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International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38006

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

Automatic (Headlight) Beam Controlling module for two-wheelers

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Abstract: ***Automatic High Beam controller is a device made due to the rising number of accidents at night because of LED headlamps temporarily affecting the vision of the driver on the opposite lane. According to AAA, LED lights do a much better job of illuminating the roadway, particularly in the low-beam application versus a halogen reflector at 150 feet more during testing. But, still, that brings the max vehicle speed to about 52 miles an hour, which is still falling short of highway speeds. So, the users are suggested to drive with high beam on if there is no oncoming traffic within a reasonable distance and the roadway is improperly lit. But in practice most people drive with the high beam settings in places with or without traffic great from the user's standpoint. However, even on low beam, they have such a high intensity that on 2-lane roads, especially when the oncoming driver of a car or small pickup approaches the LED equipped truck at night, in rain, fog, or snow the oncoming driver is blinded at a level equal to or greater than if the LED equipped vehicle were using conventional halogen high beams.***
This device is made without distance or ambient lighting being deciding factors and entirely based on user's discretion. The transmitter model is fitted with a button that sends a signal to the receiver model using nrf24L01 modules and AT Mega 8 microcontroller (programmed using Arduino UNO). The pressing of button causes the state of the button to be set to HIGH. This signals the receiving circuit to set the LED pin to LOW. Therefore, the High Beam is set to Low Beam for 5 seconds when the impulse is received. Due to the use of H4 C6 headlamps which are rated for 36W with a minimum power requirement of 12W an adapter was connected to convert 220V AC supply to 12V, 3A DC supply for the LED and the rest of the circuit.

I. COMPONENTS REQUIRED

A. AT-MEGA-8
B. nrf24L01
C. BC 547 NPN Transistor
D. LM 7805 Voltage Regulator
E. Resistors 10kΩ
F. Capacitors (Electrolytic and Ceramic)
G. YXC 16.0SDX (16MHz Crystal Oscillator)
H. Plain Copper Clad Board (PCB)- Glass Epoxy
I. Ferric Chloride for Etching
J. Drill Bit
K. Soldering Iron
L. Soldering Flux
M. Soldering Wire
N. LED Headlamps
O. Adapter (AC -> DC)
P. HL JQC-3FC(T73)-DC12V (PCB Relay)
Q. Push Button

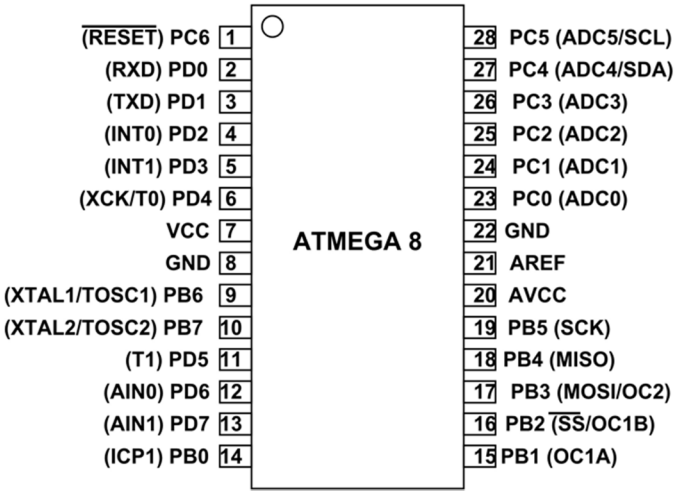
II. THEORY

A. AT-MEGA-8

ATmega8 is an 8-bit AVR microcontroller that is based on RISC CMOS technology and comes with 28-pin interface for PDIP package. The Program memory is 8K Flash while RAM and EEPROM are 1K and 512 bytes, respectively. This microchip has been the main source for producing PIC and AVR microcontrollers that are mainly used in embedded and industrial automation systems.

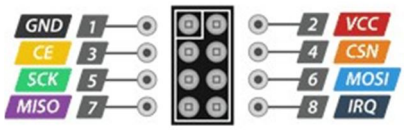
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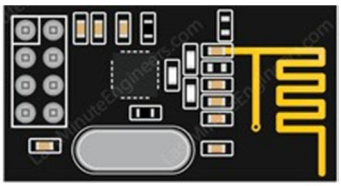
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B. nrf24L01

nRF24L01 is a single chip radio transceiver for the worldwide 2.4 - 2.5 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator, modulator and Enhanced Shock Burst protocol engine.





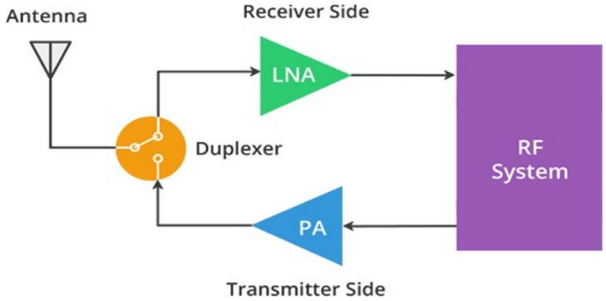
nRF24L01+ Pinout

The nRF24L01+ transceiver module communicates over a 4-pin Serial Peripheral Interface (SPI) with a maximum data rate of 10Mbps. All the parameters such as frequency channel (125 selectable channels), output power (0 dBm, -6 dBm, -12 dBm or -18 dBm), and data rate (250kbps, 1Mbps, or 2Mbps) can be configured through SPI interface.

The SPI bus uses a concept of a Master and Slave, in most common applications our Arduino is the Master and the nRF24L01+ transceiver module is the Slave. Unlike the I2C bus the number of slaves on the SPI bus is limited, on the Arduino Uno you can use a maximum of two SPI slaves i.e., two nRF24L01+ transceiver modules.

The PA stands for Power Amplifier. It merely boosts the power of the signal being transmitted from the nRF24L01+ chip. Whereas LNA stands for Low- Noise Amplifier. The function of the LNA is to take the extremely weak and uncertain signal from the antenna (usually on the order of microvolts or under - 100 dBm) and amplify it to a more useful level (usually about 0.5 to 1V)

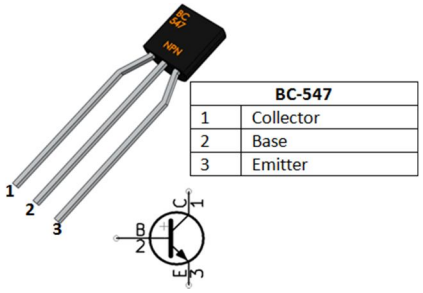
The low-noise amplifier (LNA) of the receive path and the power amplifier (PA) of the transmit path connect to the antenna via a duplexer, whichseparates the two signals and prevents the relatively powerful PA output from overloading the sensitive LNA input.



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C. BC 547 NPN Transistor

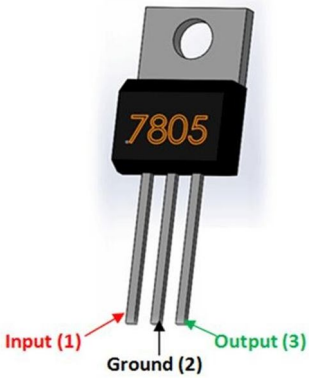
BC547 is an NPN transistor hence the collector and emitter will be left open (Reverse biased) when the base pin is held at ground and will be closed (Forward biased) when a signal is provided to base pin. BC547 has a gain value of 110 to 800, this value determines the amplification capacity of the transistor. The maximum amount of current that could flow through the Collector pin is 100mA, hence we cannot connect loads that consume more than 100mA using this transistor. To bias a transistor, we must supply current to base pin, this current (I_B) should be limited to 5mA. When this transistor is fully biased then it can allow a maximum of 100mA to flow across the collector and emitter. This stage is called Saturation Region and the typical voltage allowed across the Collector-Emitter (V_{CE}) or Base-Emitter (V_{BE}) could be 200 and 900 mV respectively. When base current is removed the transistor becomes fully off, this stage is called as the Cut-off Region and the Base Emitter voltage could be around 660 mV.



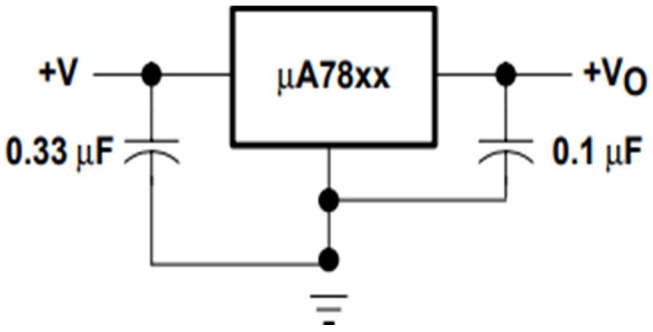
BC-547	
1	Collector
2	Base
3	Emitter

D. LM 7805

7805 IC is a regulator IC that finds its application in most of the projects. The name 7805 signifies two meaning, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. So, our 7805 will provide a +5V output voltage. The output current of this IC can go up to 1.5A.



7805 as a +5V regulator is a typical application circuit of the 7805 IC. We just need two capacitors of value 33µf and 0.1µf to get this IC working. The input capacitor 0.33µF is a ceramic capacitor that deals with input inductance problem and the output capacitor 0.1µF is also a ceramic capacitor that adds to the stability of the circuit. These capacitors should be placed close to the terminals for them to work effectively. Also, they should be of ceramic type since ceramic capacitors are faster than electrolytic.

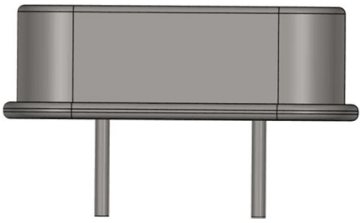


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E. YXC 16.0SDX (16 MHz Crystal Oscillator)

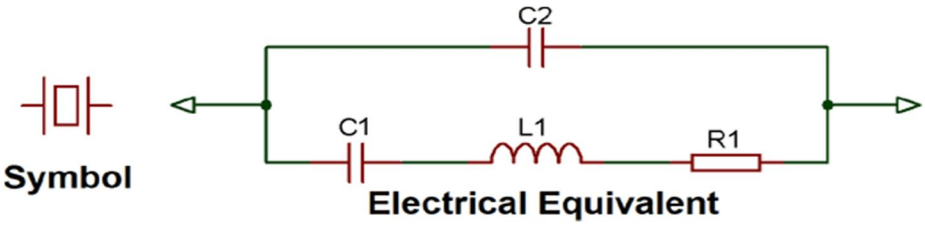
YXC 16.0SDX is a 16 MHz Crystal Oscillator module is designed to handle off-chip crystals that have a frequency of 4-16 MHz, the crystal oscillator is output is fed to the System PLL as the input reference. The oscillator design generates low frequency and phase jitter.



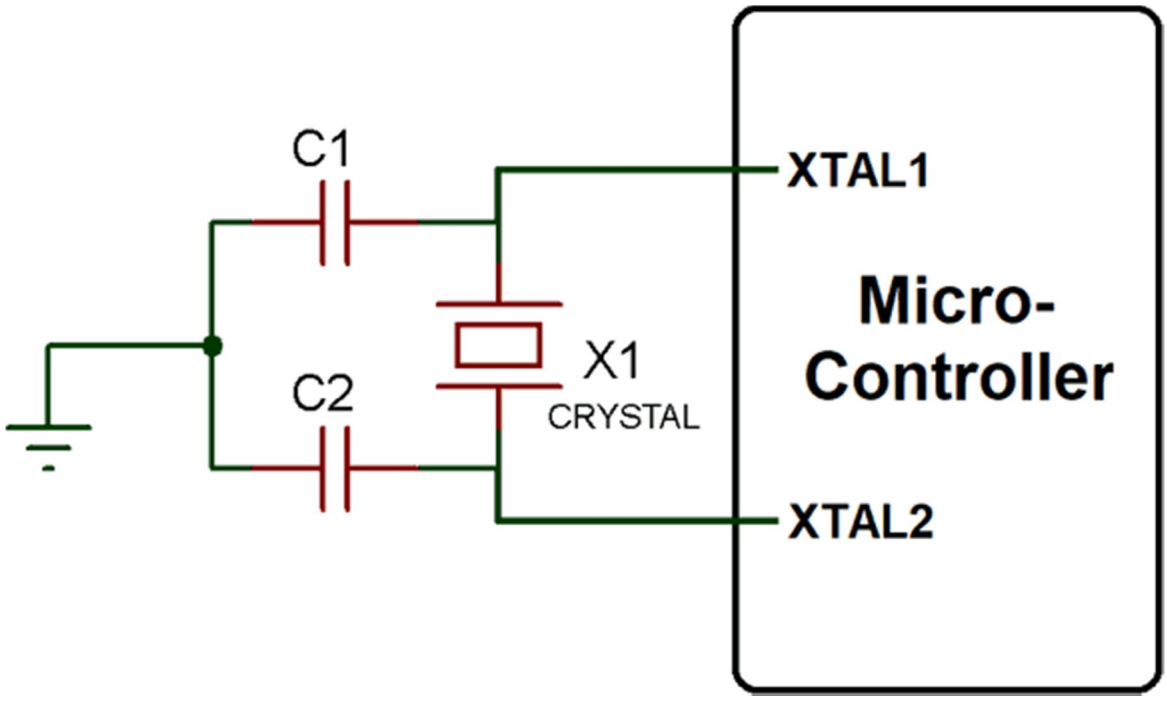
Crystal oscillator works on the principle of the Inverse Piezoelectric Effect, the applied electrical field will generate a mechanical distortion across some material. Therefore, it utilizes the vibrating crystal's mechanical resonance, which is made through a piezoelectric material for generating an electrical signal of a certain frequency.

The clock source used for microcontrollers are based on mechanical resonant devices such as crystal oscillator. All microcontrollers have pins for connecting crystal oscillator. The pins generally named as XTAL1 and XTAL2, here the connection of crystal oscillator with micro-controller is given below:

The reason for using two capacitors in series with crystal oscillator is to resonate with the crystal inductance which cause the crystal to oscillate on its fundamental parallel resonant mode.



There are some factors which affect the frequency stability of an oscillator like variation in temperature, load, and supply.



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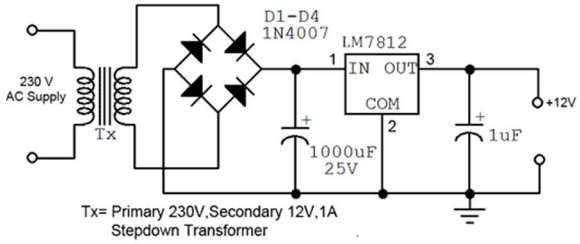
F. LED Headlamps

An LED Headlamp consists of multiple LEDs is set to low beam or high beam is dependent on the number of lights that are shining. When set to low beam, the individual lights of the LED will adjust to create a defined line so there is no light coming out above the beam. This particular model has a power rating of 36W, so an Adapter is required to provide it with DC power.



G. Adapter 12V, 3A (AC->DC)

If we connect an AC supply to the DC devices and equipment: The positive and negative voltage will destroy (this is not always the case) some of electronic components such as transistors and electrolytic capacitors. In case of higher AC voltage, they may burn with a blast and catch fire. So, we use an Adapter that converts AC power supply to DC to power the circuit.

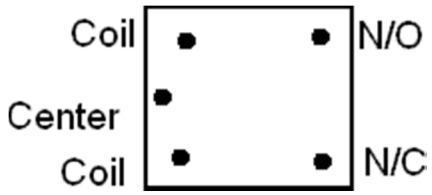




H. HL JQC-3FC(T73)-DC12V

A relay is an electrically activated switch. It consists of a coil internally which will create a magnetic field that attracts a movable lever and then changes switch contacts when a current is flowing through it. The typical usage of relay is to allow a low DC voltage circuit (circuit #1) to switch on or off a high voltage (DC or AC) circuit (circuit #2) without direct electrical connection between them. This means circuit #1 and circuit #2 are magnetically and mechanically linked but not electrically connected. **Single Pole Double Throw (SPDT)** – Such relay has 5 terminal pins which consists of a pair of coil pins, a common pin, a normally open (NO) pin and a normally closed (NC) pin. When the relay is not activated, the common pin is in contact with the NC pin and when it is activated, the common pin will break away from contact with the NC pin and subsequently comes in contact with the NO pin. Also, when the relay is deactivated (from activated state), the common pin will conversely break away from contact with the NO pin and returns to its original position that is, in contact with the NC pin.

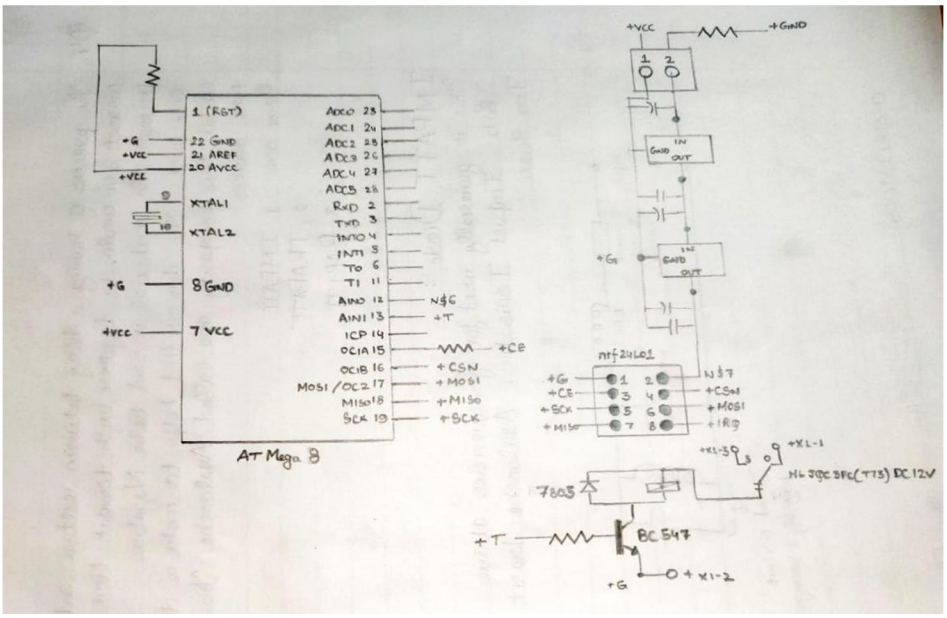




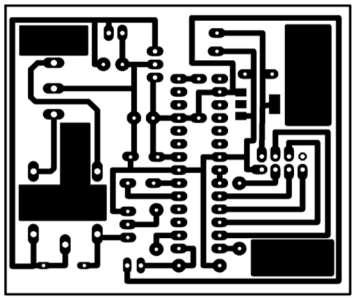
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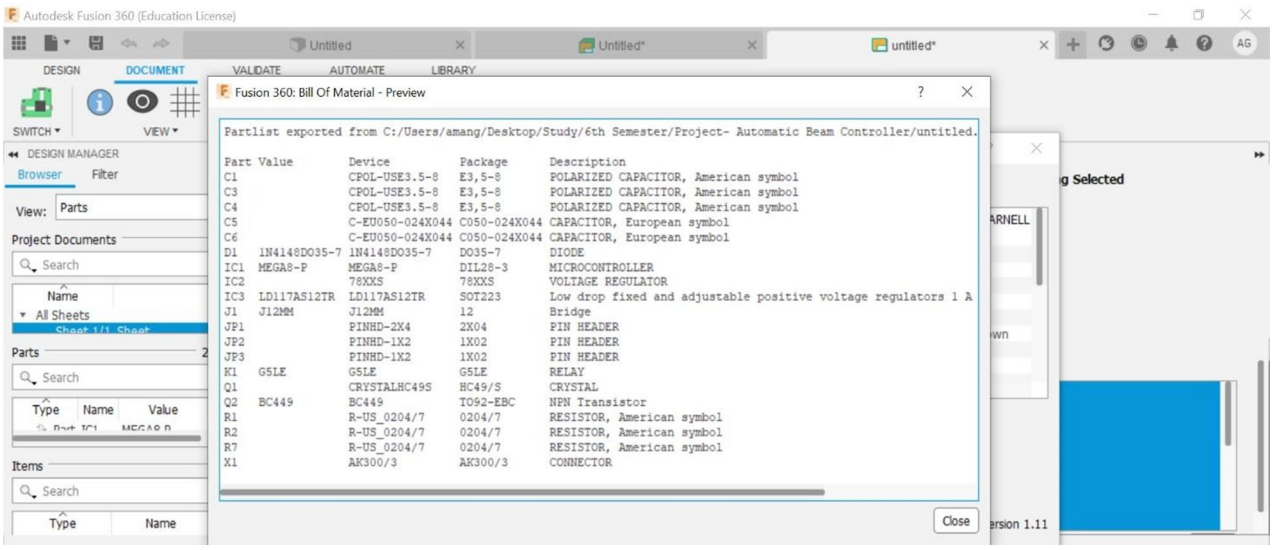
III. CIRCUIT DIAGRAM AND CODE



Circuit Diagram



PCB Layout



List of Materials

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Transmiter_Light | Arduino 1.8.13 (Windows Store 1.8.42.0)

File Edit Sketch Tools Help

Transmiter_Light

```
#include <SPI.h>
#include <nRF24L01.h>
#include <RF24.h>
RF24 radio(9, 10); // CE, CSN
const byte addresses [][6] = {"00001", "00002"};  //Setting the two addresses. One for transmitting and one for receiving
int button_pin = 14;
int led_pin = 15;
boolean button_state = 0;
boolean button_state1 = 0;
void setup() {
  pinMode(button_pin, INPUT);
  pinMode(led_pin, OUTPUT);
  radio.begin();                           //Starting the radio communication
  radio.openWritingPipe(addresses[1]);     //Setting the address at which we will send the data
  radio.openReadingPipe(1, addresses[0]);  //Setting the address at which we will receive the data
  radio.setPALevel(RF24_PA_MIN); //You can set it as minimum or maximum depending on the distance between the transmitter and receiver.
}
void loop()
{
  delay(5);
  radio.stopListening();                          //This sets the module as transmitter
  button_state = digitalRead(button_pin);
  radio.write(&button_state, sizeof(button_state));  //Sending the data
  delay(5);


}
```

Transmitter Side Code

Reciever_Light | Arduino 1.8.13 (Windows Store 1.8.42.0)

File Edit Sketch Tools Help

Reciever_Light

```
#include <SPI.h>
#include <nRF24L01.h>
#include <RF24.h>

RF24 radio(9, 10); // CE, CSN
const byte addresses [][6] = {"00001", "00002"};    //Setting the two addresses. One for transmitting and one for receiving
int button_pin = 15;

boolean button_state = 0;
boolean button_state1 = 0;
int led_pin = 14;

void setup() {
  pinMode(led_pin, OUTPUT);
  Serial.begin(9600);
  radio.begin();                           //Starting the radio communication
  radio.openWritingPipe(addresses[0]);     //Setting the address at which we will send the data
  radio.openReadingPipe(1, addresses[1]);  //Setting the address at which we will receive the data
  radio.setPALevel(RF24_PA_MIN);           //You can set it as minimum or maximum depending on the distance between the transmitter and receiver.
}

void loop()
{
  delay(5);
  radio.startListening();                  //This sets the module as receiver
  if (radio.available())                   //Looking for incoming data
  {


    radio.read(&button_state, sizeof(button_state));
    if(button_state == HIGH)
  {
     digitalWrite(led_pin, LOW);
  }
  else
  {
     digitalWrite(led_pin, HIGH);
  }
  delay(5);

  }
}
```

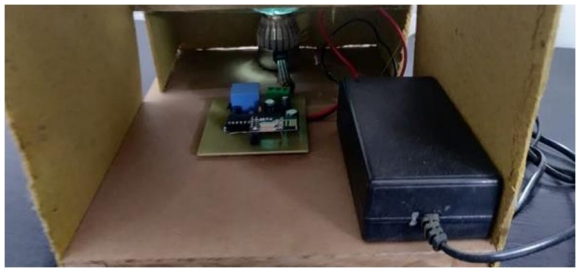
Receiver Side Code

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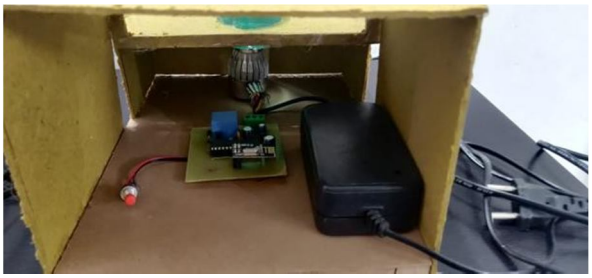
IV. PROJECT WORKING



Front of the receiver and transmitter model



Receiver



Transmitter



Low Beam

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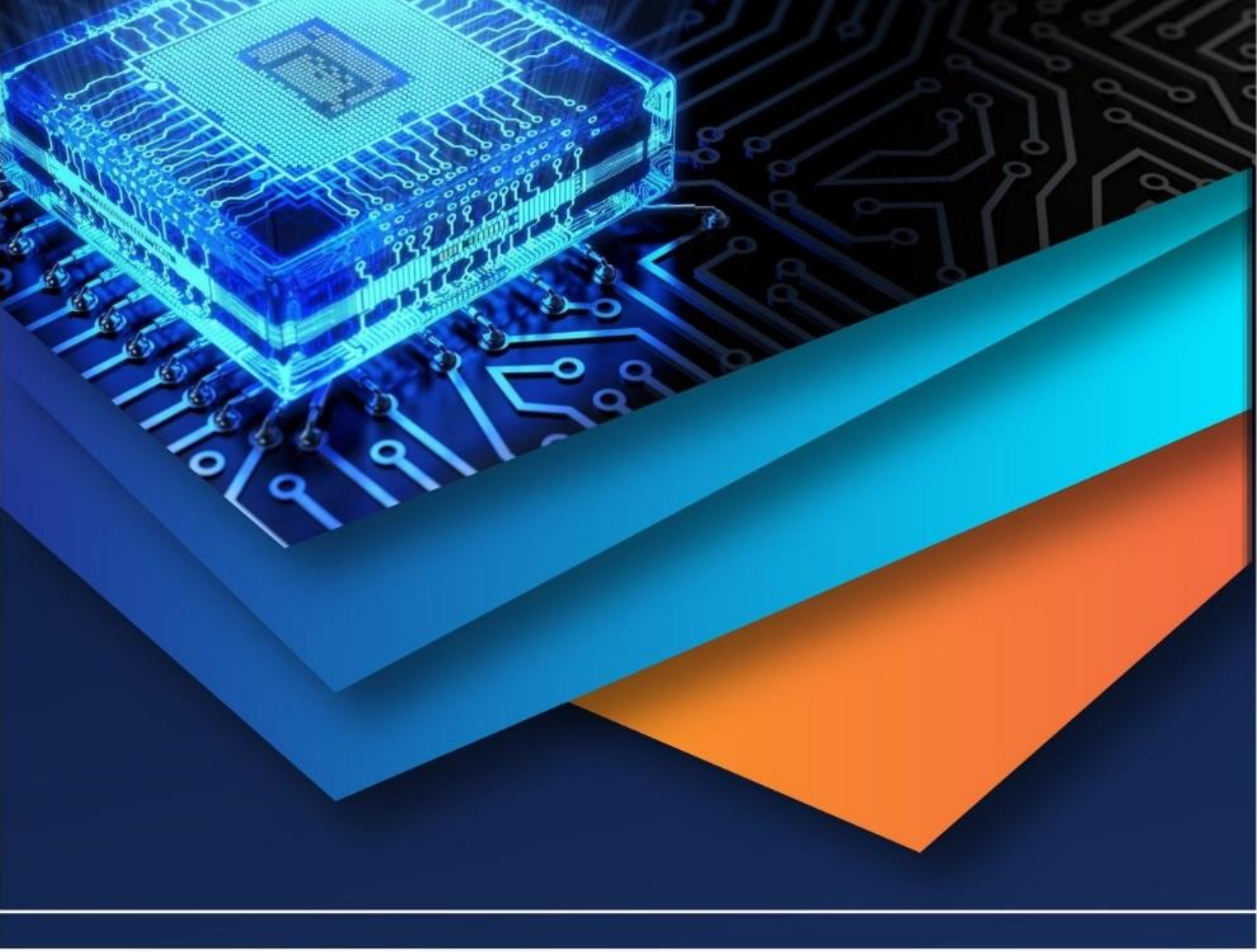


High Beam

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