

A Practical activity Report submitted  
for Engineering Design Project-II (UTA-024)  
by

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**Submitted to**  
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**INDIA**  
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## Experiment: 1

### Objective:

- (a) To draw a schematic diagram of pulse width modulation (PWM) based transmitter for generating specified pulse width waveforms for gantries placed at different locations on the path using CAD tool (Eagle).
- (b) To design a printed circuit board layout of pulse width modulation (PWM) based transmitter using CAD tool (Eagle).

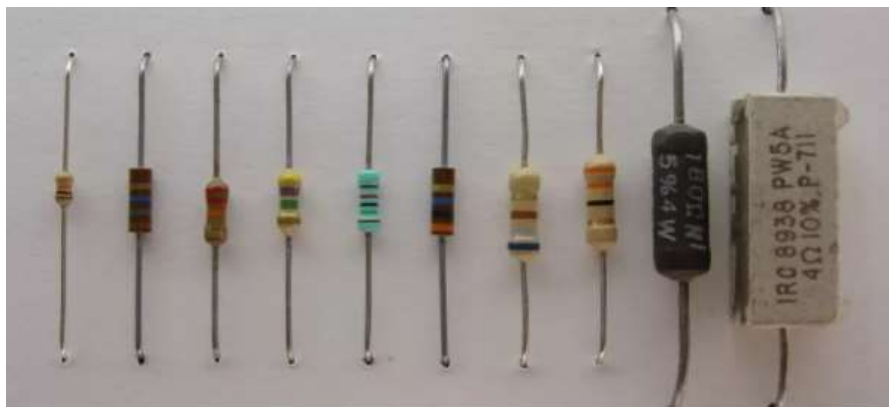
**Software Used:** Eagle Software

### Component Used:

Sr. No	Name of Components	Value	Specifications
1.	Resistor	330 $\Omega$	Carbon Resistor with 5% Tolerance
2.	Capacitor	10pF	Electrolytic Capacitor
3.	Capacitor	1uF	Electrolytic Capacitor
4.	DCJ0202	-	DC Power Jack
5.	LED3MM	5V	Dome Lamp
6.	IC 78L05Z	+5V	Positive Voltage Regulator
7.	22-23-2031 (3)	-	PCB Header
8.	Attiny45-20P	-	Microcontroller

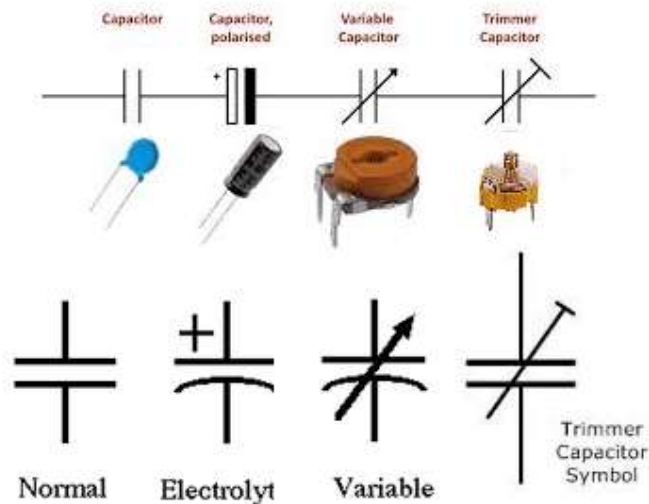
### Theory:

- (a) **Resistor:** A resistor is an electronic component that resists the flow of electric current in a circuit. The electrical resistance of a circuit component is defined as the ratio of the applied voltage to the electric current that flows through it. Unit of resistance is ohm. Only one resistor of 330ohm is used in the circuit along with the LED.



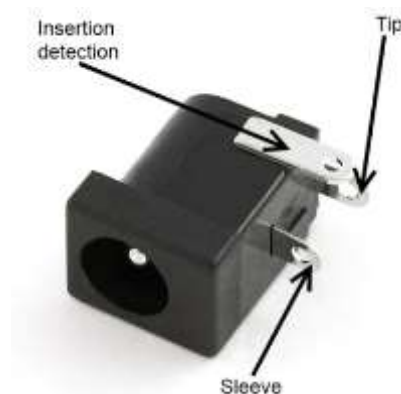
**Fig. 1.1** Various types of resistors [1]

- (b) **Capacitor:** A capacitor is a passive element that store electric charge. A capacitor is a device that store electric charge in the form of electric field. The simplest capacitor consists of two flat conducting plates separated by a small gap. The potential difference, or voltage, between the plates is proportional to the difference in the amount of the charge on the plates. This is expressed as  $Q = CV$ , where  $Q$  is charge,  $V$  is voltage and  $C$  is capacitance. The unit for measuring capacitance is the farad (F), named for Faraday, and is defined as the capacity to store 1 coulomb of charge with an applied potential of 1 volt.



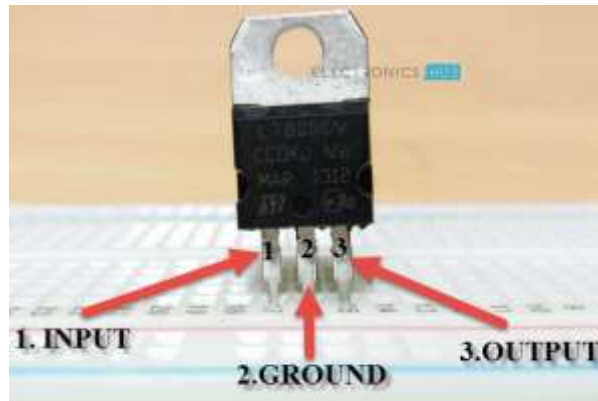
**Fig. 1.2** Various types of capacitors [2]

- (c) **DCJ0202:** It is a common barrel-type DC connector used to supply DC power to the electric circuit by connecting an external power source into the barrel of the connector. DCJ0202 is a 5.5 mm jack with a 2.1 mm central pole at its center. A DC jack is a component used in many electronic devices that allows a steady power source to be plugged in. Therefore, with most electronics, an AC adapter connected to a DC jack is necessary to supply power in a usable way.



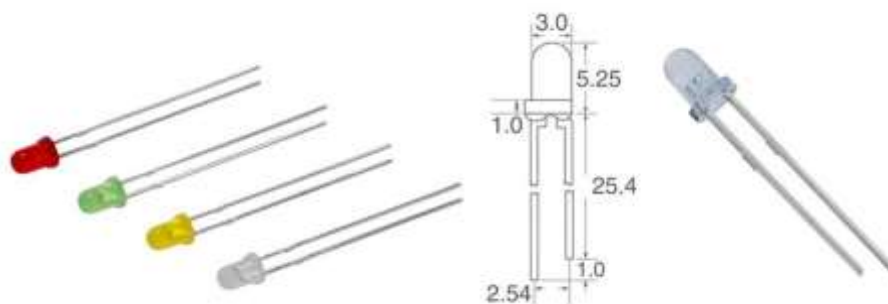
**Fig. 1.3** DCJ0202 [3]

- (d) **IC 78L05Z**: 78L05Z is a three terminal linear voltage regulator IC with a fixed output voltage of 5V which is useful in a wide range of applications. The name 78L05 has two meanings, "78" means that it is a positive voltage regulator and "05" means that it provides a 5V output. So 7805 will provide an output voltage of + 5V. The 78L05 is a three terminal voltage regulator.



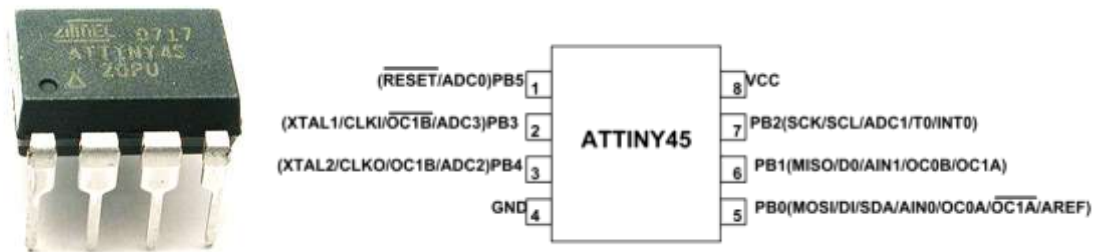
**Fig. 1.4** Voltage regulator 78L05Z [4]

- (e) **LED3MM**: An LED is a passive semiconductor device used as a light source. There are different types of LED, including miniature, high power, AC powered etc. It is connected in series with resistor to microcontroller to provide indication of output, i.e., when the led glows- it indicates that output is conformed and vice versa.



**Fig. 1.5** LED3mm [5]

(f) **Attiny45-20P:** ATTINY45 is high performance, low power controller from ATMEL. It is an 8 pin iC. It allows the designer to optimize power vs performance through programming. It is low-power Atmel 8-bit AVR RISC- based microcontroller combines 4KB ISP flash memory, 256-Byte EEPROM, 256B SRAM, 6 general purpose I/O lines, 32 general purpose working registers, one 8-bit timer/ counter with compare modes, one 8-bit high speed timer/counter, USI, internal and external Interrupts, 4-channel 10-bit Analog to Digital converter, programmable watchdog timer with internal oscillator, three software selectable power saving modes, and debug WIRE for on- chip debugging.



**Fig. 1.6** ATTINY45 [6]

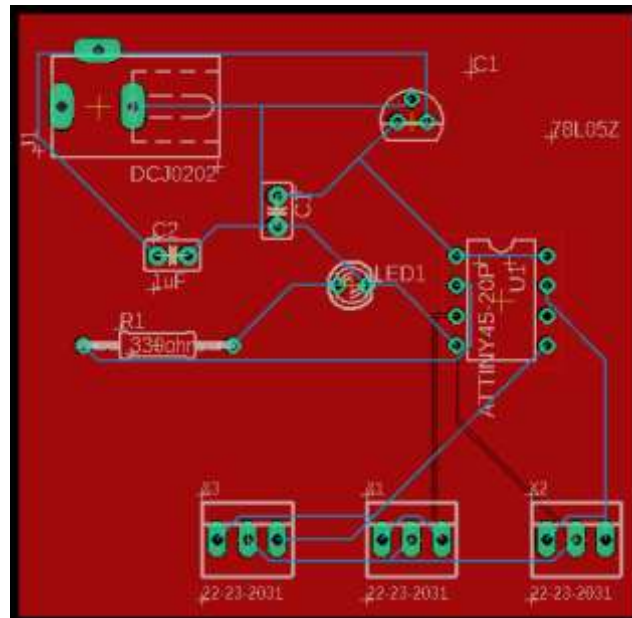
(g) **22-23-2031:** 22-23-2031 is a 2.54 mm pitch wire to board connectors. It is used as a bridge between multiple PCBs by using only one connection and to connect printed circuit boards (PCBs) with (crimped) wires to the contacts / terminals, which are then inserted into the appropriate housing to complete the assembly of the connector system.



**Fig. 1.7** 22-23-2031 [7]

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### Printed Circuit Board layout:



**Fig. 1.9** PCB layout of Transmitter circuit

## **Discussion:**

In this experiment, we have learnt how to use eagle software and created Pulse Width Modulation based transmitter circuit, which is used to generate different pulse width wave form when the Buggy will pass through Gantry on the track. We also have learned about various components of the electrical circuit their connections and implementations this includes resistors, capacitors, led's, etc. We also learnt how to make PCB out of the schematic diagram.

## **References:**

- [1] <https://www.livescience.com/53875-resistors-capacitors-inductors.html>
- [2] <https://www.theengineeringprojects.com/2017/01/evolution-of-capacitors.html>
- [3] <https://www.sparkfun.com/products/119>
- [4] <https://www.electronicshub.org/understanding-7805-ic-voltage-regulator/>
- [5] <https://www.make-it.ca/3mm-led-specifications/>
- [6] <https://components101.com/microcontrollers/attiny45-pinout-features-datasheet>
- [7] <https://octopart.com/22-03-2031-molex-15103>



## Experiment: 2

### Objective:

- (a) To draw a schematic diagram of receiver to receive specified pulse width IR signals from gantries using CAD tool (Eagle).
- (b) To design a printed circuit board layout of receiver circuit using CAD tool (Eagle).

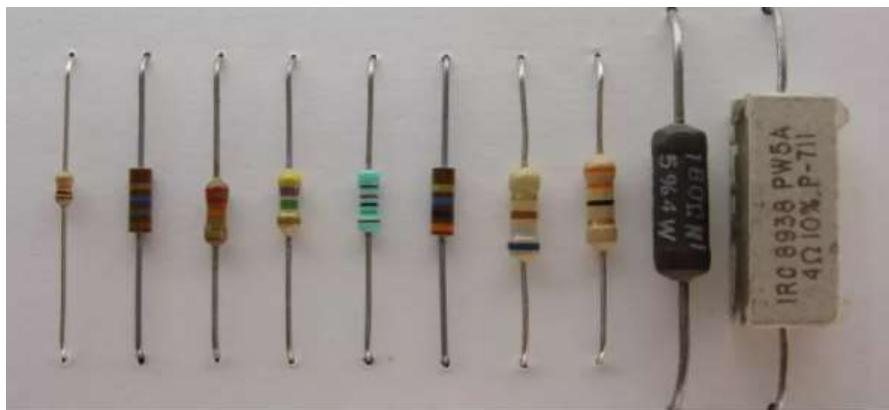
**Software Used:** Eagle Software

### Component Used:

Sr. No	Name of Components	Value	Specifications
1.	Resistor (4)	1k, 22k, 100k, 120k $\Omega$	Carbon Resistor with 5% Tolerance
2.	Capacitor	10pF	Electrolytic Capacitor
3.	LM311D	-	Differential Capacitor
4.	MBD701	-	Photo Diode
5.	22-23-2031 (3)	-	PCB Header

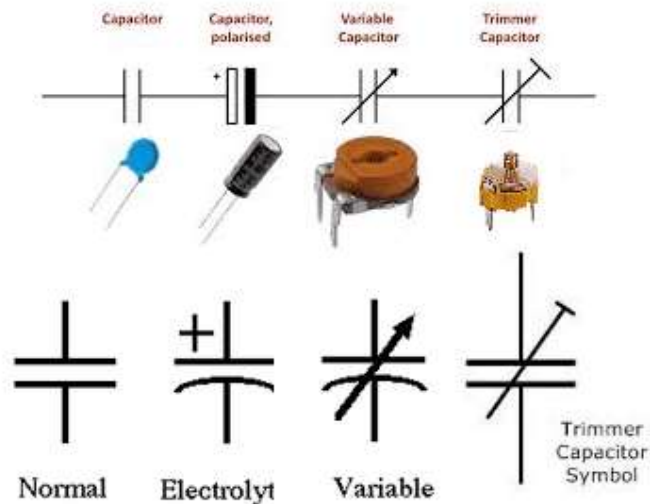
### Theory:

- (a) **Resistor:** A resistor is an electronic component that resists the flow of electric current in a circuit. The electrical resistance of a circuit component is defined as the ratio of the applied voltage to the electric current that flows through it. Unit of resistance is ohm. Only one resistor of 330ohm is used in the circuit along with the LED.



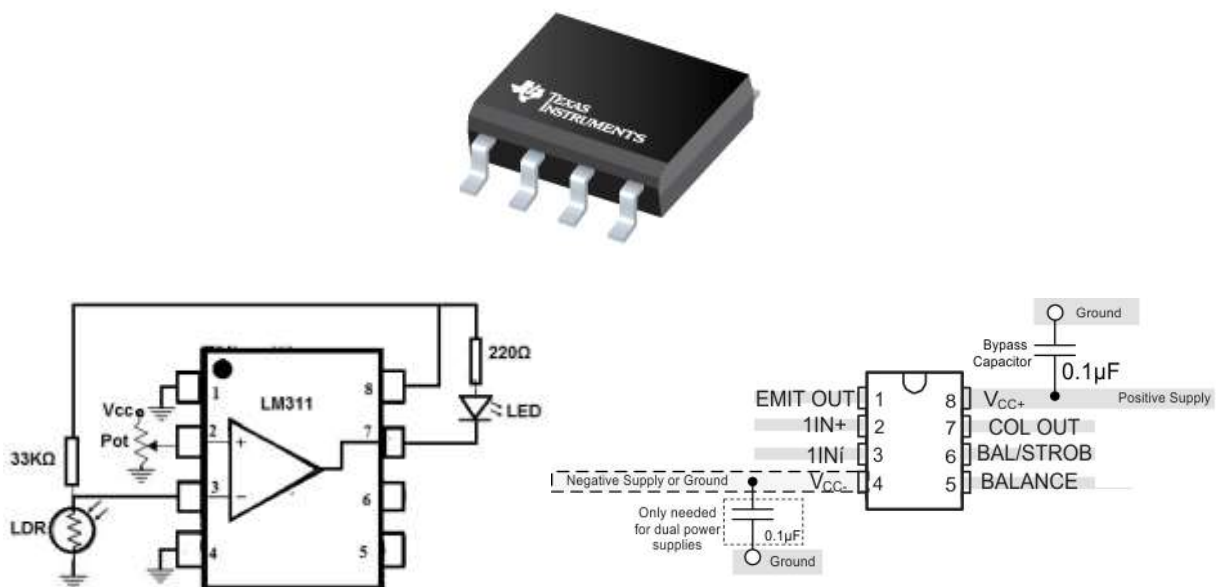
**Fig. 2.1** Various types of resistors [1]

(b) **Capacitor**: A capacitor is a passive element that store electric charge. A capacitor is a device that store electric charge in the form of electric field. The simplest capacitor consists of two flat conducting plates separated by a small gap. The potential difference, or voltage, between the plates is proportional to the difference in the amount of the charge on the plates. This is expressed as  $Q = CV$ , where  $Q$  is charge,  $V$  is voltage and  $C$  is capacitance. The unit for measuring capacitance is the farad (F), named for Faraday, and is defined as the capacity to store 1 coulomb of charge with an applied potential of 1 volt.



**Fig. 2.2** Various types of capacitors [2]

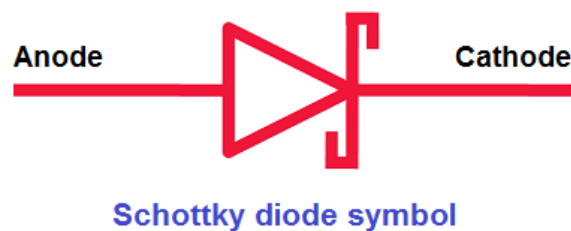
(c) **LM311D**: It is a voltage comparator that have low input currents. The LM311 Differential Comparator Op-Amp is a comparator IC from TI that has been used for Voltage comparisons for a long time in electronic designs. This IC is mainly used to compare the input voltages and decides the greater value.



**Fig. 2.3** LM311D [3]

(d) **MBD701**: It is a Schottky diode. It is a semiconductor diode and compared to a silicon diode, it has very low voltage drop so it is more efficient. This diode is used as a rectifier as it has very less power loss. These devices are designed primarily for high-efficiency UHF and VHF detector applications. They are readily adaptable to many other fast switching RF and digital applications. They are supplied in an inexpensive plastic package for low-cost, high-volume consumer and industrial/commercial requirements.

A Schottky diode is also known as a hot carrier diode; it is a semiconductor diode with a very fast switching action, but a low forward voltage drop. In Schottky diode, a semiconductor-metal junction is formed between a semiconductor and a metal, thus creating a Schottky barrier. The N-type semiconductor acts as a cathode and the metal side acts as the anode of the diode.



**Fig. 2.4** MBD701 [4]

(e) **22-23-2031**: 22-23-2031 is a 2.54 mm pitch wire to board connectors. It is used as a bridge between multiple PCBs by using only one connection and to connect printed circuit boards (PCBs) with (crimped) wires to the contacts / terminals, which are then inserted into the appropriate housing to complete the assembly of the connector system.

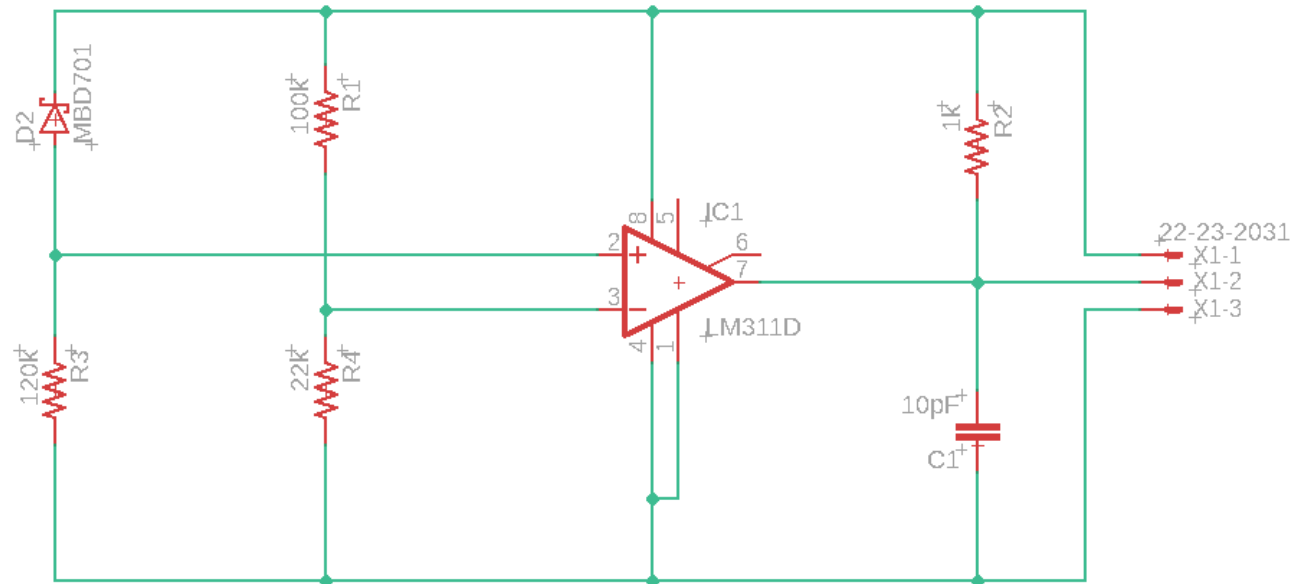


**Fig. 2.5** 22-23-2031 [5]

## Schematic diagram:

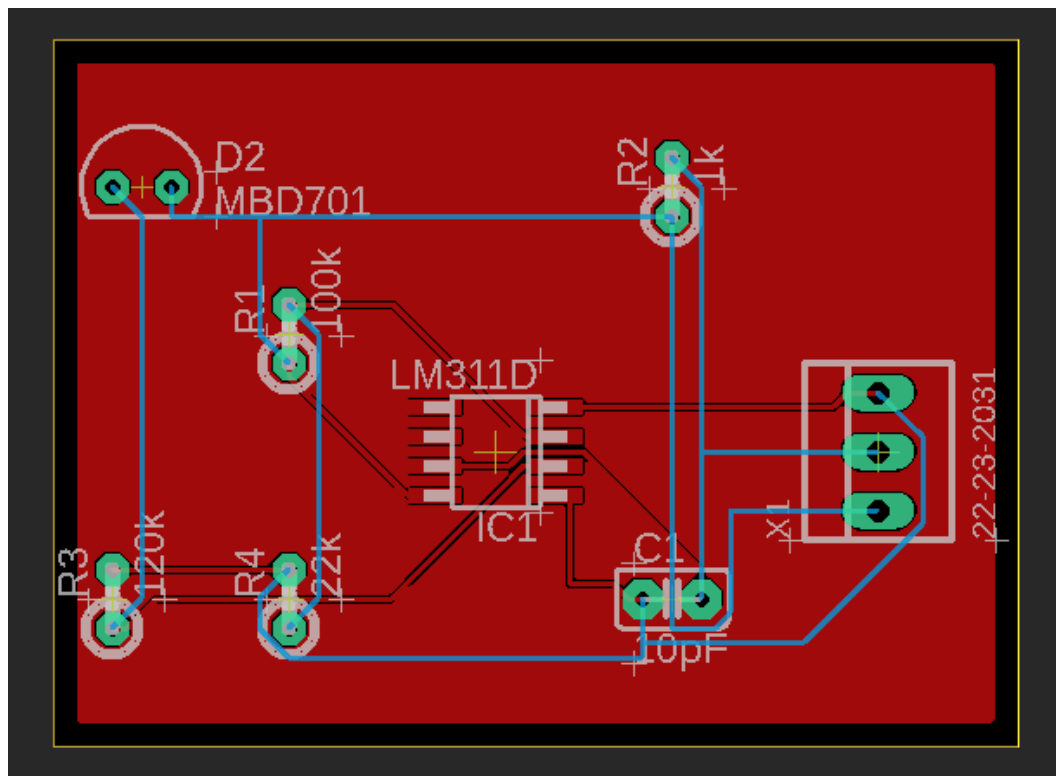
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**Fig. 2.6** Schematic diagram of Receiver circuit

## Printed Circuit Board layout:



**Fig. 2.7** PCB layout of Receiver circuit

## **Discussion:**

In this experiment, we have learnt how to design and implement a receiver circuit. We learnt to design its schematic in EAGLE and also create its PCB. We also learned about the connection's configuration of the receiver circuit for the communication with buggy and this will be used in determining the gantry through which buggy passes. We also comprehended the concept of comparator circuit and its application in operational amplifiers. The receiver uses electronic filters to separate the desired radio frequency signal from all the other signals picked up by the antenna, an electronic amplifier to increase the power of the signal for further processing, and finally recovers the desired information through demodulation.

We also learned how to use various components like MBD701 and LM311D.

## **References:**

- [1] <https://www.livescience.com/53875-resistors-capacitors-inductors.html>
- [2] <https://www.theengineeringprojects.com/2017/01/evolution-of-capacitors.html>
- [3] <https://www.elprocus.com/lm311-pin-configuration-circuit-diagram/>
- [4] <https://www.physics-and-radio-electronics.com/electronic-devices-and-circuits/semiconductor-diodes/schottkydiode.html>
- [5] <https://octopart.com/22-03-2031-molex-15103>

**SIGNATURE OF FACULTY MEMBER**

## Experiment: 3

### Objective:

- (a) To draw a schematic diagram of IR sensor module circuit (required to move Buggy module on a predefined the path) using CAD tool (Eagle).
- (b) To design a printed circuit board layout of IR sensor module circuit using CAD tool (Eagle).

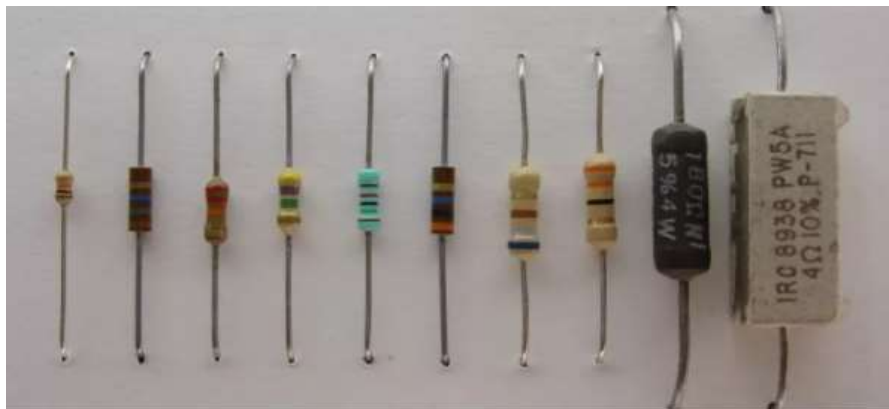
**Software Used:** Eagle Software

### Component Used:

Sr. No	Name of Components	Value	Specifications
1.	Resistor (6)	330, 10k $\Omega$	Carbon Resistor with 5% Tolerance
2.	LMV358mm (2)	3V	High Gain Operational Amplifier
3.	LED3mm (2)	-	PN Junction Diode
4.	Potentiometer (2)-PT10	10k	Variable Resistance and Potential Divider
5.	SFH482 (2)	1.5 V	IR LED
6.	MTA02-100	-	AMP Connector
7.	BPX65 (2)	-	Photo Diode

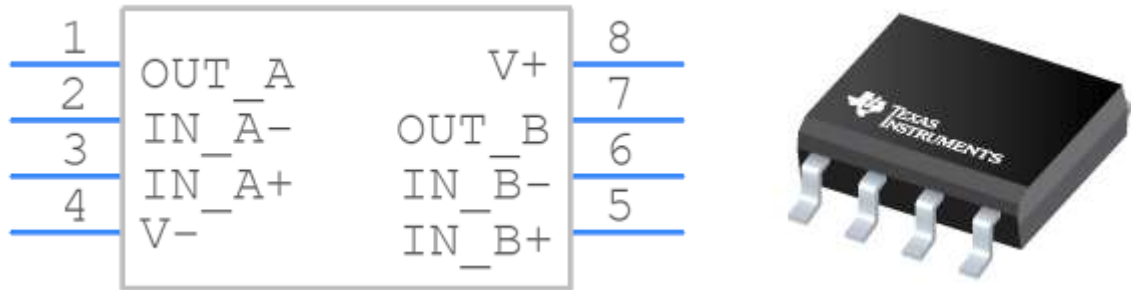
### Theory:

- (a) **Resistor:** A resistor is an electronic component that resists the flow of electric current in a circuit. The electrical resistance of a circuit component is defined as the ratio of the applied voltage to the electric current that flows through it. Unit of resistance is ohm. Only one resistor of 330ohm is used in the circuit along with the LED.



**Fig. 3.1** Various types of resistors [1]

(b) **LMV358mm**: It is a single general purpose low voltage OP-AMP. Operational Amplifiers are used to amplify weak signals. They have two input pins and 1 output pin. The output signal's voltage is the difference in voltages of the two input signals. The LMV358mm is a low cost, space saving device ideal for our project. This amplifier is designed for low voltage operation. 2.7V-5V. It is an Low Power Dual Operational Amplifier IC LM358. It has total 8 pins. It is used in this circuit as voltage comparator. It also allows the designer to place the device closer to the signal source to reduce noise pickup and increase signal integrity. It has bipolar input and output stages for improved noise performance and higher output current drive.



**Fig. 3.2** LMV358mm [2]

(c) **Potentiometer - PT10**: Potentiometers are used to compare the E.M.F. or the electromotive force between two cells. The working principle of the potentiometer is that when a constant current is flowing through a wire of cross-sectional area the voltage drop between those two points is directly proportional to the length of the wire between the two points. There are 3 terminal resistors with sliding or rotating contact that forms an adjustment voltage divider. When we use its two terminals only then it works as a rheostat or a variable voltage regulator.



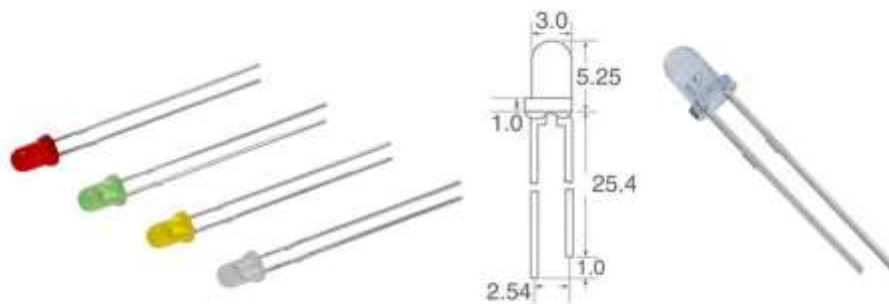
**Fig. 3.3** DCJ0202 [3]

(d) **SFH482:** It is an infrared light-emitting diode, with a forward voltage of 1.5V used as a transmitter to make the schematic circuit complete in the IR receiver circuit. It is a high-power IR emitter, fabricated in a liquid phase epitaxy process with High reliability. It is used in Photo-interrupters, IR remote control, Sensor technology and in Light-grille barrier. Its Wavelength is ranging from 700 nm to 1mm.



**Fig. 3.4** SFH482 [4]

(e) **LED3MM:** An LED is a passive semiconductor device used as a light source. There are different types of LED, including miniature, high power, AC powered etc. It is connected in series with resistor to microcontroller to provide indication of output, i.e., when the led glows- it indicates that output is conformed and vice versa.



**Fig. 3.5** LED3mm [5]



(f) **MTA02-100:** It is a connector system with all the contacts in a single row on a 2.54mm (0.100") center line. It has both wires to wire and wire to board applications. It is based on the insulation displacement contact technology. It is a 2-pin connector and is used as a connector in the IR Sensors Circuit. It has no resistance. The configuration features wire feed-through capacity for daisy-chain applications. Insulation displacement contact (IDC) are utilized to end a wide scope of conductor sizes. Ribbon cable can likewise be ended when the suitable container gathering and strain relief cover are used. Header configurations for board mount applications include right-edge and vertical mount items available in through hole and surface mount arrangements.



**Fig. 3.6** MTA02-100 [6]

(g) **BPX65:** It is a photodiode or IR Receiver used to convert light energy into electric current. It is a semiconductor diode which absorbs photons to generate free flowing charges giving rise to electric current. It is a PN junction with an intrinsic layer present.

BPX65 is especially suitable for applications from 350 nm to 1100 nm and it has high photo-sensitivity with Fast optical sensor of high modulation bandwidth. It has short switching time (typ. 12 ns) and hermetically sealed metal can package (TO-18), suitable up to 125 °C.

It is used in Industrial electronics, for control and drive circuits and in High-speed photo detector.

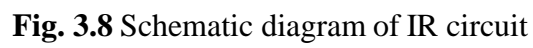
2 BPX65 pieces are used in the circuit. It gives response, by detecting the intensity of infrared light reflected by the obstacle.



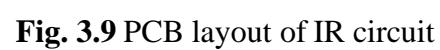
**Fig. 3.7** BPX65 [7]

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### Printed Circuit Board layout:



## **Discussion:**

In this experiment, we learnt how to design an IR emitter circuit using the EAGLE software. The working of our sensor is based on the fact that the color black absorbs all incident radiation whereas white color reflects all incident radiation. The IR emitters constantly emit IR radiation and the IR sensors detect the reflected IR radiation. When the sensor is above a black line it will detect almost 0 IR radiation whereas if it is over a white surface, it will detect radiation with sufficient intensity. The circuit we have designed consists of two IR emitters which will be placed on either side of the black line we want our buggy to follow. Whenever a turn comes, one of the sensors will sense a black line and accordingly the appropriate wheel will be slowed down so as to turn the buggy along the turn.

## **References:**

- [1] <https://www.livescience.com/53875-resistors-capacitors-inductors.html>
- [2] <https://componentsearchengine.com/part-view/LMV358MM%2FNOPB/Texas%20Instruments>
- [3] <http://www.soundwell-cn.com/en/PT10%20hollow%20shaft%20series/260.html>
- [4] <https://uk.rs-online.com/web/p/ir-leds/6547820/>
- [5] <https://www.make-it.ca/3mm-led-specifications/>
- [6] <https://www.te.com/usa-en/product-3-647050-2.html>
- [7] <https://uk.rs-online.com/web/p/photodiodes/0846755/>

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