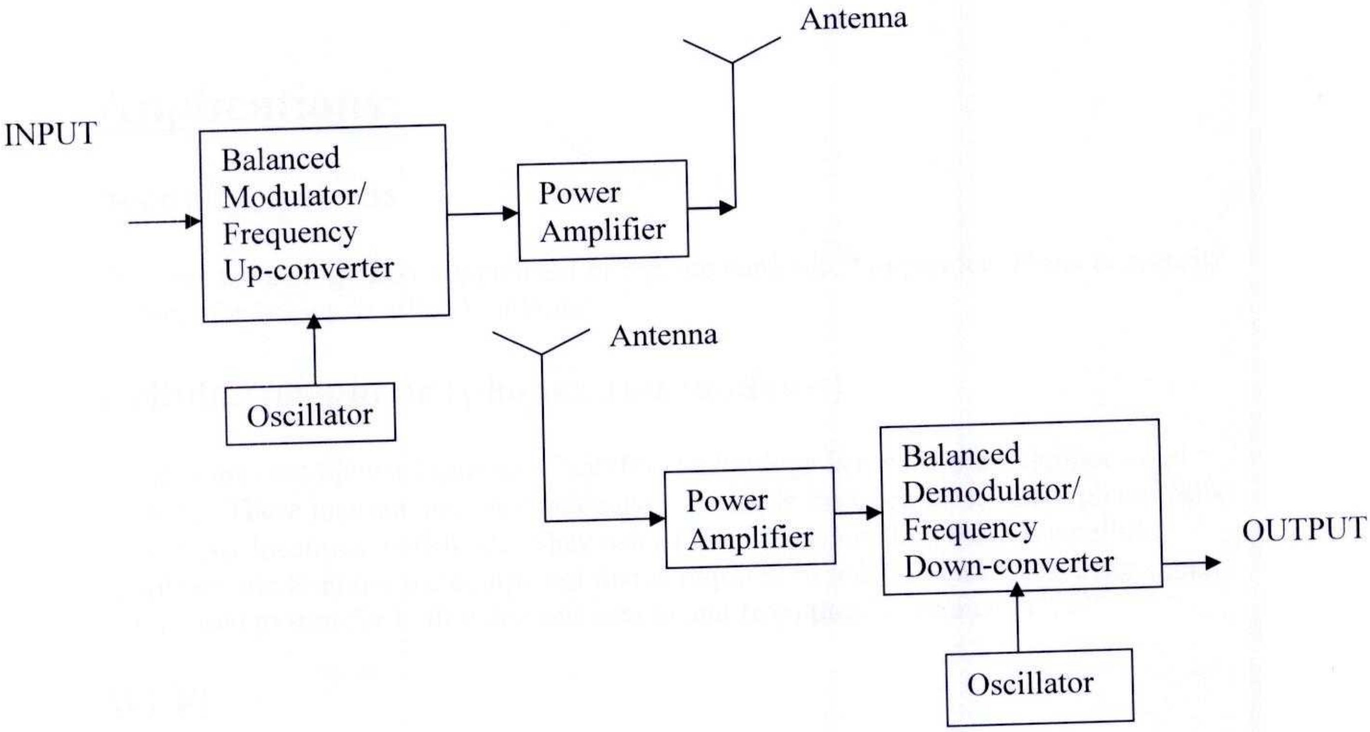
Abstract: In this research, we will develop and test a niche which may be used as a standard to convert wired links into wireless links. We will develop a step by step procedure to identify the key parameters of a wired system that should be used to convert the system into a wireless one. Afterwards we will develop a model which will enable a cost effective and simple transformation from wired to wireless technology. We will also conduct experiments to support our models and realize sample system transformation.

Project overview:



In this research, we intend to completely convert wired systems into wireless systems on replacing the wires with antennas that will substitute the used of wire. For this purpose, there also are included components like balanced modulator, oscillator, frequency up and down converter and power amplifier. The intended implementation in block diagram is shown below.

Block diagram:



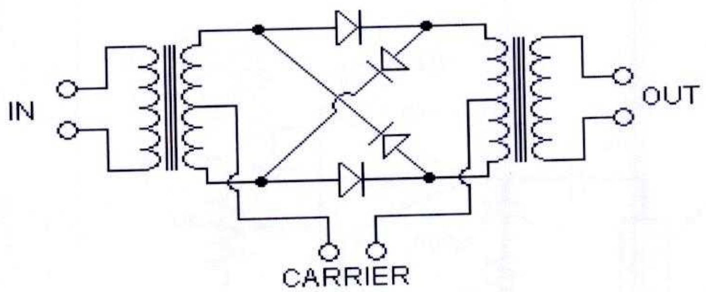
Background:

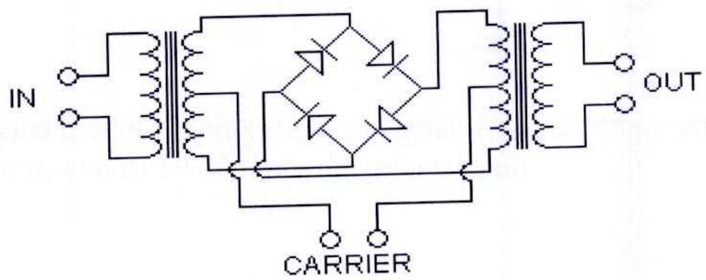
Eight years before Hertz's experiments, David E. Hughes, transmitted radio signals over a few hundred yards by means of a clockwork keyed transmitter. As this was before Maxwell's work was understood, Hughes' contemporaries dismissed his achievement as mere "Induction". In 1885, T. A. Edison used a vibrator magnet for induction transmission. In 1888, Edison deployed a system of signaling on the Lehigh Valley Railroad. In 1891, Edison obtained the wireless patent for this method using inductance (U.S. Patent 465,971).

In the *history of wireless technology*, the demonstration of the theory of electromagnetic waves by Heinrich Hertz in 1888 was important. The theory of electromagnetic waves was predicted from the research of James Clerk Maxwell and Michael Faraday. Hertz demonstrated that electromagnetic waves could be transmitted and caused to travel through space at straight lines and that they were able to be received by an experimental apparatus.[2][3] The experiments were not followed up by Hertz. Jagadish Chandra Bose around this time developed an early wireless detection device and helps increase the knowledge of millimeter length electromagnetic waves.[4] Practical applications of wireless radio communication and radio remote control technology were implemented by later inventors, such as Nikola Tesla. [1]

Principle of operation:

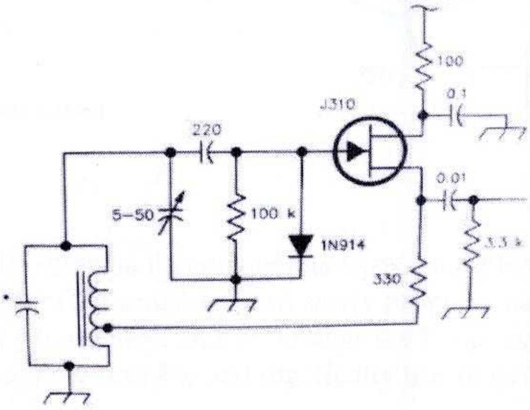
Balanced Modulator:





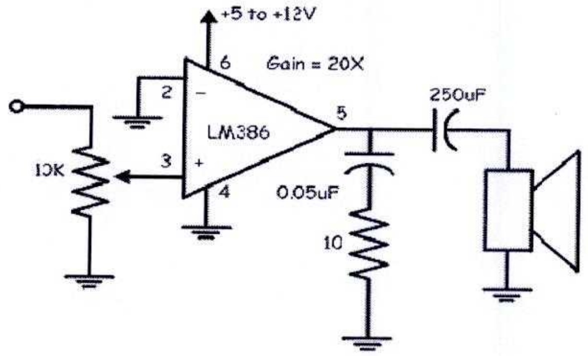
A balanced modulator is required to convert electrical energy into electromagnetic wave, preferably radio wave or microwave. We can implement the above circuit to bring about the desired conversion and utilize LM1596 integrated circuit.

Oscillator:



An oscillator is required to multiply a high frequency to the original wave acquired, which will, then, act as the carrier. A carrier with very high frequency is required so the path loss is the minimum during transmission. We will use a crystal oscillator for this purpose and the frequency added by the oscillator strictly depends on the type of wave in concern.

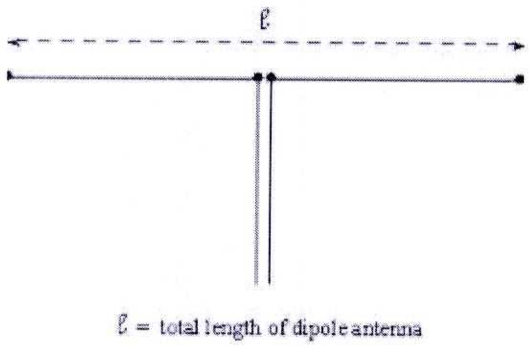
Power Amplifier:

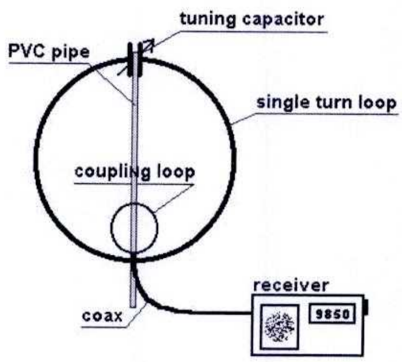


A power amplifier is used to amplify the final signal. Here, STK350-030 is a power amplifier that returns almost 10-20 times the original gain.

Antenna:

Dipole Antenna and Loop Antenna:





A dipole antenna is a radio antenna that can be made by a simple wire, with a center-fed driven element. The length of the antenna is inversely proportional to the frequency of the wave by a relation 147/frequency. Hence, greater the frequency, smaller is the size of the antenna, resulting in a more feasible and practically useful device.

Applications:

Security systems

Wireless technology may supplement or replace hard wired implementations in security systems for homes or office buildings.

Cellular telephone (phones and modems)

Perhaps the best known example of wireless technology is the cellular telephone and modems. These instruments use radio waves to enable the operator to make phone calls from many locations worldwide. They can be used anywhere that there is a cellular telephone site to house the equipment that is required to transmit and receive the signal that is used to transfer both voice and data to and from these instruments.

Wi-Fi

Wi-Fi is a wireless local area network that enables portable computing devices to connect easily to the Internet. Standardized as IEEE 802.11 a,b,g,n, Wi-Fi approaches speeds of some types of wired Ethernet. Wi-Fi hot spots have been popular over the past few years. Some businesses charge customers a monthly fee for service, while others have begun offering it for free in an effort to increase the sales of their goods.

Wireless energy transfer

Wireless energy transfer is a process whereby electrical energy is transmitted from a power source to an electrical load that does not have a built-in power source, without the use of interconnecting wires.

Computer interface devices

Currently, many manufactures of computer peripherals are turning to wireless technology to satisfy their consumer base. Originally these units used bulky, highly limited transceivers to mediate between a computer and a keyboard and mouse, however more recent generations have used small, high quality devices, some even incorporating Bluetooth.

Random wire antenna:

A random wire antenna (or long-wire antenna) is a radio frequency antenna consisting of a wire whose length does not bear a relation to the wavelength of the radio Such antennas are usually not as effective as antennas whose length is adjusted to resonate at the wavelength to be used. They are widely used as receiving antennas on the long wave, medium wave, and short wave bands, as well as transmitting antennas on these bands for small outdoor, temporary or emergency transmitting stations, as well as in situations where more permanent antennas cannot be installed. Random wire antennas are a type of monopole antenna and the other side of the receiver or transmitter antenna terminal must be connected to an earth ground. waves used, but is typically chosen more for convenience. This type of antenna sometimes is called the zig-zag antenna, as it may be strung back and forth between trees just to get enough wire into the air.

The radiation pattern of a straight random wire antenna is unpredictable and depends on its electrical length, it may have several lobes at angles to the antenna axis. The radiation will drop off to zero on the axis. A folded or zig-zag antenna will have an even more unpredictable pattern.

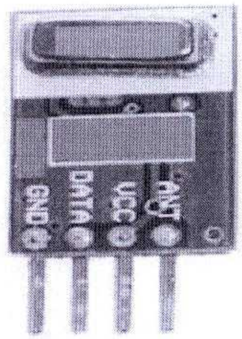
Usually, it consists of a long (at least one quarter wavelength) wire with one end connected to the radio and the other in free space, arranged in any way most convenient for the space available. Ideally, it is a straight wire strung as high as possible between trees or buildings, the ends insulated from supports with strain insulators. Typically it is made from number 12 or 14 AWG (1.6 to 2.0 mm (0 in) diameter) copper clad wire. Folding (to fit in space available) will reduce effectiveness and make theoretical analysis extremely difficult. (The added length helps more than the folding typically hurts.)

If used for transmitting, a random wire antenna usually will also require an antenna tuner, as it has a random impedance that varies with frequency. One side of the output of the tuner is connected directly to the antenna, without a transmission line, the other to a good earth ground. One-quarter wavelength works best, and one half wavelength will work poorly with most tuners. Since the antenna is located very close to the transmitter, RF feedback can be an issue. RF feedback can be minimized by selecting a wire length that causes the low feed-point impedance at a current loop to occur at the transmitter. Alternately, a remote tuner can be fed with feedline, and the tuner located on the antenna.

The ground for a random wire antenna may be chosen by experimentation. Grounds could be returned to a nearby cold water pipe or a wire that's approximately one-quarter wavelength long.

THESIS 1 SEMESTER

Transmitter:

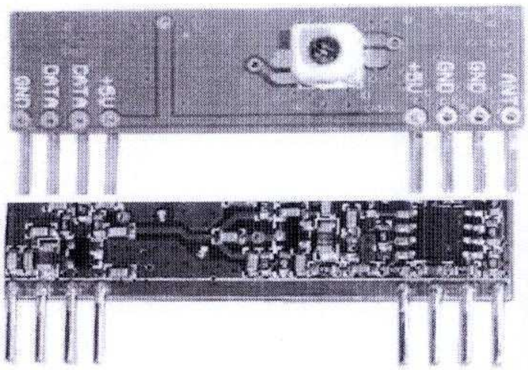


This transmitter is ideal for remote control applications where low cost and longer range is required. The transmitter operates from a 1.5V to 12V supply, making it ideal for battery-powered applications.

Some properties of the transmitter

1. The transmitter's operating voltage is between 1.5V to 12V.
2. 433.92 MHz frequency range.
3. Digital data input. This input is CMOS compatible and should be driven with CMOS level inputs.
4. It can work in -20 degrees Celsius to 60 degree Celsius temperature.
5. Very low cost.

Receiver:



This receiver is ideal for short-range remote control applications where cost is a primary concern.

Some properties of the receiver

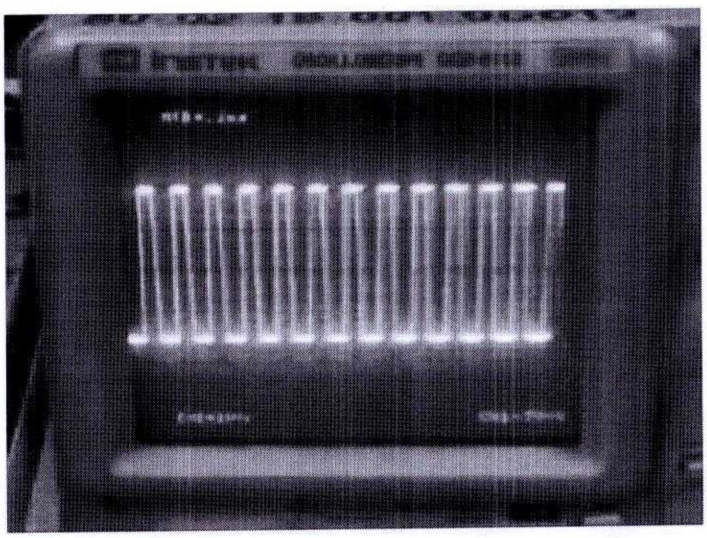
1. The receiver's operating voltage is between 4.5V to 5 V.
2. The frequency range is 433.92 MHz.
3. Can operate from -10 degree Celsius to 60 degree Celsius.
4. It's turn on time is 25 ms.

In thesis 1 semester, we performed a series of experiments using a set of transmitter and receiver modem for the basic understanding of transition from wired to wireless data transfer over a short distance and they are as follows.

<u>STAGE 1</u>

In stage 1 the experimental setup was placed to observe performance of the transmitter and the receiver under optimum conditions, i.e. in absence of obstacles. The block diagram of the setup is shown below.

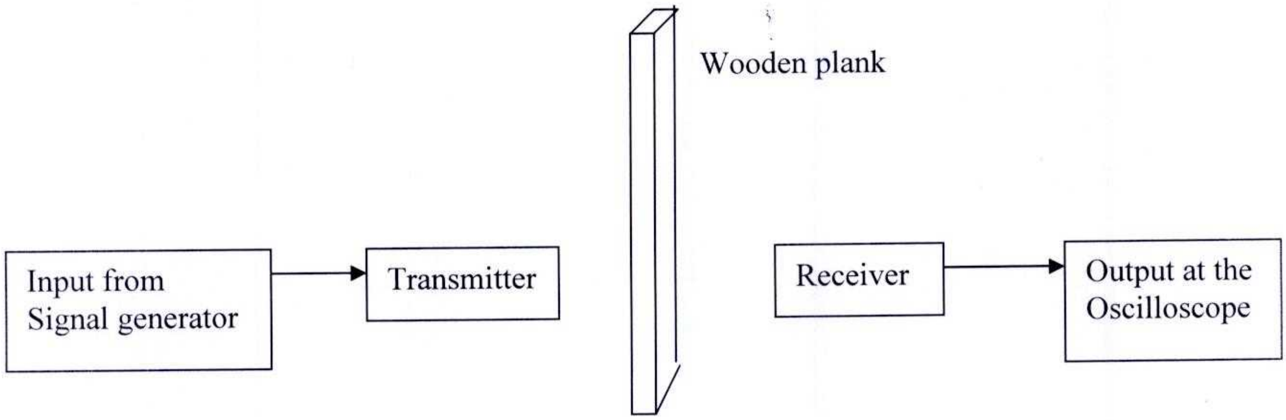
The output obtained in the oscilloscope is shown below.



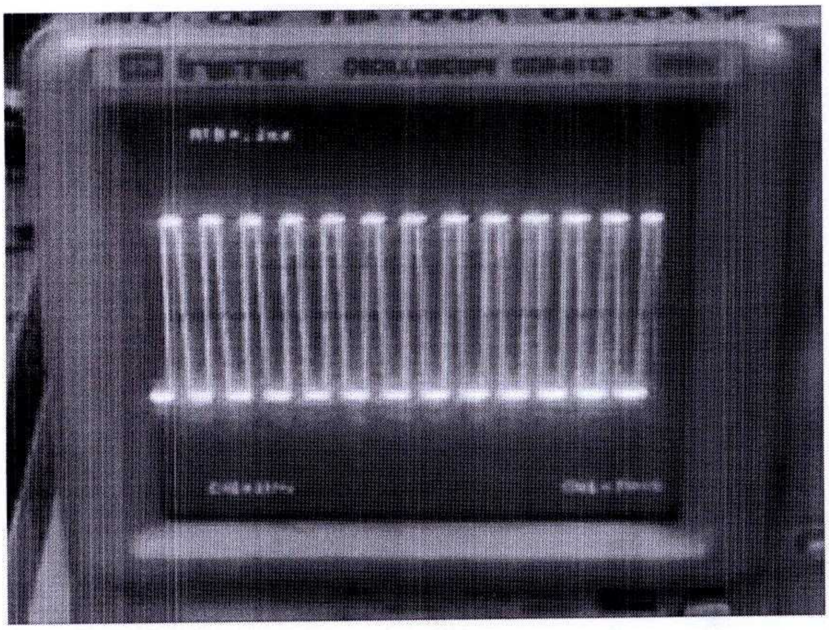
The signal transmitted and received at this stage was very strong and was unaltered upto a distance of about 3 meters.

STAGE 2

In stage 2 the transmitter and the receiver modems were set with a wooden obstacle between them to observe if there is any form of disturbance created by it.



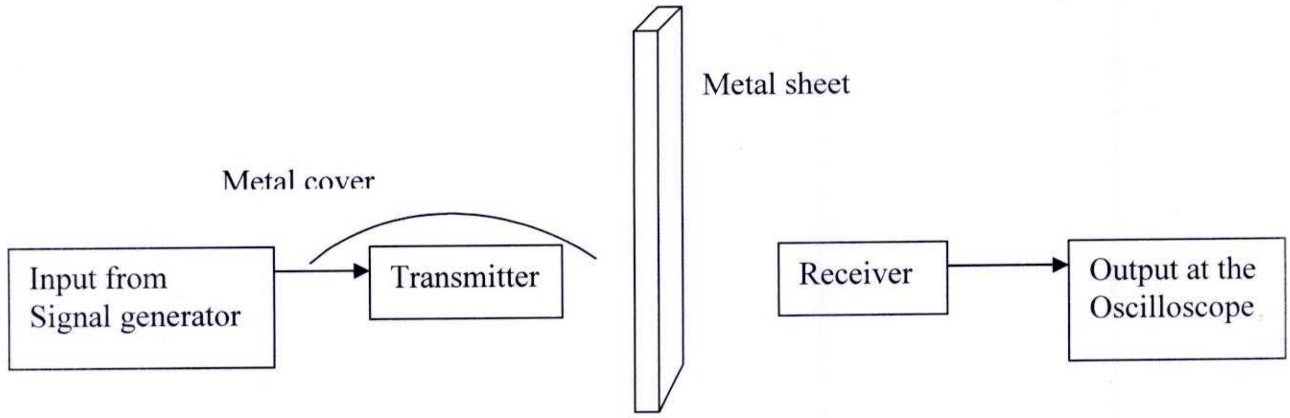
The wooden plank did not alter the transmitted data and the data signal received by the receiver modem was perfect as shown below.



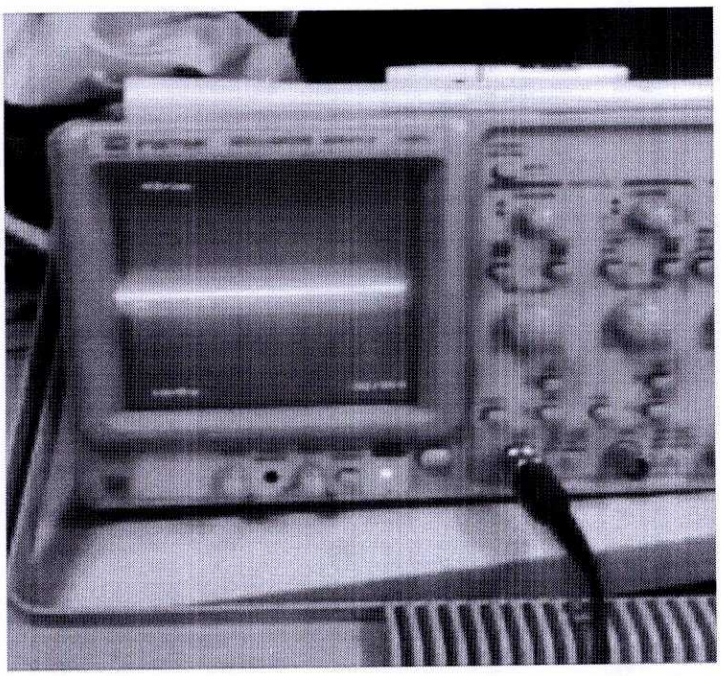
The signal transmitted and received at this stage was very strong and was unaltered upto a distance of about 3 meters.

STAGE 3

In stage 3, between the transmitter and the receiver ends, a metal was placed to observe what kind of obstacle it poses to the transmitted signal. The block diagram is shown below.

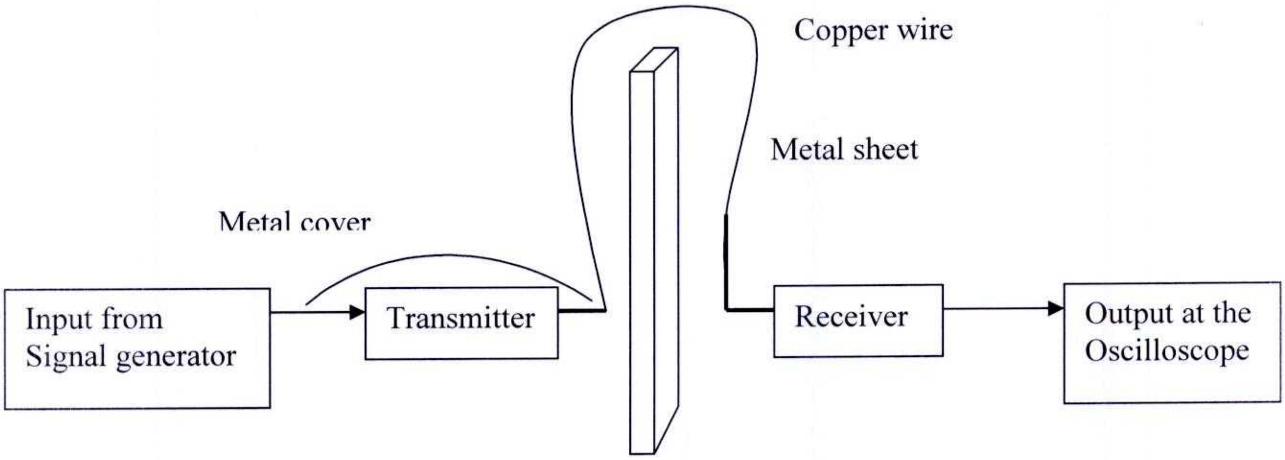


During the experiment, a metal sheet of steel was placed between the transmitter and receiver set up. And besides this metal obstacle, the transmitter was also covered with a metal case to stop any kind of data being transmitted. And there was no signal received at the output. The output at the oscilloscope is shown below.

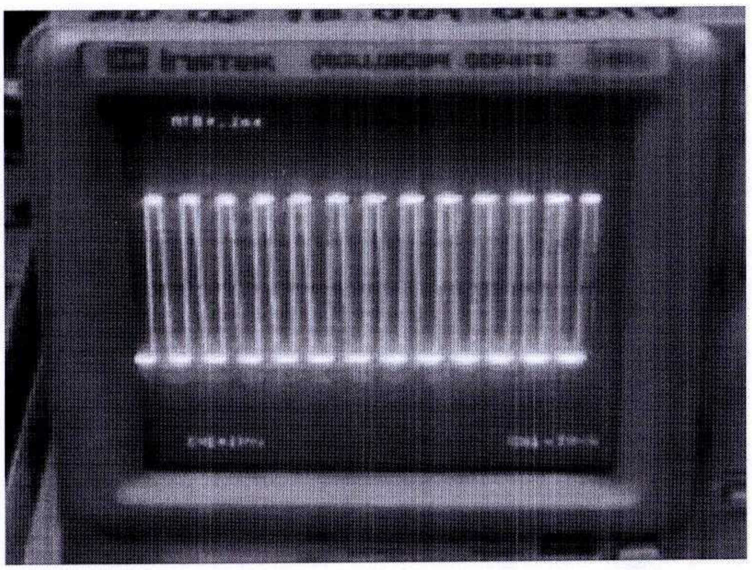


STAGE 4

In stage 4 the transmitter and receiver was set up in according to the previous setup with an upgrade by connecting the antenna ports of the transmitter and the receiver with a connecting copper wire. The block diagram and the output observed at the oscilloscope are shown below.

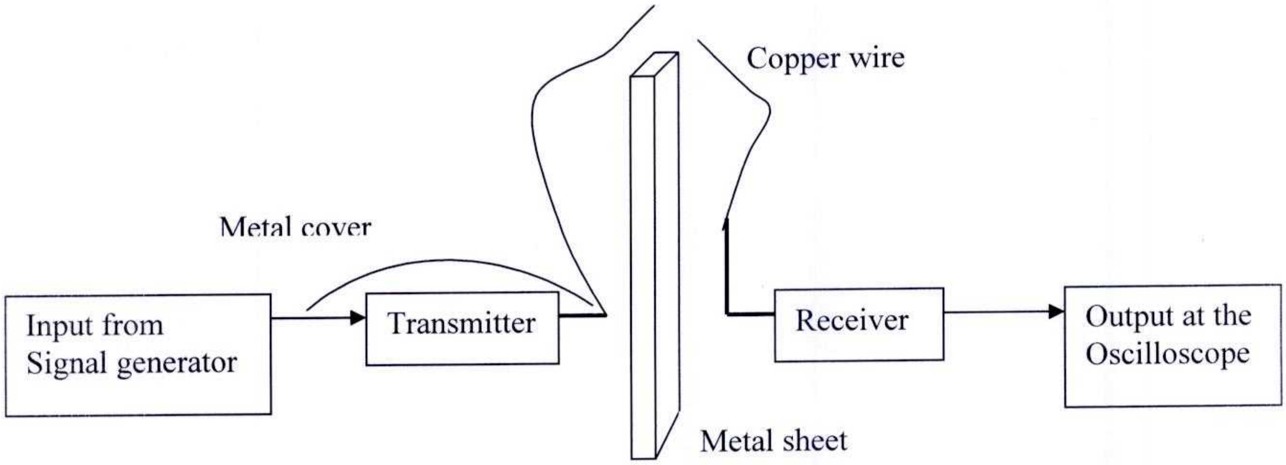


On connecting the antenna ports of the transmitter and the receiver the receiver end was now able to collect the signal directly and the output received was perfect like stage 1 and 2. The output obtained from the oscilloscope is as below.

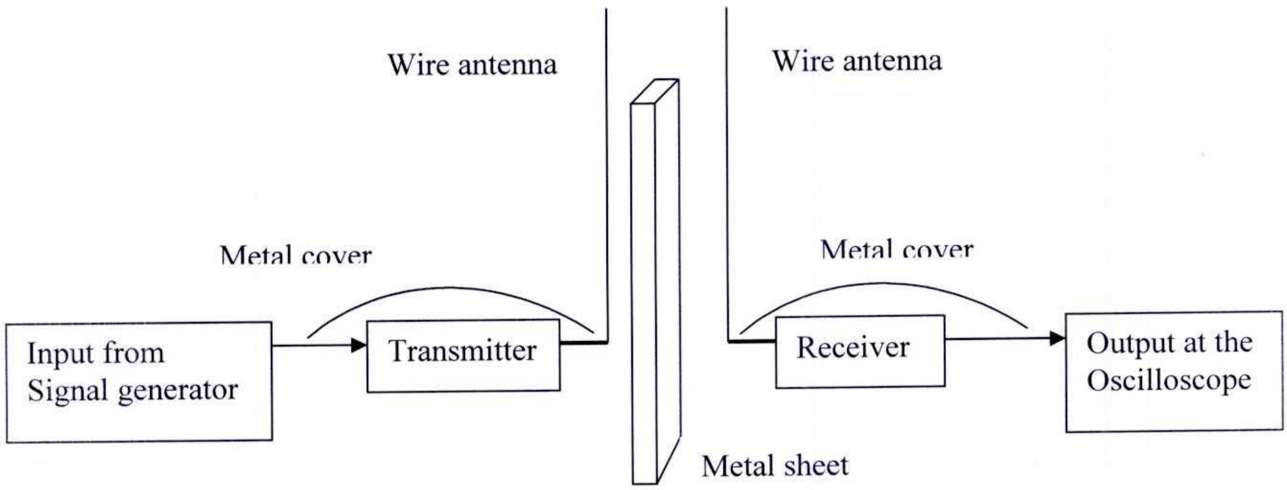


Stage 5

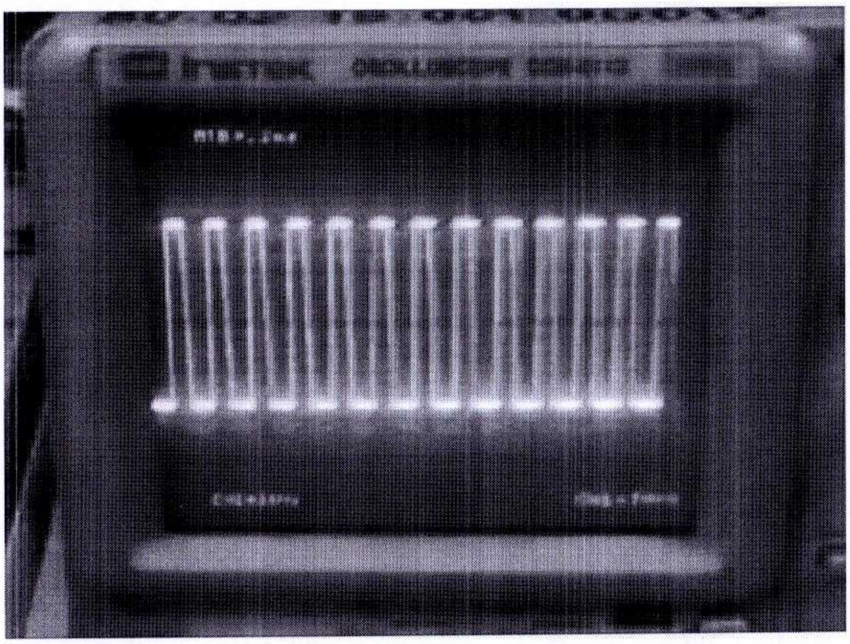
In stage 5, the circuit setup of the transmitter and receiver modem remains the same with an upgrade to the system as the connecting copper wire is cut into two halves.



And then, after cutting the connecting wire into two halves, the antenna ports were connected to small wires of definite length that acted as wire antennas.



And thus, on improving the system with wire antennas at the transmitter and receiver's antenna ports, even with the transmitter and the receiver cover with steel casing, the transmitted signal still reached the receiver through the respective antenna and the output signal ws as below.



Although the system was improved so as to receive the transmitted signal, the range of distance between which the transmitter and receiver was able to operate perfectly reduced from 5 meters to approximately 2 meters.

Observations:

The following table shows the change of range in distance for transmission with and without obstacles as per experimented in this semester.

The stage of experiment	Presence of obstacle	Distance for flawless transmission
Stage 1	No	Upto 5 meters
Stage 2	Yes,wooden	Upto 5 meters
Stage 3	Yes, metallic	No output
Stage 4	Yes, metallic	Upto 5 meters
Stage 5	Yes, metallic	Upto 3 meters

Achievement:

In thesis semester 1, we have been able to successfully experiment with the theoretical prospect of the subject. Besides making use of the transmitter and the receiver modems, we have successfully observed the different possible outcomes that are associated and have been able to overcome the demo obstacles and transmitting the signal across to the receiver end.

Future work:

- Observe the output obtained in thesis 1 semester with amplitude variation at input and record output for with and without obstacles.
- Integrate a Low noise amplifier, high power amplifier, encoder and decoder in the circuit.
- Replace the transmitter and the receiver modems with self-made modulators and a Colpitts oscillator.

Cost analysis:

The conversion from wired to wireless system, apart from deducting the cost of truck-rolling, also reduced the wiring cost. The cost of the circuit used for the experiment is as below.

Name of the equipment	Cost of the equipment
A set of transmitter and receiver modems	Tk 900

Conclusion:

We had studied the theoretical aspects of the conversion mechanism in pre thesis semester and have practically implemented the concept with the help of the ready-made transmitter and receiver modems in thesis 1 semester. We will further improve the circuit in thesis 2 semester with the full-length completion of the list of future work mentioned above.

Reference:

1. History, Early wireless work, http://en.wikipedia.org/wiki/Wireless
2. http://www.electroniq.net/files/RF/LM1596-suppressed-carrier-modulator-circuit.jpg
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8. http://en.wikipedia.org/wiki/Antenna_%28radio%29
9. http://en.wikipedia.org/wiki/Radio_wave
10. http://en.wikipedia.org/w/index.php?title=Special%3ASearch&search=construction+of+an+oscillator