DESIGN AND PERFORMANCE EVALUATION OF MONOFREQUENCY TRANSMITTER AND RECEIVER FOR RADIO PROPAGATION AT L-BAND

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Abstract: This paper presents an approach to designing and construction a monofrequency transmitter and monofrequency receiver at L band frequency range of 1.1GHz and the transmitting power is 5watts. The is aimed at instituting monofrequency transmitter and monofrequency receiver at L band for Laboratory uses and to investigate the behavior of radio propagation within the L frequency band (1-2GHz) was successful. The operational pattern of the messages sent through the transmitter was finally observed alongside the attenuation observed at the receiver .

Keywords: transmitter; receiver; radio propagation; L band

1. Introduction:

Communication System is to transmit information-bearing signals from electronic transmitter through a transmission channel and receive at the electronic reviver. In general, the basic elements of communication system are transmitter, transmission channel and, receiver. The information generated by the source (which might be data, voice, and video) is converted into an electrical signal. The transmitter then converts this signal into form that suitable for transmission. The transmission channel is the physical medium that is used to propagate signal from the transmitter to the receiver to recover the message signal at the receiving end and a transducer then converts into a form that is suitable for the users. Transmitter and receiver are essential components of communication system in the sense that, their efficiencies determine the performance of a good communication system [1]. This research developed monofrequency transmitter and monofrequency receiver for communication system at L band. The L band as defined by ITU lies within the range of 1 to 2GHz and wavelength 15-30cm of the electromagnetic spectrum and applications are mobile service, satellite navigation, Telecommunication use, aircraft, surveillance, amateur radio, digital audio, audio broadcasting and astronomy.

2. Methodology:

Figure 1 showing the L – Band transmitter block diagram when the push buttons are meant to send messages through the microcontrontroller, to process the digital signal and the RF *Transmitter* module transmitted the messages through a wireless medium at a frequency range of 1100 MHz to a RF Amplifier, where signals convert a low-power radio-frequency signal into a higher power signal to the antenna. The research development approach as shown in figure 1 and 2 respectively

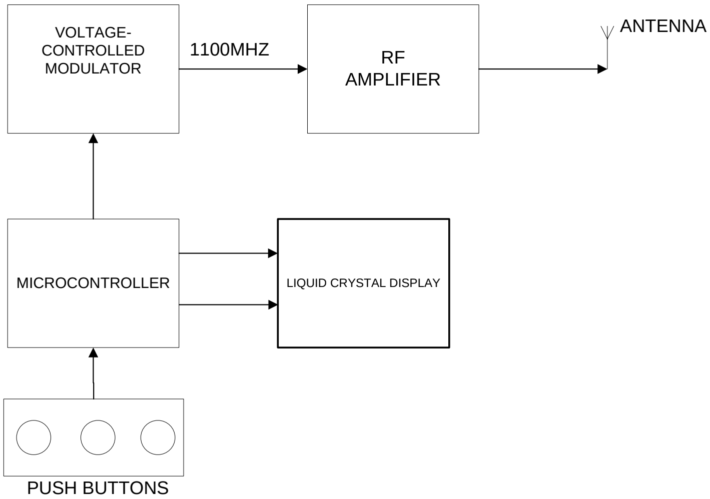

Figure 1: L-band transmitter block diagram.

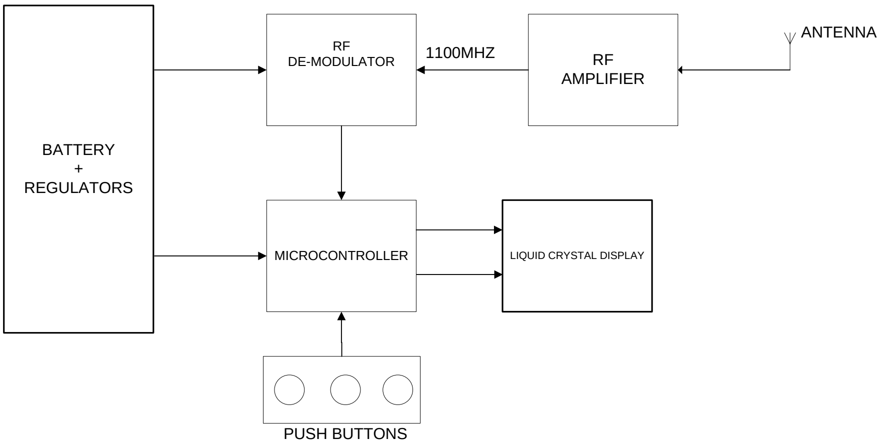

Figure 2: L-band measuring/receiving block diagram.

Figure 2 showing L- Band measuring /receiving block diagram where the amplified signals are receiving at 1100MHZ , RF De-modulator ,where the extraction of the original information-bearing signal from a carrier wave, through the microcontrontroller, to process the digital signal and the RF *receiver* module received the messages through a wireless medium.

2.2. DC power supply unit for receiver:

In designing the +5V and +9V DC power supply required for the microcontroller and the associated RF circuits, LM317 adjustable regulators are used for designing of DC power supply unit for receiver incorporation.

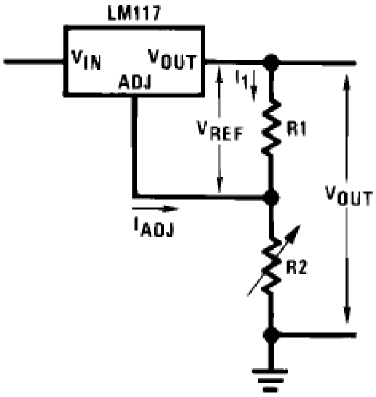

Figure 3: LM317 basic circuit diagram [1].

The regulator output voltage is determined by two resistors R1 and R2 which are connected to form a potential divider. This potential dividing network determines the output voltage of the regulator as shown in figure 3. In operation, the LM317 develops a nominal 1.25V reference voltage, V_{REF}, between the output and adjustment terminal. The reference voltage is developed across resistor R_1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R_2, giving an output voltage as showed in equation 1

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2 \quad (1)$$

I_{ADJ} is the current from the adjustment terminal. It represents an error term; the LM317 has been designed to minimize I_{ADJ} and make it very constant with line and load changes; and it has a constant value of about 100 µA. The current set resistor, R_1 connected between the adjustment terminal and the output terminal is usually 220Ω.

Using the formula in equation in 1 above:

$$V_{out} = 1.25(1 + R_2/220) + (100/10^6) R_2$$

Given that V_{out} = 5.0V

$$5.0 = 1.25(1 + R_2/220) + 0.0001R_2$$
$$5.0 = 1.25 + R_2/176 + 0.0001R_2$$
$$5.0 = 1.25 + 0.0057818R_2$$
$$0.0057818R_2 = 5.0 - 1.25 = 3.75$$

R_2 = 3.75/0.0057818 = 648.6Ω. Since the closest resistor is 680Ω. 680Ω is then selected for R2 as shown in figure 4. Given that V_{out} = 9.0V

$$9.0 = 1.25(1 + R_2/220) + 0.0001R_2$$
$$9.0 = 1.25 + R_2/176 + 0.0001R_2$$
$$9.0 = 1.25 + 0.0057818R_2$$
$$0.0057818R_2 = 9.0 - 1.25 = 7.75$$

R_2 = 7.75/0.0057818 = 1340.4Ω. Since the closest resistor is 1400Ω, 1400Ω is chosen for R2 as shown in fi8gure 4

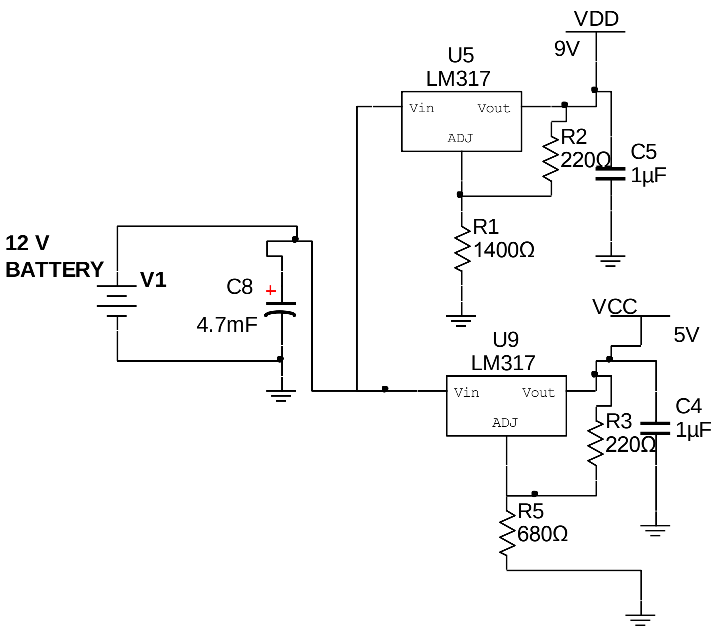

Figure 4: DC power supplies circuit diagram.

Figure 5 is showing digital designing of front end for the RF Receiving/measuring unit with the incorporated with power supplies circuit and USB interface to pc. The battery used was a 12v.

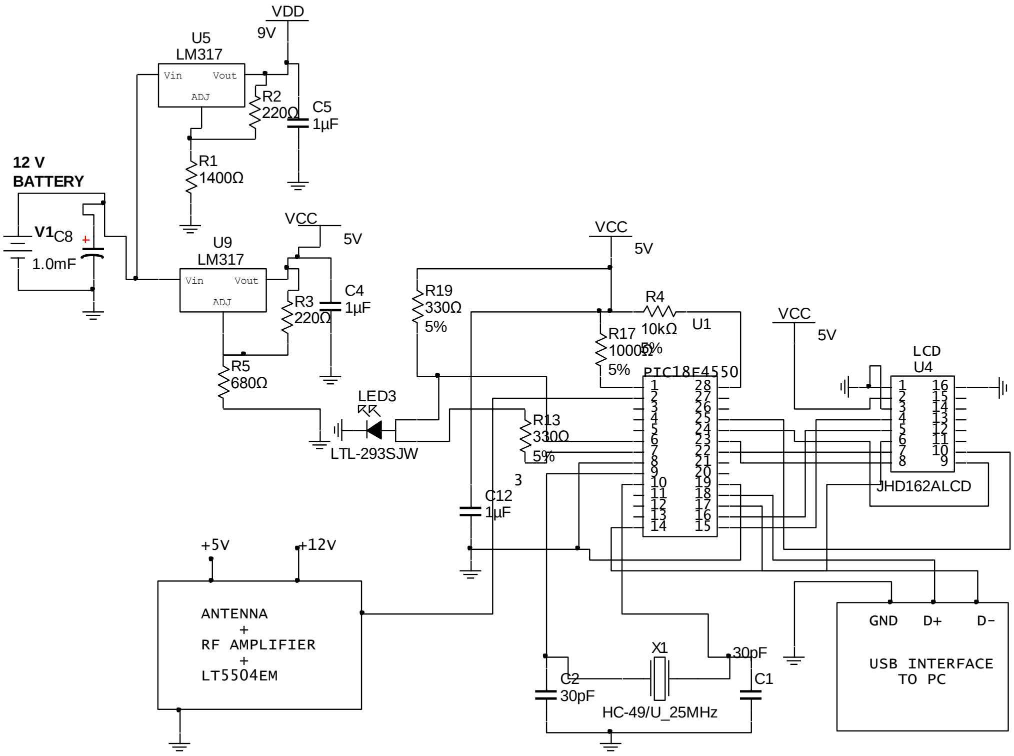

Figure 5: Digital front-end for the rf power receiving/measuring unit.

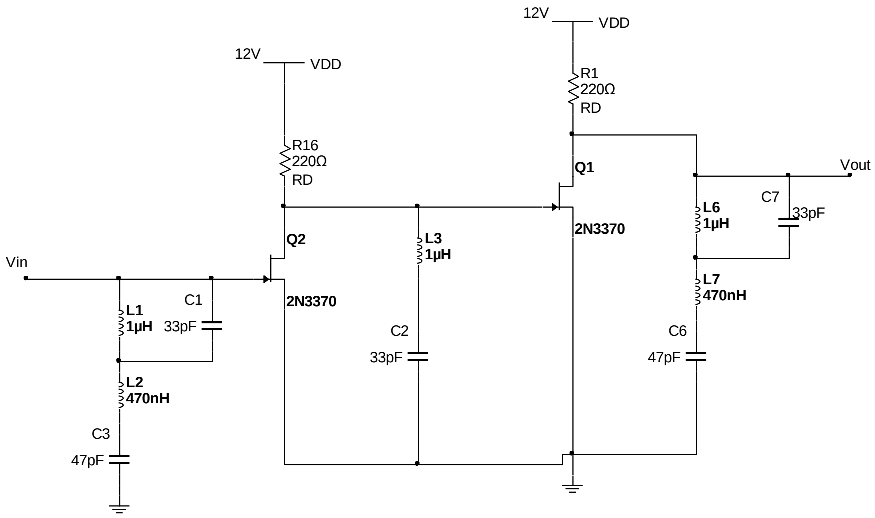

Figure 6: Low Noise RF Amplifier (1MHz -3GHz).

Figure 6 shows Low Noise Amplifier (LNA) at 1MHz -3GHz which is the most critical part of a receiver front end, in term of the receiver performance. Many circuits with different configurations have been proposed for LNA, in different applications. After choosing proper circuit for LNA, this circuit for this research was designed and optimized to suit the needed application of this research. Various techniques have been proposed for LNA design and Optimizations. LNA circuits in CMOS technology are designed as Common Source (CS) or Common Gate (CG) stages. Cascode stage that is widely used in CMOS RF LNAs, can be considered as current –reuse configuration of a CS stage, followed by a CG stage. Choosing proper circuit depends on the specific application and LNA can also be designed base on the designer experiences choice. [2][3][4][5][6]

3. Result and discussion:

3.1. Flowchart of the transmitter:

This represents the programming flowchart of the operation system of the transmitting process as illustrated in figure 7

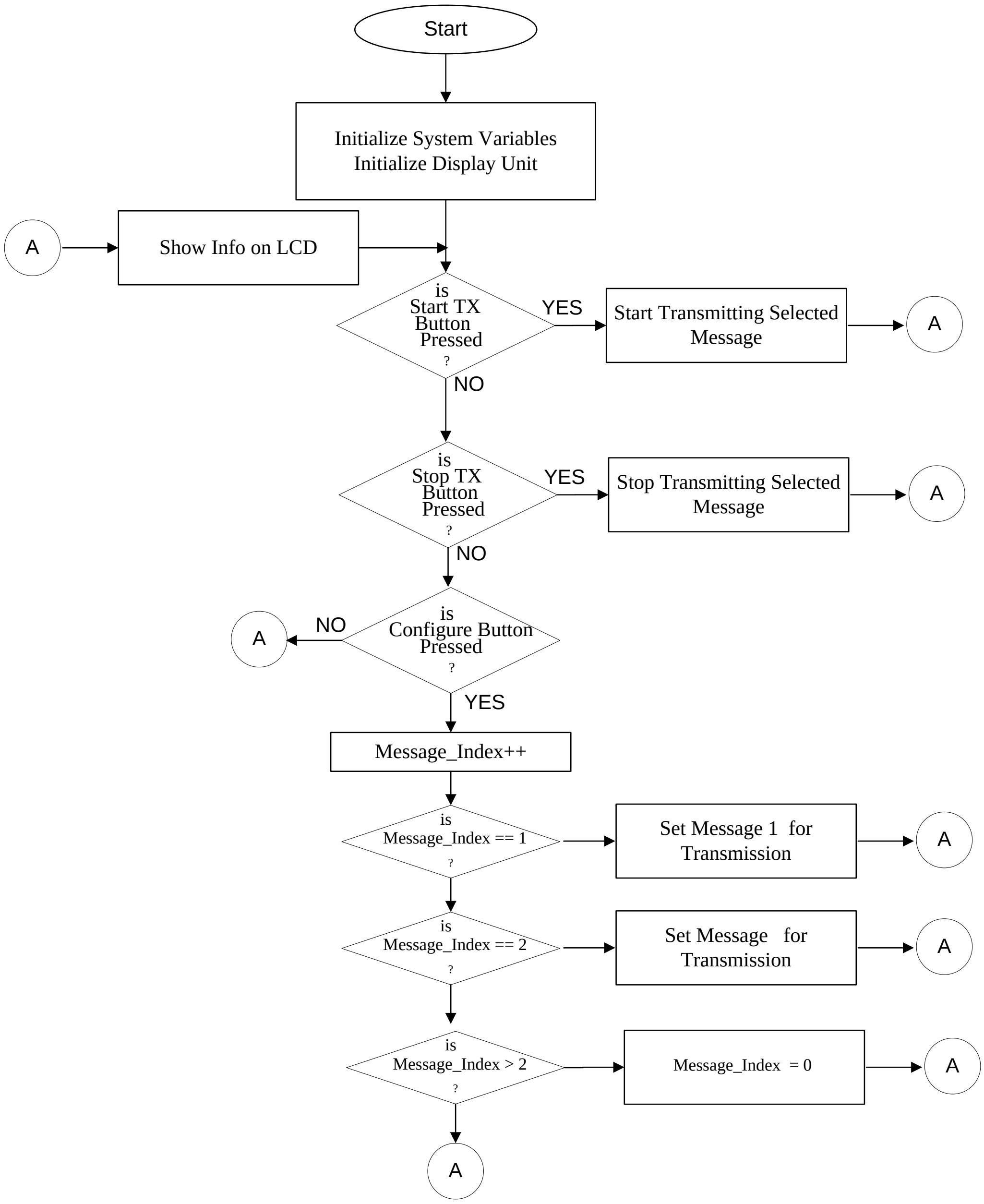

Figure 7: Transmitter flowchart.

3.2. Flowchart of the transmitter:

This represents the programming flowchart of the operation system of the receiving unit as illustrated in figure 8

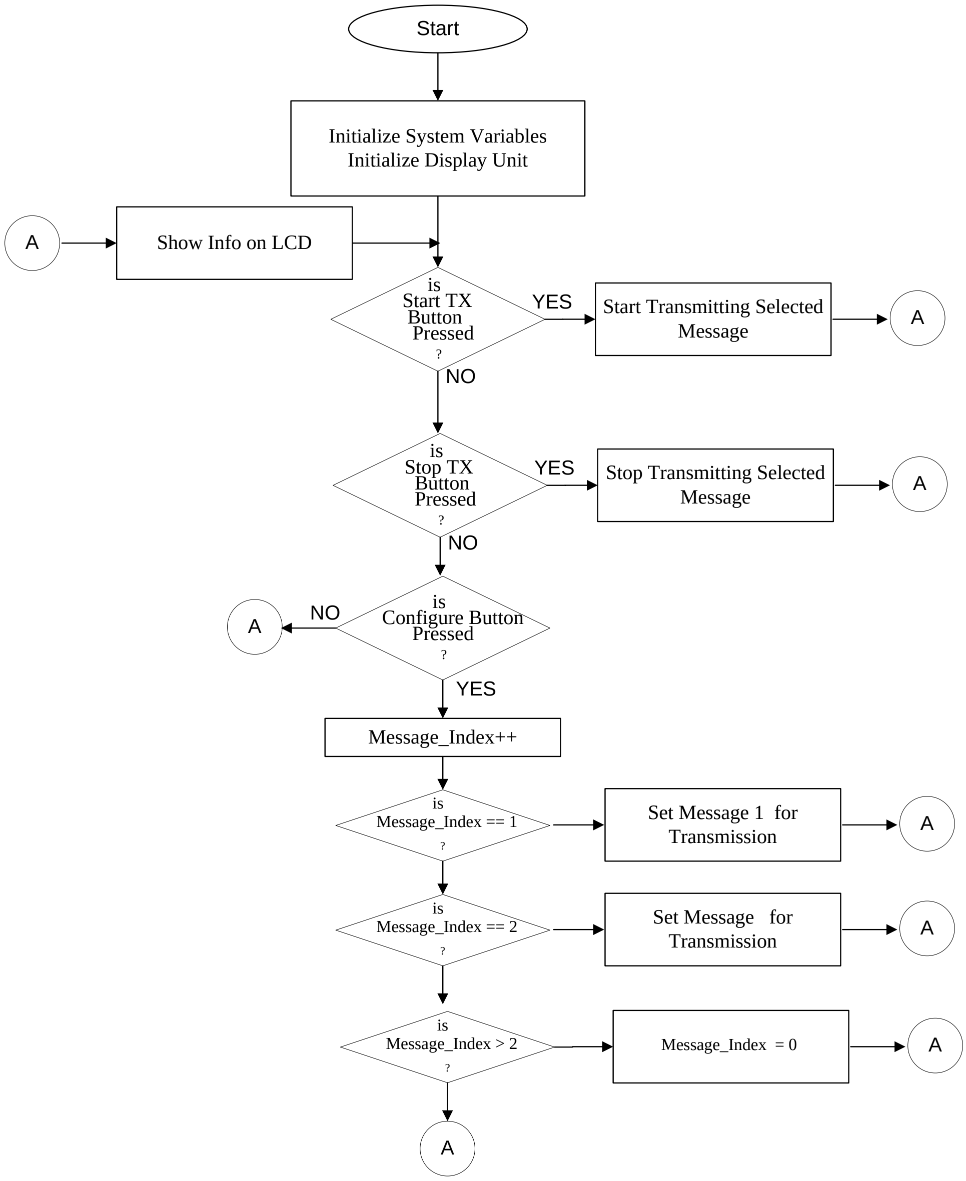

Figure 8: Receiver flowchart.

Table 1: Result for indoor implementation.

Message Size (No of Characters)	Max Distance Covered (m)	Signal Strength (dBm)
14	70	37
12	75	36
10	88	34
8	92	33
7	97	31
6	103	30

Table 2: Result for bush Implementation.

Message Size (No of Characters)	Max Distance Covered (m)	Signal Strength (dBm)
14	98	42
12	102	39
10	108	38
8	120	37
7	160	36
6	180	33

Table 3: Result for open space implementation.

Message Size (No of Characters)	Max Distance Covered (m)	Signal Strength (dBm)
14	160	70
12	175	65
10	189	61
8	200	60
7	220	58
6	250	57

Tables 1- 3 are showing the relationship between the transmitter and the receiver, The messages size (No of character) sent through the transmitter to the channel (maximum distance covered) between the transmitter and receiver . The signal was measured at the receiving end (receiver). During the experimental testing in the indoor, bush ,and open space implementations respectively. The results showed as the no of messages sent through the transmitter increased, the maximum distance covered decreased and also the messages (signals) suffer less attenuation during propagation due to factors affecting radio propagation like vegetation, building and other factors that influence the behavior of electromagnetic wave.

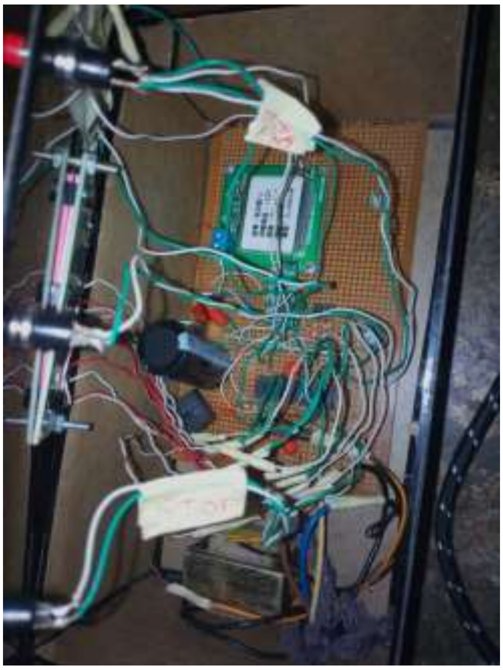

Figure 9a: Inside of the transmitter.

Figure 9b: Transmitter

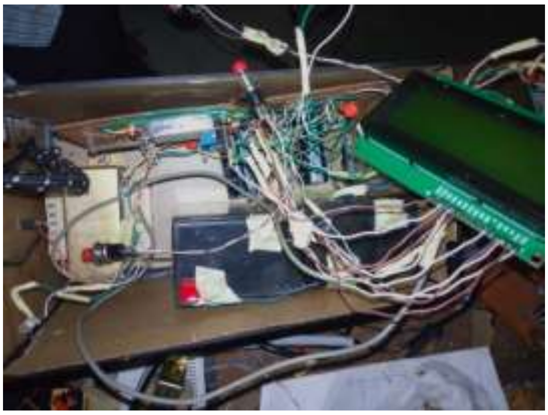

Figure 10a: Inside of receiving unit.

Figure 10b: Receiver.

Uses:
For laboratory experiments
For studying of radio propagation
For sending information

4. Conclusion:

The construction monofrequency transmitter and monofrequency receiver at L band frequency was successful for laboratory use, for study of propagation and also to promote less expensive of building transmitter and receiver at L band for institute of laboratory and the only limitation is the transmitter power of 5 watt. This will limit the range of the transmitted signal can be covered between the transmitter and receiver.

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