EFFECT OF INPUT CURRENT AND THE RECEIVER-TRANSMITTER DISTANCE ON THE VOLTAGE DETECTED BY INFRARED RECEIVER

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Abstract-This paper investigates the effect of the input current and the distance of separation between the IR transmitter and IR receiver on the voltage detected by infrared (IR) receiver Line-of-Sight IR propagation. The research was carried out using IR533C IR transmitter and FDS 100 IR receiver. Regulated digital power supply was used to provide stable 5V supply to the transmitter circuit. A 5V, 100kHz square wave from the signal generator was used to switch the BC338 transistor to modulate the frequency of the IR transmitter. The resistance of the potentiometer was varied from 27Ω to 117Ω. Two high precision digital voltmeters were used in the measurement of the detected voltage and the voltage drop across the potentiometer. The IR transmitter input current was calculated by dividing the voltage drop across the potentiometer by the potentiometer resistance. The distance separating the IR transmitter and IR receiver was varied from 1.4cm to 4.4cm. From the result obtained, it was observed that the voltage detected by the IR receiver increases with the increase in the magnitude of the input current applied to the transmitter. It was also observed that the magnitude of the detected voltage decreases with the increase in the distance separating the transmitter and receiver.

Index Terms: Infrared Receiver, IR transmitter, Voltmeters, Regulated digital power supply

1.1. Introduction

Recent research on wireless infrared (IR) communication has focused on Line-of-Sight (LOS) IR propagation. In LOS IR propagation, communication between IR transmitter and IR receiver requires a straight and unobstructed path for reliable communication [1, 2]. The IR transmitter transmits the IR signal while the IR receiver receives the signal. The LOS IR propagation has an advantage over the diffused IR propagation since it can operate at a data rate of more than 100Mbits/s compared to a maximum of 50Mbits/s for diffused IR propagation. and do not require high optimal power [2]. However, LOS IR propagation has less coverage area compared to diffused IR propagation [3]. In diffused IR propagation, the IR signal is focused on the reflective surface to ensure a high area of coverage.

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In IR communication, the signal received by the receiver depends on the distance between the transmitter and receiver and the power of the transmitted signal. The power of the transmitted signal depends on the magnitude of the input current to the transmitter.

1.2. Methodology

The purpose of this paper is to investigate the effect of the distance of separation between the IR transmitter and IR receiver and IR transmitter input current on the magnitude of the voltage detected by the IR receiver for Line-of-Sight IR propagation. The methodology applied in this experiment is the design of the transmitter and receiver circuits and the measurement of experimental parameters.

1.3. Design of the System

The electrical parameters of the components used in the research are shown in Table 1. The circuit diagram of the transmitter is shown in Figure 1. The input signal to the BC338 transistor is a square wave with a period of 10μs (f=100KHz).

In Figure 1, the magnitude of current through IR transmitter (I_{IR}) and the Resistance (R_2) of the resistor connected to the base of the transistor are calculated from (1) and (2) respectively. In (1), Vcc is the DC voltage supply to the transmitter circuit, V_{IRF} is the barrier voltage of the IR transmitter, V_{CEsat} is the collector-emitter saturation

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voltage, R_1 is the resistor that limits the current flowing through the IR transmitter and V_{R1} is the voltage drop across R_1.

$$I_{IR} = \frac{V_{cc} - V_{IRF} - V_{CEsat}}{R_1} = \frac{V_{R_1}}{R_1} \quad (1)$$

On the other hand, v_i is the switching voltage applied to the base of the transistor, V_{BE} is the base-emitter barrier voltage of the transistor and I_{Bsat} is the saturation base current of the transistor.

$$R_2 = \frac{v_i - V_{BE}}{I_{Bsat}} \quad (2)$$

The value of R_2 is calculated as 86Ω and 100Ω were used in the experiment. The values of R_1 used in the experiment are 27Ω, 37Ω 47Ω, 57Ω, 67Ω, 77Ω, 87Ω, 97Ω, 107Ω, and 117Ω.

The receiver section of the system used in the experiment is shown in Figure 2. An op-amp used is in the voltage follower configuration and it is connected to the output of the IR receiver to prevent loading.

1.4. Data Measurement

In the transmitter circuit, a high precision potentiometer was used to vary the magnitude of current (I_{IR}) through the IR transmitter. A high precision voltmeter was used to measure the voltage drop (V_{R1}) across the potentiometer resistor (R_1). The current through the IR receiver is computed using (3).

$$I_{IR} = \frac{V_{R_1}}{R_1} \quad (3)$$

The output voltage (V_0) of the receiver circuit is measured using a high precision digital voltmeter.

1.5. Results and Discussion

The effect of IR transmitter input current on the voltage detected by IR receiver is shown in Figure 3. From the figure, it was observed that the voltage detected by the IR receiver increases with the increase in the IR transmitter input current. This was because the increase in IR transmitter input current increases the power of the transmitted IR signal. It also showed that the voltage detected by IR receiver was inversely proportional to the distance separating the IR receiver and IR transmitter. The effect of separating distance on the detected voltage became very clear in Figure 4. From the Figure, it was clearly observed that the detected voltage varies inversely as distance. This simply implies that the lower the distance the higher the detected voltage. Therefore, distance has a proficient impact/effect on detected voltage.

1.6. Conclusion

In this research paper, the effect of IR transmitter input current and the separating distance between the IR receiver and transmitter on the voltage detected by IR receiver was investigated. From the work, it was observed that the voltage detected increased with the increase in the IR transmitter input current. The paper also showed that the voltage detected was inversely proportional to the distance separating the transmitter and the receiver. This implied that to transmit IR signal to a long distance, the transmitter input current must be high to ensure that the IR signal has high power.

Table 1: The Electrical Parameters of the Components

BC338 [4]	I_{Csat}=500 mA	I_{Bsat}=50mA	V_{CEsat}=0.7V V_{BE}=0.7V	
IR533C [5]	V_{IRF}=1.2 V	I_{pulse} =1000mA I_{Dcmax}=100mA	Wavelength= 940nm	Angle =25^0
FDS100	V_{0max}=1.0V	I_{0max}=3.0 mA	d_{max}=30cm	
R_1 (Potentiometer)	100KΩ			
R_2 (Fixed)	100Ω			
LM741	v_i=±18V	V_0=±15V	Voltage supply=±20V	

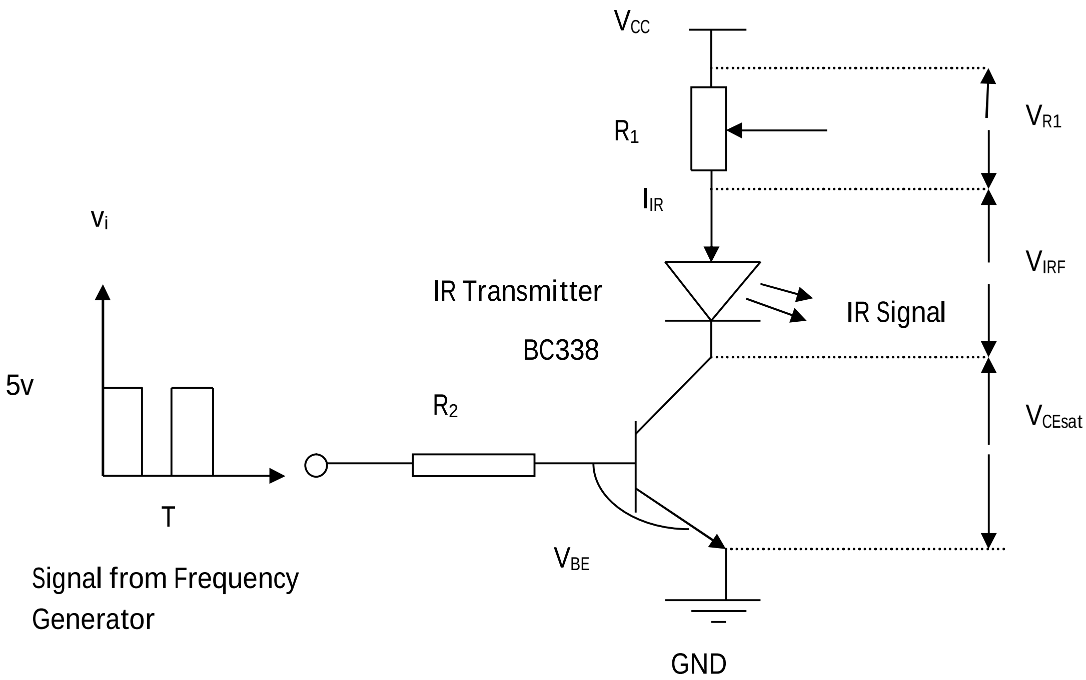

Figure 1: The Transmitter Circuit for the Experiment

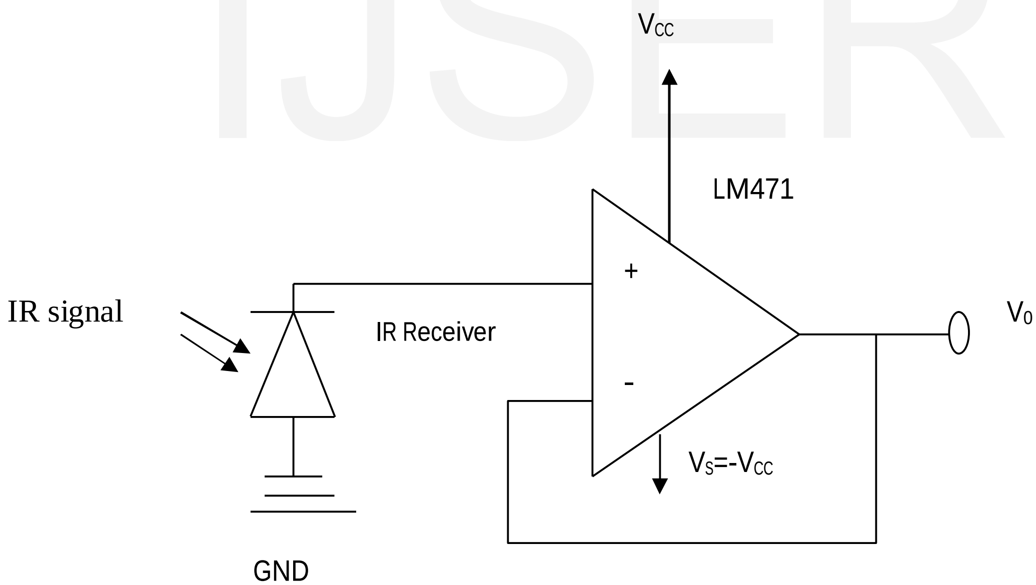

Figure 2: The receiver circuit for the experiment

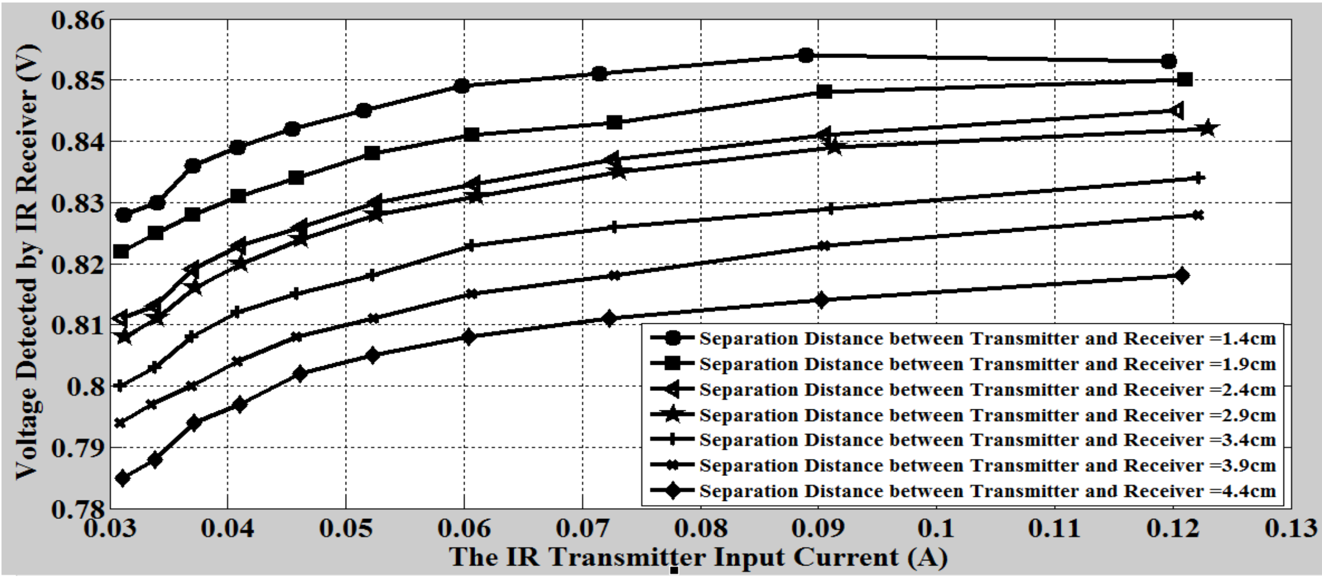

Figure 3: Plot of Detected Voltage by IR Receiver against IR Transmitter Input Current for Different Separating Distances.

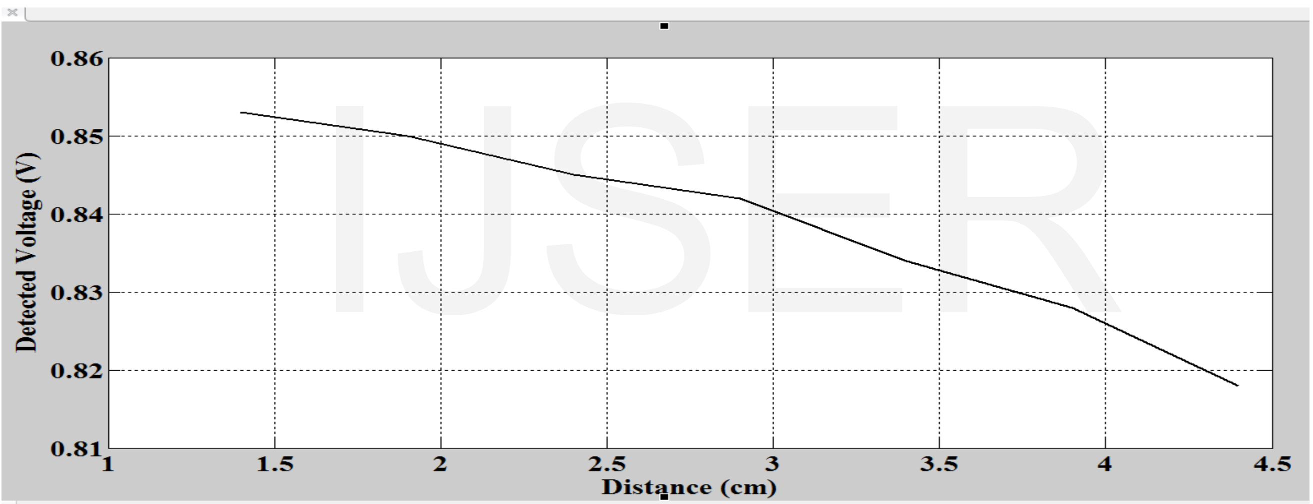

Figure 4: Plot of Detected voltage against distance at f=100KHz and I=120mA

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