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Wireless RGB LED Light

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ABSTRACT
In this work, an RGB light-emitting diode (LED) lamp was designed for a smart home system. The ultimate aim of this research is to produce an energy-efficient as well as an environmentally-friendly lamp that is able to be utilized for primarily home activities. The RGB lamp device is made-up of an ESP8266 microcontroller, which controls RGB LED lamp using pulse-width modulation (PWM). The RGB lamp device itself is controlled by the user using Android-based application, which communicates using Wi-Fi (Wireless Fidelity) with a central host that passes the command to the lamp device through TCP/IP protocol. The end-result of this work is an RGB lamp that uses 42.8 mA current consumption in an idle condition and 603.1 mA in active condition for 5 VDC supply voltage.

Keywords : LED, PWM, TCP/IP protocol, APP, ESP8266, Microcontroller

I. INTRODUCTION

In recent years, the exhaustion of fossil fuel and the issue of climate change have attracted public attention on energy conservation and environment protection. Governments and professional associations have successively regulated the specification for “green” products and generated the certificate mechanism. As energy consumption on lighting rises continuously, lighting equipment which is environmentally friendly and possesses high energy efficiency becomes popular. Energy and cost can then be saved through the enhancement of lighting efficiency. Among all the lighting products, Light Emitting Diode (LED) is one of most promising light sources since LED provides several unique strengths including small size, directional light emission, cold temperature operation, and controllability. With the development of related technologies, LED now can be widely applied on various areas. Applications from household appliance to indoor lighting are common in the daily life. Furthermore, the smart phones and tablets have ushered in a new lifestyle for people. Many control systems have been developed and integrated with applications (APPs) of smart phones and tablets. Users can download the APP and then remotely control the household appliance, which is very different from traditional ways. In this paper, a LED lighting control system based on the Bluetooth wireless network is proposed. Fig.1 shows the system diagram. Through the connection between Bluetooth in the smart phone and the Bluetooth module, signal and command are transmitted wirelessly. Users can control the brightness and colors of LEDs by APP on Android system. Integrated with microcontroller, a wireless RGB LED dimming control system is also implemented.

The light-emitting diode (LED) has been drawing much attention as a state-of-the-art illuminator because of its numerous advantages, including energy savings, long lifetime. Red-green-blue (RGB) LEDs can provide a wide color gamut for LCD backlighting, as well as full color adjustability for general lighting applications. This newly-developed illuminant is the only light source currently capable of this type of vivid and dynamic lighting performance. However, the tunable light outputs have been found to induce light consistency issues for RGB LED lighting, because the luminous intensity and color outputs are easily influenced by junction temperature variations caused by self-heating of the LEDs and disturbances in ambient temperatures. Therefore, proper control strategies are required to stabilize light output, in order to counteract temperature variations. In our project we have considered all the parameters and we have designed the circuit in such a way that it can be stable on the same current output for longer time and we have used a heat sink to dissipate heat produced by the LED.

The power supply is an electronic device which supplies power to the microcontroller. A dc supply of certain volts is being given to the rectifier followed by regulator inside the power supply which produces a regulated output. This regulated output is given to the microcontroller.

The microcontroller performs the operation of multiple colors generation from RGB primary colors by using the switches. When the circuit is switched on, red color of the RGB LED glows for a pre-programmed time interval. It then switches off for the same time. This is followed by green and blue colors switching on and off in a similar manner and for the same time periods. By mixing red and green colors yellow color is obtained. When red and blue colors are mixed together we get magenta. Cyan is obtained by mixing blue and green colors.

The output color of RGB LED is controlled by varying the level of each of the three color LEDs i.e. red, green, blue. The three colors are combined to create a different color. The level of each color is set by the duty cycle of the PWM signal driving the transistor controlling the LED. As long as the frequency of PWM is higher than 50Hz no flickering is observable to human eyes. Higher the duty cycles gives higher levels of each color.

The following diagram gives the result of 3pwm signals. The red PWM is 50% duty cycle, green is 100% duty cycle and blue is 33% duty cycle due to this we get light green color.

The overall brightness of RGB LED is adjusted by the pulse width modulating the PWM signals for each color; whereas the overall modulation is the same for all three PWM signals. This allows the color levels to remain the same ratio between red, green and blue while dimming or increasing the overall brightness. The resulting waveforms create a different color but the overall brightness of RGB LED will be significantly reduced.

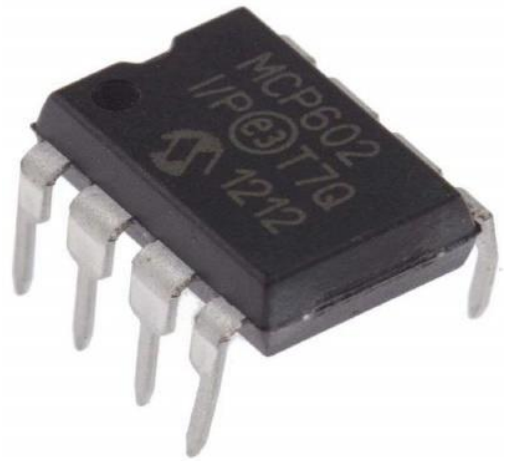
To create the three PWMs the timers of ESP8266 are used. To create the brightness PWMs the software counters are used.RGB LED lights create a range of colors and types of light, be easy to program and to control in real time and easy to install discreetly. Their brightness can be easily changed. On top of this, their long lifetime and small size make them the light source of the future.

II. METHODS AND MATERIAL

Components Used:

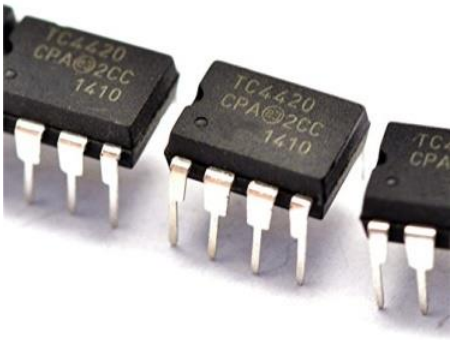
10W RGB LED (Common anode and 3 cathode)

IRLZ44N MOSFET



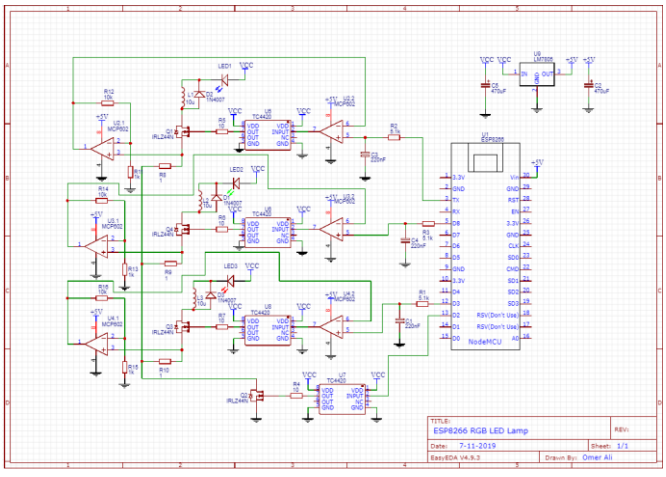
MCP602 OpAmp

In this project we have aimed in the conversion of PWM signal to a simple DC signal this is the main reason the MCP620 OpAmp IC is used. As we can see the D3, D4, D8 and Tx pins of the ESP8266 are used to control OFF/ON function, Red, Blue, Green Light intensity. This LED driver circuit is designed in a manner that it supplies constant current of 300mA for the LED so that it gets least hot and don't change its intensity due to temperature parameters.

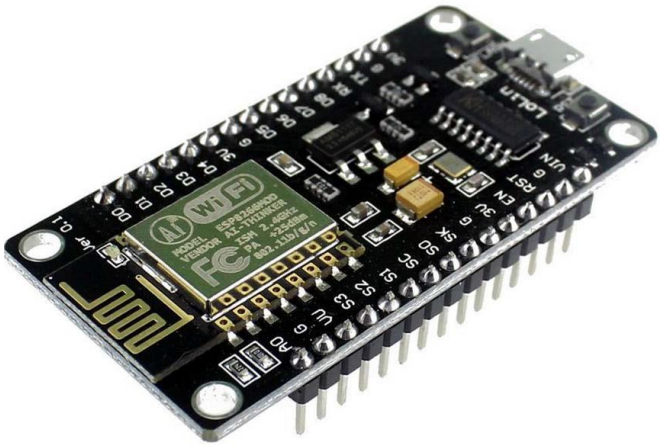


TC4420 MOSFET Driver

Schematic

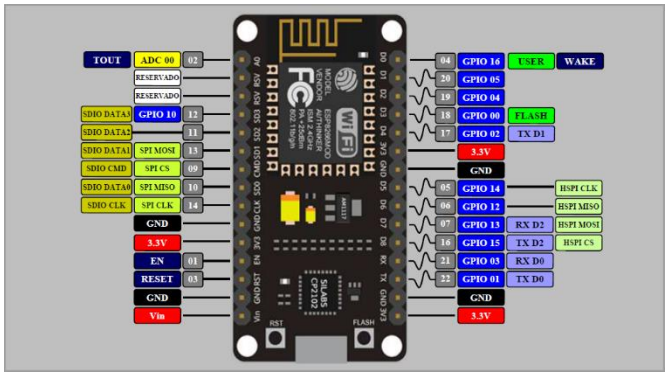


ESP8266 Microcontroller Unit:



The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

Pin Definition:



The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a WIFI/Serial transceiver. However, this is not convenient. What we recommend is using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE. Following the below step to install ESP8266 library to work in Arduino IDE environment.

ESP8266 Pin	Description
CH_PD	Pull high, connect to Vcc +3.3V
Vcc	Power Supply +3.3V
TXD	Connect to RXD (white) of PL2303HX USB-Serial converter cable
RXD	Connect to TXD (Green) of PL2303HX USB-Serial converter cable
GPIO0	Pull low, connect to GND pin
GND	Power Supply ground

The GPIO(General Purpose Input/Output) allows us to access to pins of ESP8266 , all the pins of ESP8266 accessed using the command GPIO, all the access is based on the I/O index number on the NoddMCU dev kits, not the internal GPIO pin, for example, the pin 'D7' on the NodeMCU dev kit is mapped to the internal GPIO pin 13, if you want to turn 'High' or 'Low' that particular pin you need to called the pin number '7', not the internal GPIO of the pin. When you are programming with generic ESP8266 this confusion will arise, which pin needs to be called during programming, if you are using NodeMCU devkit, it has come prepared for working with Lua interpreter which can easily program by looking the pin names associated on the Lua board. If you are using generic ESP8266 device or any other vendor boards please refer to the table below to know which IO index is associated to the internal GPIO of ESP8266.

III. RESULTS AND DISCUSSION

ESP8266 Block Diagram:

Features

- ✓ 802.11 b/g/n
- ✓ Integrated low power 32-bit MCU
- ✓ Integrated 10-bit ADC
- ✓ Integrated TCP/IP protocol stack
- ✓ Integrated TR switch, balun, LNA, power amplifier and matching network

- ✓ Integrated PLL, regulators, and power management units
- ✓ Supports antenna diversity
- ✓ WiFi 2.4 GHz, support WPA/WPA2
- ✓ Support STA/AP/STA+AP operation modes
- ✓ Support Smart Link Function for both Android and iOS devices
- ✓ SDIO 2.0, (H) SPI, UART, I2C, I2S, IR Remote Control, PWM, GPIO
- ✓ STBC, 1x1 MIMO, 2x1 MIMO
- ✓ A-MPDU & A-MSDU aggregation & 0.4s guard interval
- ✓ Deep sleep power <10uA, Power down leakage current < 5uA
- ✓ Wake up and transmit packets in < 2ms
- ✓ Standby power consumption of < 1.0mW (DTIM3)
- ✓ +20 dBm output power in 802.11b mode
- ✓ Operating temperature range -40C ~ 125C
- ✓ FCC, CE, TELEC, WiFi Alliance, and SRRC certified

Major Applications

- ✓ Major fields of ESP8266EX applications to Internet-of-Things include:
- ✓ Home Appliances
- ✓ Home Automation
- ✓ Smart Plug and lights
- ✓ Mesh Network
- ✓ Industrial Wireless Control
- ✓ Baby Monitors
- ✓ IP Cameras
- ✓ Sensor Networks
- ✓ Wearable Electronics
- ✓ WiFi Location-aware Devices
- ✓ Security ID Tags
- ✓ WiFi Position SystemBeacons

General Purpose Input/output Interface (GPIO)

There are up to 17 GPIO pins. They can be assigned to various functions by the firmware. Each GPIOcan be configured with internal pull-up (except XPD_DCDC, which is configured with internal pulldown),input available for sampling by a software register, input triggering an edge or level CPUinterrupt, input triggering a level wakeup interrupt, open-drain or push-pull output driver, or outputsource from a software register, or a sigma-delta PWM DAC.
These pins are multiplexed with other functions such as I2C, I2S, UART, PWM, IR Remote Control, etc.

Data I/O soldering pad is bidirectional and tri-state that include data input and output controllingbuffer. Besides, I/O can be set as a specific state and remains like this. For example, if you intend tolower the power consumption of the chip, all data input and output enablesignals can be set asremaining low power state. You can transport some specific state into the I/O. When the I/O is notpowered by external circuits, the I/O will remain to be the state that it was used the last time. Somepositive feedback is generated by the state-remaining function of the pins, therefore, if the externaldriving power must be stronger than the positive feedback. Even so, the driving power that isneeded is within 5uA.

Advantages

RGB LED lights create a range of colors and types of light, be easy to program and to control in real time and easy to install discreetly. Their brightness can be easily changed. On top of this, their long lifetime and small size make them the light source of the future.
This project is mainly concentrated in utilizing the capability of RGB so that with in only one light source we can have more than one light shade. And the primary advantage here is also we can use IoT with this MCU to monitor usage of the unit and get more accurate census for production of future product.

IV. APPLICATIONS

This Product can be used in home lighting solutions containing the concept of Home Automation, it can be used in gaming rooms to create a Gamer's like ambience, it can be used in outdoor lighting solutions and in many more places.

V. CONCLUSION

This paper we can able to generate the multiple color using the primary colors RED, GREEN, BLUE. RGB LED is used for generating multiple colors. An RGB LED is simply three separate LEDS crammed into a single 5mm LED package. RED, GREEN, and BLUE can be combined in various proportions to obtain any color in the visible spectrum, using microcontroller.

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