

Review and Simulation of QRP Transceiver

¹Isaiah Anugboba, ²A.I. Habib, ³J.U. Ezeah, ⁴H. Otaru, ⁵M.U. Mainta

^{1, 2, 3, 4, 5}Power Equipment and Electrical Machinery Development Institute (PEEMADI), Okene, Kogi State, Nigeria

Abstract: This paper focuses on the use of efficient software (Proteus ISIS Professional) in the design analysis and simulation of a QRP transceiver which consists of both a transmitter and a receiver for frequency modulation (FM) signals in enhancing communication via a radio frequency. This technology deploys the use of radio frequency (RF) signals. QRP transceiver is simply a device that transmits at a reduced (low) power. The distinguishing characteristic of this transceiver is that it was designed and then optimized for high performance. It is relatively easy to build something that works, but usually requires a great deal more effort to produce something that works really well. That effort has gone into this rig, and the result is a continuous wave (CW) transceiver which has the following characteristics: Keying and quiet transceiver operation, stable variable frequency oscillation (VFO) coverage, receiver incremental tuning (RIT), radio frequency (RF) output, and high performance direct-conversion receiver.

Keywords: QRP, VFO, Radio frequency, Transmitter, Receiver, Simulation, Proteus ISIS Pro.

1. INTRODUCTION

The importance of an effective and efficient means of communication in virtually every industry today cannot be overemphasized. Technology has helped to improve communication methods in many respects but there is still need for improvement in the existing technologies available, this improvement makes the system indispensable.

QRP transceiver was first published in August, 1980 by Roy Lewallen. It is still the best available portable rig in many respects. Many QRP rigs have been described in Amateur Radio publications over the years [1]. Transceiver is a complex electronic device that can transmit and receive various ranges of frequency signals simultaneously [2]. The term applies to wireless communication devices such as cellular telephones, cordless telephone sets, handheld two-way radios and mobile two-way radios. Occasionally, the term is used in reference to transmitter/receiver devices in cable or optical fiber systems [3]. Simple analog transceivers or telephones could be designed as early as the invention of radio frequency (RF) signal systems. Such transceiver systems usually consisted of two enclosed circuitry connected via coaxial cables [4].

1.1 QRP:

This is a code in telecommunication that represents “low power signal transmission”. In other words, it means the transmission of signal at a very reduced or minimized power [8].

1.2 Motivation for the Use of QRP Transceiver:

The concept of simulating the optimized QRP transceiver was formulated to simultaneously relate the mode of transmission and reception of radio frequency signals at the voltage levels from both ends [7], [10]. Even though the knowledge has been in existence for over three decades, the QRP transceiver technology is still an emerging research topic in the wireless communication fields as previous research made has not had a perfect breakthrough.

A new invention or technology as a matter of fact, must prove its usefulness, cost-effectiveness and solve a problem that warrants its existence. QRP transceiver provides us with a solid evolutionary lesson in a technology that has many starts, stops and stalls along the way to becoming a commonplace real-time means of communication system used throughout by professionals, industries, government, schools, and military around the world.

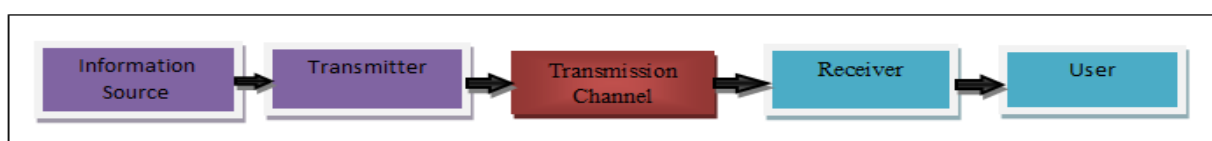


Fig 1: Block diagram of a Simple Communication System [10]

2. TRANSCEIVER SYSTEM AND ITS COMPONENTS

A transceiver is a device that has both a transmitter and a receiver which are combined and shared common circuitry or a single housing. Similar devices include transponders, transverters, and repeaters.

2.1 Receiver:

The function of the receiver is to select the wanted signal from all the signals picked up by the aerial, rejecting all others, to extract the intelligence contained in the modulated signal and to produce an audio frequency output power to operate the loudspeaker or other receiving devices. The receiver consists of the following stages, Antenna, Tuned radio frequency amplifier, Local oscillator, Mixer, Intermediate frequency (I.F) amplifier, Detector, Automatic gain control, Audio frequency and Loudspeaker.

2.2 Transmitter:

The Transmitter is that in which signal modulation is carried out. It sends already modulated signals that are converted from sound (Audio) energy into electrical energy. The various stages of a transmitter are; R.F oscillator, Buffer amplifier, R.F amplifier, Microphone, Microphone amplifier, Audio amplifier and the Transmitting aerial.

2.3 VFO:

This receiver is on a par with all but the best super-het for any type of operation, except during contests in conjunction with a high-power transmitter. Yet it has but a fraction of super-het complexity. Note also that to use a super-het in a transceiver, an additional oscillator and mixer are necessary for the conversion of VFO to the transmit frequency. In a transceiver using a DC receiver, the required shift is only a few hundred hertz, which can be easily accomplished by pulling the VFO. Since this rig was designed for portable use, current drain was a major consideration. The oscillator is a good example of the principle that a good circuit need not be complex to work well, if properly designed. This simple Hartley circuit exhibits less than 200Hz warm-up drift, with about half of that within one minute after turn-on. This drift performance is completely repeatable [9].

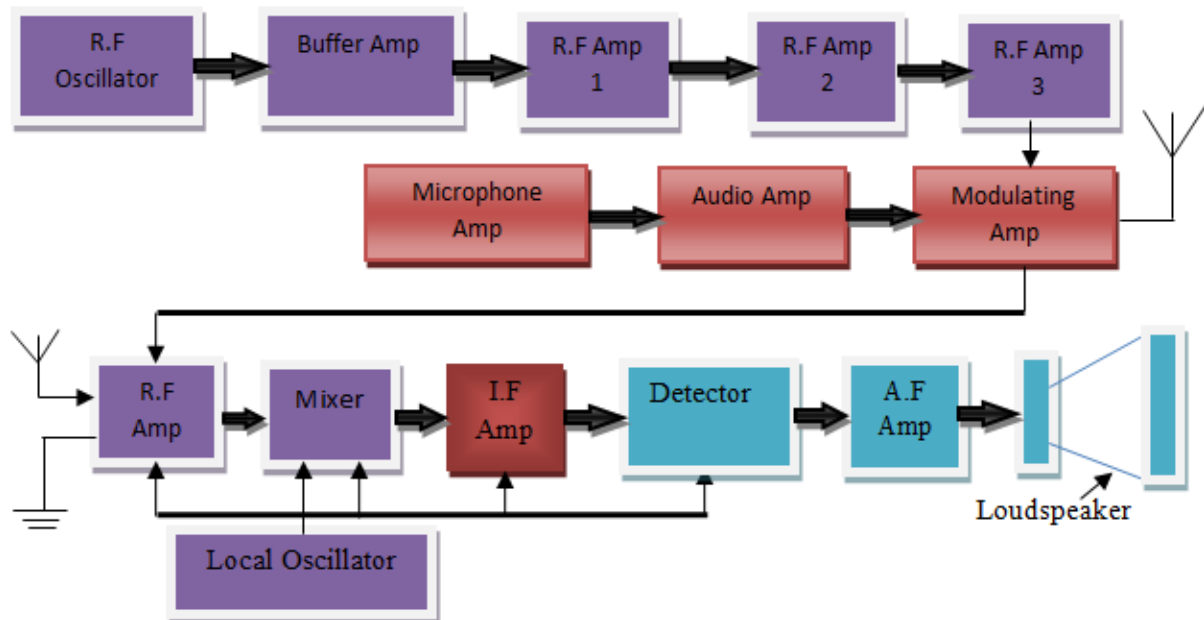


Fig 2: Block diagram of a typical Transceiver system [10]

3. CALCULATIONS AND METHODS

“High-performance direct-conversion receiver” may seem to be self-contradictory. After all, direct-conversion (DC) receivers are so simple that they cannot possibly compete with a good super-het, right? Wrong! DC receivers have only one significant disadvantage when compared to super-het. The presence of an audio image which doubles the amount of noise and interference heard. The only other inherent disadvantage is the inability to generate radio frequency (RF) or Intermediate frequency (IF)-derived automatic gain control (AGC).

3.1 Frequency:

Transceiver operates in parts of radio frequency spectrum which ranges from about 3 KHz to about 300 GHz. For the purpose of this paper, we consider using frequency modulation (FM), the most important stage responsible for frequency generation in this design is the Hartley oscillator which cannot be extensively discussed in this paper.

Table 1: QRP Frequency Ranges and Bandwidth [11]

Band	CW	Phone
160m	1810-1843 kHz	1910 kHz
80m	3560 kHz	3986-3690 kHz
60m		5346.5 kHz (Ch2)
40m	7030-7122 kHz	7090-7285 kHz
30m	10106-10116 kHz	
20m	14060 kHz	14285 kHz
17m	18096 kHz	18130 kHz
15m	21060 kHz	21285-21385 kHz
12m	24906 kHz	24950 kHz
10m	28060kHz	28365-28385 kHz

Nomenclature: f =Frequency, L=Inductance, C=Capacitance, l= Length of the coil, μ =Permeability, d=Diameter
 A=Cross sectional area, N1=Number of primary turns, N2=Number of secondary turns, E1=Primary Voltage (input)
 E2=Secondary voltage (output)

Using the formula $f = \frac{1}{2\pi\sqrt{LC}}$ (1)

To calculate for the inductance,

The number of turns for an inductor is given by $N = \sqrt{\frac{Ll}{\mu A}}$ (2)

$\mu = \mu_0\mu_r = 4\pi \times 10^{-7}$ (3)

$A = \pi r^2$; where $r = \frac{d}{2}$

From the transformation equation; $\frac{E1}{E2} = \frac{N1}{N2}$ (4)

Where $E_1 = 12v$ and $E_2 = 2.5v$

From the equations above, at every instance the values of the circuit inductance, capacitance which determines the frequency of the system are calculated.

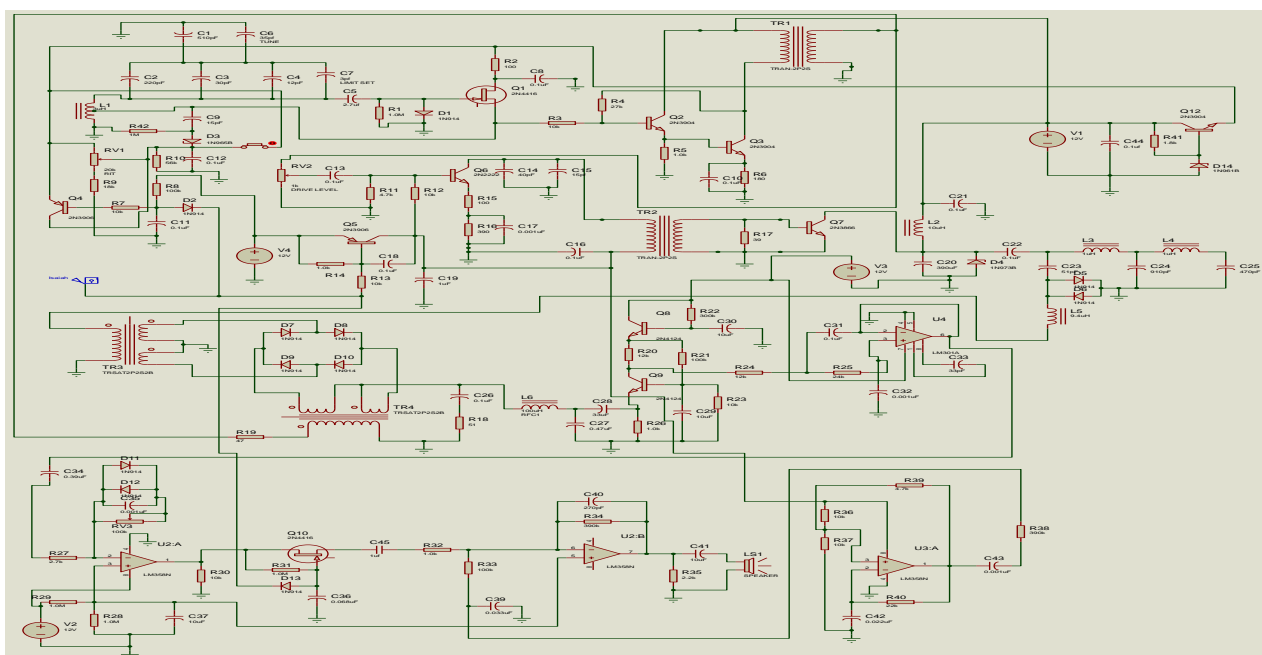


Fig 3: Complete circuit diagram of a transceiver system [9]

3.2 The Software (Proteus ISIS Professional):

Proteus ISIS Professional is digital software developed by Lab-center Electronics. The advancement in technology and the trend has made it impossible to use other versions of software as speed and accuracies are required. This digital software is deployed in this project because of its ability to; (a) Simulate circuit diagrams. (b) Draw circuit diagrams within a short period of time. (c) Debug the circuit components. (d) Convert circuits from schematic into their PCB version.

The Proteus Professional demonstration is intended for prospective customers who wish to evaluate professional level products. It has a PCB version which combines the schematic capture and ARES CB layout programs to provide a powerful, integrated and easy to use suite of tools for professional PCB design. All Proteus PCB designed products include an integrated shape based auto-router and a basic SPICE simulation capability as standard. The Virtual System Modeling (VSM) aspect of combines circuit simulation, animated components and microprocessor models to simulate the interaction between software running in microcontroller and any analog or digital device connected to it [15].

3.3 How to Make Circuit Diagram Using Proteus ISIS:

Here you can study step by step method of using Proteus ISIS as shown below

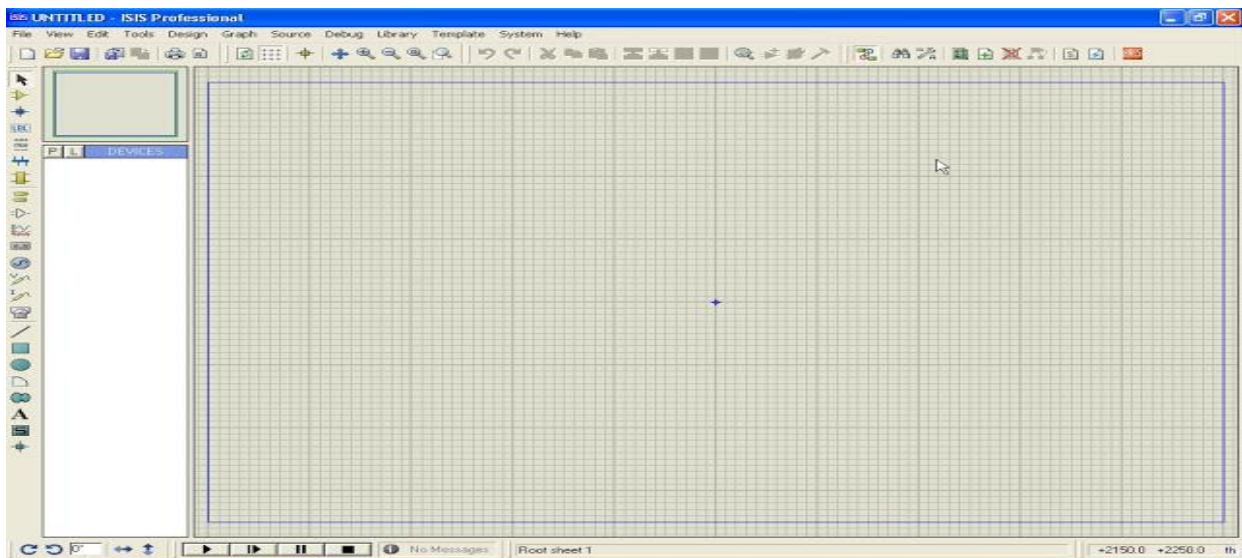


Fig 4: Go To Start >> All Programs >> Proteus 7 Professional >> ISIS 7 Professional [13]

From the above window, click the P on left side to display items from which you make components selections.

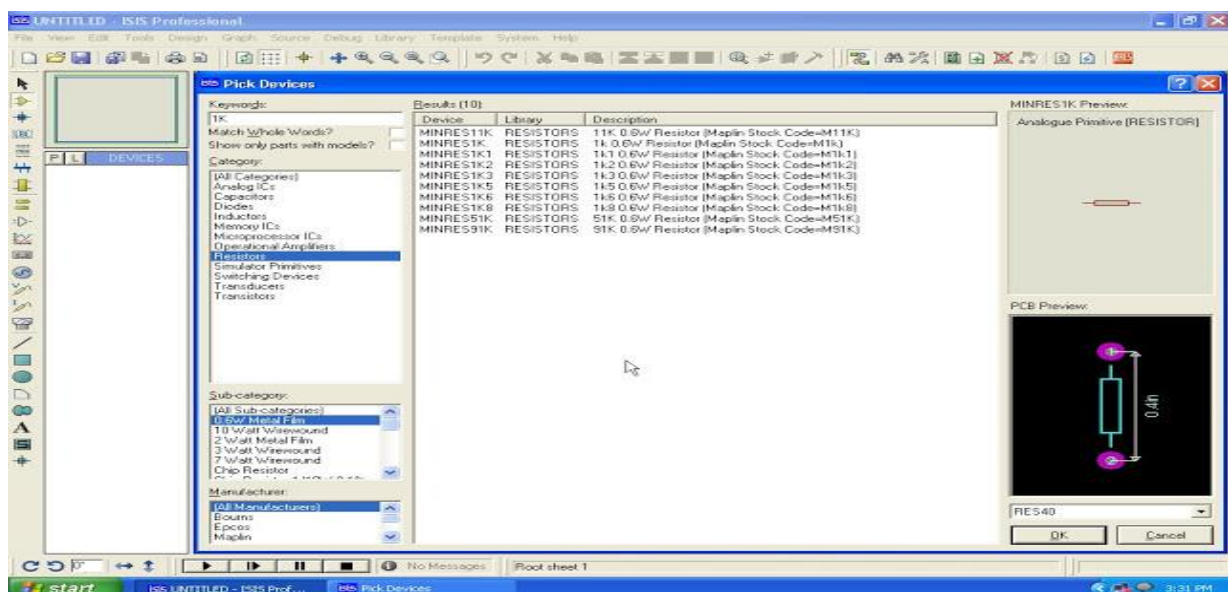


Fig 5: Window Showing Various Components to Select [13]

Now the related items are showing in the 'Pick Devices' window. Then select Resistor >> Select resistor type you want in the sub category section (suppose you want 1k,0.6w, then click 0.6 watts in the sub category after that click 1K,0.6 w resistor also you can see the PCB preview in the right side bar).

Now you can see the 1k resistor in device's section. Then click on the place you want it to appear. Go to make wires, pencil mark used to making wire. Then select which pin you want to make wire with then drag the pencil mark to link with another component.

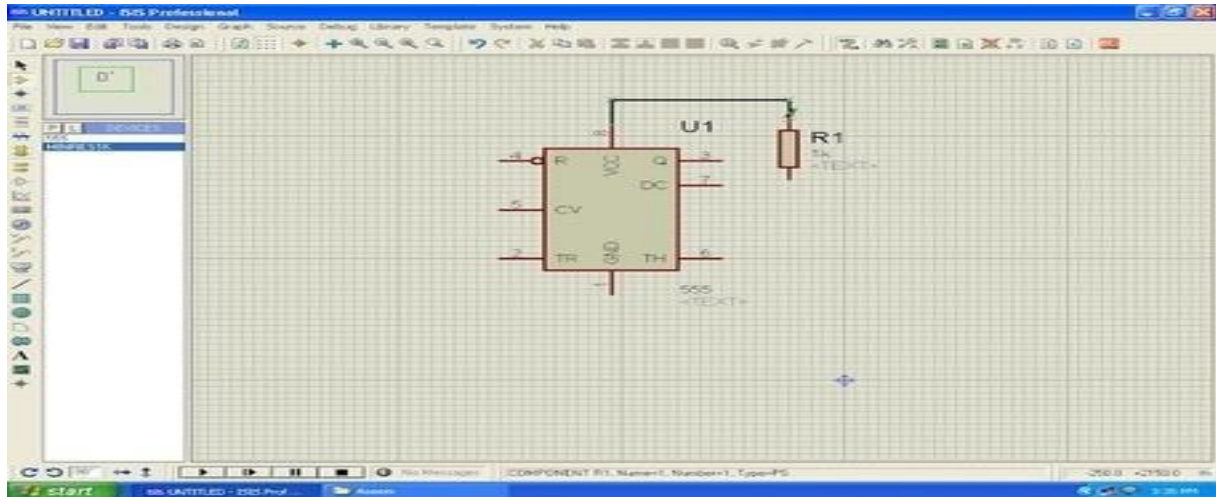


Fig 6: Page Showing How to Drag Wire to the Component [13]

4. SIMULATION

4.1 Voltage Test:

Voltages at each section's input and output were tested and the result was good enough as shown in the table below;

Table 2: Showing Results for Voltages at Different Sections

S/No	Various Sections	Voltage Levels
1	Input Voltage	12 Volts
2	Regulated output voltage	9.26 volts
3	Voltage at reception	9.24 volts
4	Transmitting voltage	9.26 volts
5	VFO output voltage	2.5 volts

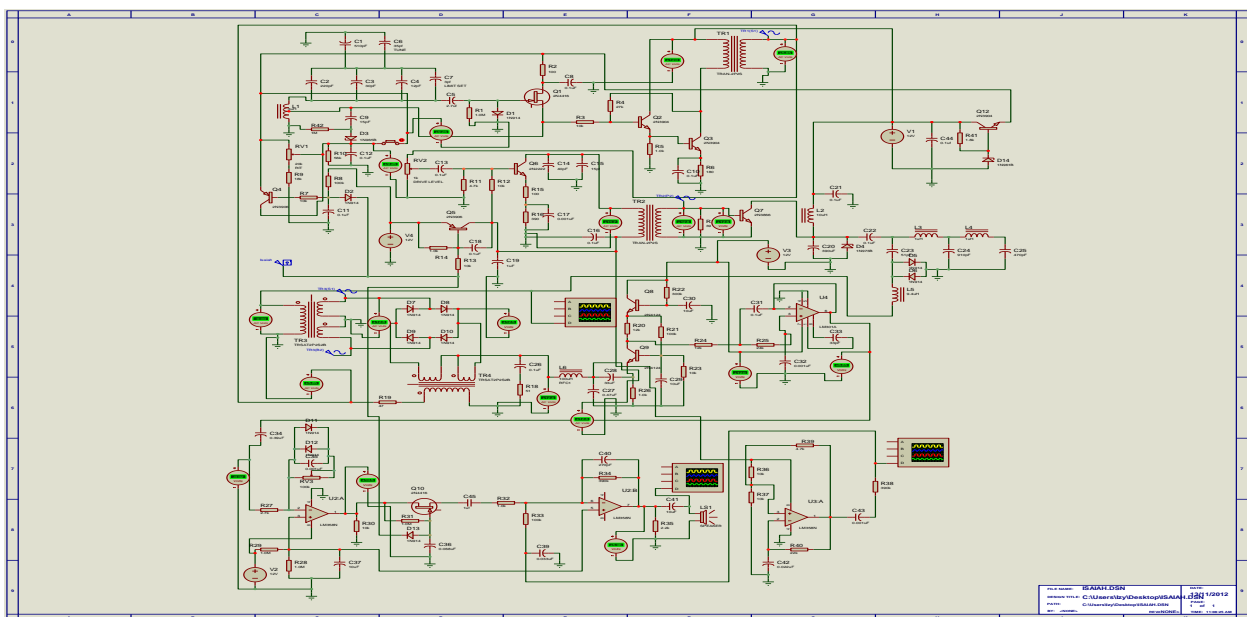


Fig 7: Simulated Circuit Diagram Displaying Different Voltage Levels [9]

5. CONCLUSION AND RECOMMENDATIONS

The QRP transceiver technology has evolved over time into a good communication solution for different professionals and various industries. Its efficacies cannot be overemphasized as it takes communication to a whole new level by giving users who are far away from each other the feeling as though they are close to one another. Through the use of transceiver, a lot more can be achieved in education, business, medicine, etc, at a reduced cost. Transceiver technology has become the dominant and a widely accepted technology for everyone.

Even though it (transceiver technology) has been in existence for quite some time, it is recommended that the QRP transceiver technology be properly harnessed in order to make communication more easy and efficient for use in corporate environments in form video conferencing to enhance collaboration as well as increase productivity.

REFERENCES

- [1] Taub H. and Schilling (1971), Principle of Communication Systems. McGraw Hill Book Company, New York.
- [2] J. J Johnson & B.D Fletcher (1997), Introductory Radio and Television Electronics. Macmillan Education Limited, London.
- [3] Radio and Lines transmission "B" 1st Edition. Pitman Education Limited, 39 Parket Street, London WC2B5PB.
- [4] The Evolution of Cell Phone between 1938-2011. This is Available (ONLINE): <http://www.TheEvolutionofTheCellPhoneBetween1938-2011Ginva.htm>
- [5] Pat Hawker G3VA (1980) Amateur Radio Techniques (Seventh Edition)
- [6] Wes Hayward, W7Z01, Rick Campbell, KK7B, and Bob Larkin, W7PUA (2009), Experimental methods in RF design
- [7] P. Baran on Distribution Communication Network, IEEE Transactions on communication system, Vol.12, no.1, pp. 1-9, march, 1964.
- [8] Richard H. Arland (2004), Low power communication: The Art and Science of QRP. On amazon.com
- [9] Available (ONLINE): <http://www.arrl.org/files/file/Technology/tis/info/pdf/93hb3037.pdf>
- [10] Richard E. Blahut (2010), Modern Theory; an Introduction to Telecommunication, University of Illinois, Urbana-Champaign,
- [11] Available (ONLINE): www.qrparci.org
- [12] Telecommunication History (ONLINE): <http://www.TelecommunicationHistorySystemsToolsandIndustry.html>
- [13] Available (ONLINE): www.electronics-circuits.in/2012/08/proteus-7-isis-tutorial-how-to-make.html