

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE

## DESCRIPTION

The IS31FL3197 is a charge pump LED driver with programmable sequence operation for automated RGBW lighting effects. It is capable of driving 4 LEDs up to 10mA (adjustable in 256 current levels and 4096 PWM levels) from a small coin size battery supply.

The built-in charge pump structure will automatically toggle between 1x, 1.5x or 2x operation depending on the battery's state of charge. This DC/DC converter operates at a high switching frequency which enables the use of small external capacitors and achieves a 90% peak efficiency. To conserve battery life, the charge pump goes into high impedance mode whenever the IS31FL3197 is shutdown.

The IS31FL3197 can operate in either "Current Level & PWM mode" or "Pattern" mode. In Current Level & PWM mode, the output current of each output is independently programmed and controlled in 4096 steps to achieve color mixing and the PWM duty cycle of each output is also independently programmed and controlled in 4096 steps to simplify color mixing or for smoothly dimming control. In Pattern mode, the timing characteristics for RGB channels output can be individually adjusted to maintain a pre-established pattern sequence without requiring any additional MCU interaction, thus saving valuable system resources.

## QUICK START

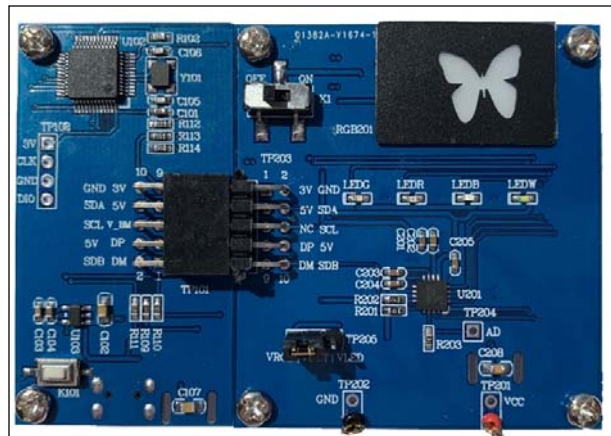


Figure 1: Photo of IS31FL3197-QFLS2 Evaluation Board

## FEATURES

- 2.0V to 3.3V supply voltage
  - UVLO of 1.8V
- Charge pump
  - 1x, 1.5x, 2x operating modes
  - Highly efficient across battery state of charge
  - 1MHz constant frequency
- Power saving operating
  - Quiescent operating current 600µA (Typ.)
  - Shutdown current 1µA (Typ.)
- Support four LEDs - RGBW
  - Resistor sets maximum 10mA output current per LED
  - Each LED has 8-bit programmable current levels
  - Each LED has 12-bit programmable PWM levels
- LEDs operate with pre-established patterns
  - Once programmed runs without micro
  - OUT1~OUT3 have their own fade ON/OFF timing registers (TS~T4) with independent start/stop/ crossfade
  - Fixed number of iterations or non-stop operation
  - Crossfade of one color to another
- Fast 400kHz I2C bus interface
  - Automatic address increment function
  - 4 selectable I2C address locations
- Over-temperature protection
- QFN-16 (4mm×4mm) and WLCSP-16 (1.88mm×2.08mm, 0.45mm ball pitch, 0.2mm ball diameter) packages
- Operating temperature T<sub>A</sub> = -40°C ~ +85°C

## RECOMMENDED EQUIPMENT

- Micro USB power supply
- CR2032 battery

## ABSOLUTE MAXIMUM RATINGS

- V<sub>CC</sub> ≤ 3.3V power supply

**Caution:** Do not exceed the conditions listed above, otherwise the board will be damaged.

## ORDERING INFORMATION

| Part No.            | Temperature Range          | Package           |
|---------------------|----------------------------|-------------------|
| IS31FL3197-QFLS2-EB | -40°C to +85°C, Industrial | QFN-16, Lead-free |

Table 1: Ordering Information

For pricing, delivery, and ordering information, please contact Lumissil's analog marketing team at [analog@Lumissil.com](mailto:analog@Lumissil.com) or (408) 969-6600.

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## PROCEDURE

The IS31FL3197 evaluation board is fully assembled and tested. Follow the steps listed below to verify board operation.

**Caution:** Do not turn on the power supply until all connections are completed.

- 1) Connect the MCU board's TP101 to the IS31FL3197 RGBW board's TP203 to enable the control of MCU (default status).
- 2) Plug in the USB power input to micro-USB.
- 3) Put the CR2032 battery in the holder (U202).
- 4) Short VOUT and VLED in TP205 to enable the single color LEDs, or short VOUT and VRGB in TP205 to enable the RGB LED.
- 5) Turn on the power supply, pay attention to the supply current. If the current exceeds 1A, please check for circuit fault.

## EVALUATION BOARD OPERATION

The IS31FL3197 evaluation board has 2 display modes. Press MODE (K101) button to switch configurations.

- 1) (Default mode) Crossfade LED mode.
- 2) RGB pattern+ White LED mode.

Toggling battery switch K1 on IS31FL3197 board to "on" and disconnect TP101 from TP203 (remove the MCU control board), the IS31FL3197 board will continue running the current pattern. If RGBW LED turns off when MCU board disconnected, it shows the CR2032 battery power is low, changing a new CR2032 will solve the problem.

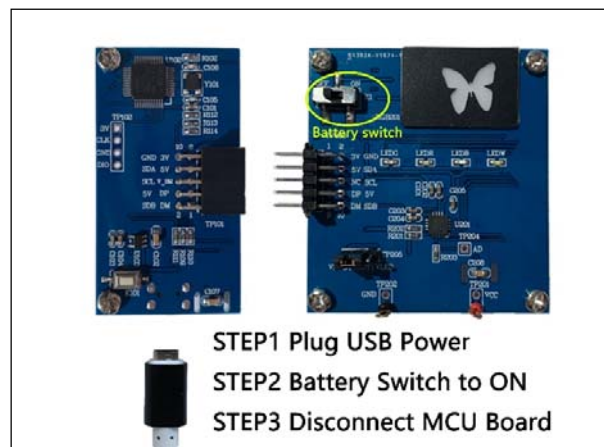


Figure 2: RGBW Board disconnect from MCU board

**Note:** IS31FL3197 solely controls the FxLED function on the evaluation board.

## SOFTWARE SUPPORT

The MCU board's TP101 interconnects with the IS31FL3197 board's TP203. If TP101 is disconnected from TP203, the MCU to IS31FL3197 communication will be removed and the IS31FL3197 board will continue running the K101 selected pattern. The I2C pins are floated and SDB pin is pulled high by R201. An external I2C and SDB signal can be connected to TP203 to externally control the IS31FL3197 LED driver. Short TP205's VOUT to VLED to enable the individual LEDs (LEDG/LEDR/LEDB), or short VOUT to VRGB to enable the RGB Butterfly. LEDW is always ON and not controlled by TP205 jumper position.

The steps listed below are an example for using the Arduino as external control.

The Arduino hardware consists of an Atmel microcontroller with a bootloader allowing quick firmware updates. First download the latest Arduino Integrated Development Environment IDE (1.6.12 or greater) from [www.arduino.cc/en/Main/Software](http://www.arduino.cc/en/Main/Software). Also download the Wire.h library from [www.arduino.cc/en/reference/wire](http://www.arduino.cc/en/reference/wire) and verify that pgmspace.h is in the directory ...program Files(x86)/Arduino/hardware/tools/avr/avr/include/avr/. Then download the latest IS31FL3197 test firmware (sketch) from the Lumissil website <http://www.lumissil.com/products/led-driver/fxled>.

Note: Most Arduino boards VCC or VOH is 5V, since the IS31FL3197 maximum VCC and VIH is 3.3V, So we suggest using Arduino board whose MCU's VOH is 3.3V, i.e. DUE.

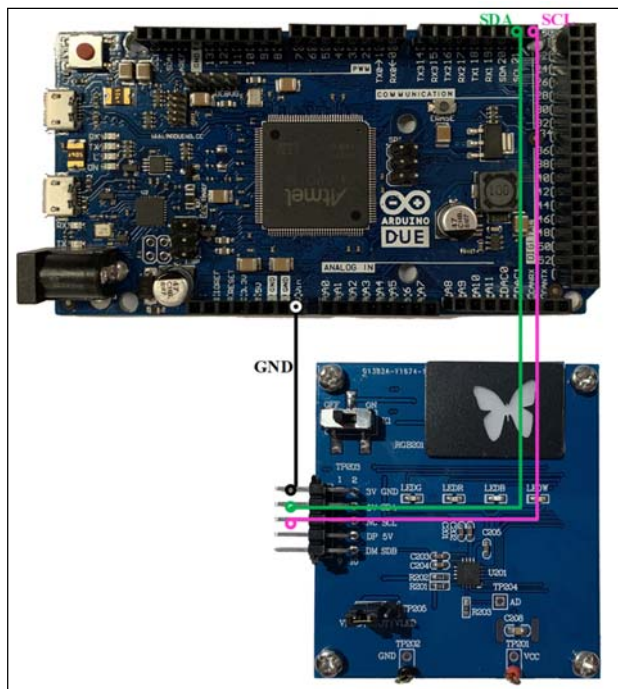


Figure 3: Arduino DUE connect to RGBW Board

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- 1) Check the CR2032 battery is ready, power switch (K1) is "ON" status.
- 2) TP101 disconnect from TP203 (Remove MCU control board)
- 3) Connect the 3 pins from Arduino board to the RGBW Board:
  - a) Arduino GND to RGBW board GND.
  - b) Arduino SDA (20) to RGBW board SDA.
  - c) Arduino SCL (19) to RGBW board SCL.
- 4) Use the test code in appendix I or download the test firmware (sketch) from the Lumissil website,  
and copy the code to Arduino IDE, compile and upload to Arduino.
- 5) Run the Arduino code which will program the IS31FL3197 to cycle through color patterns, there is no button control.
- 6) Short VOUT and VLED in TP205 to enable the single color LEDs (LEDG/LEDR/LEDB), or short VOUT and VRGB in TP205 to enable the RGB LED. LEDW is always light up.

*Please refer to the datasheet to get more information about IS31FL3197.*

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE

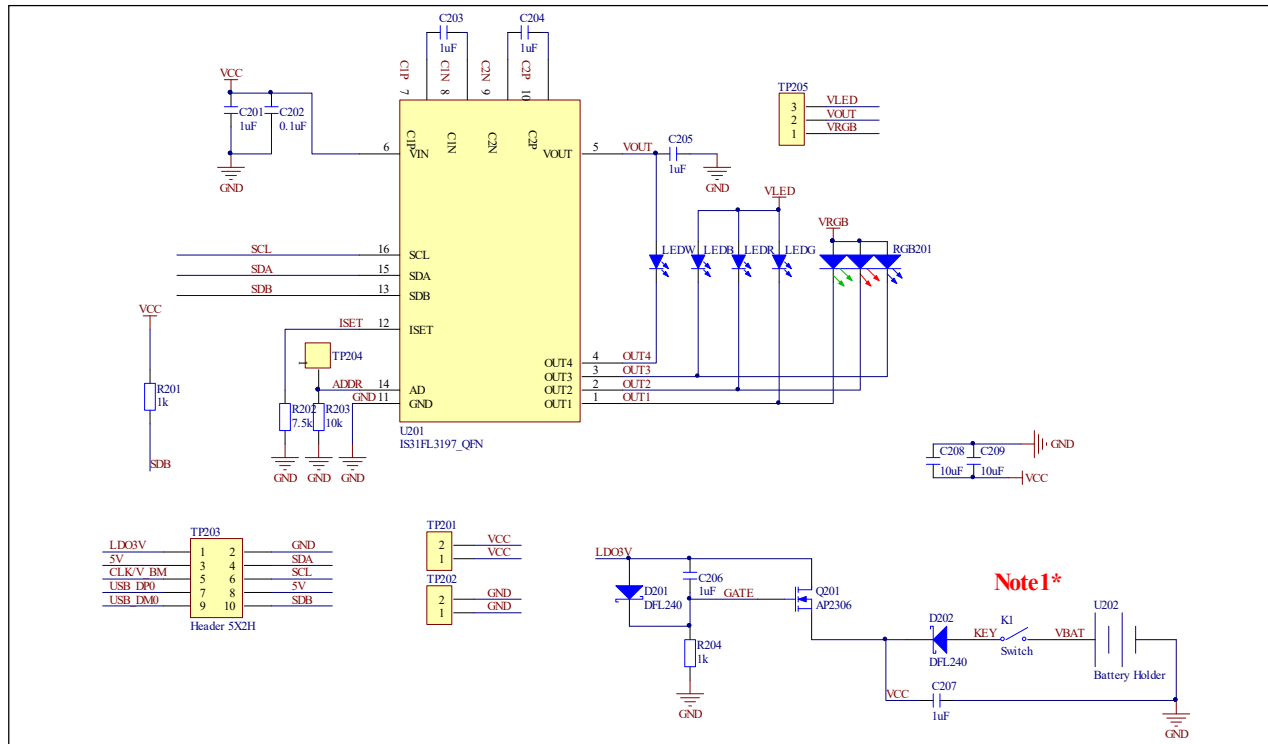


Figure 4: IS31FL3197 RGBW Board Schematic

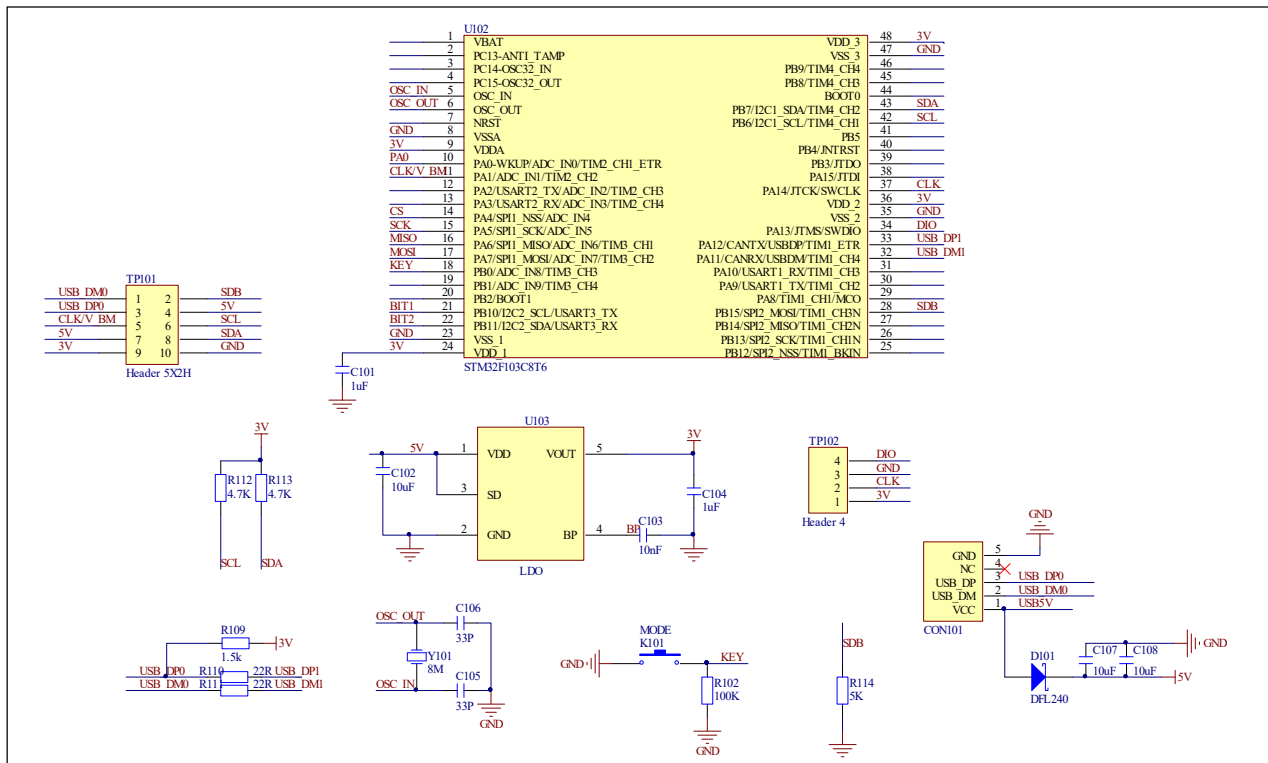


Figure 5: MCU Board Schematic

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE



## BILL OF MATERIALS

### IS31FL3197

| Name           | Symbol                          | Description                    | Qty | Supplier  | Part No.            |
|----------------|---------------------------------|--------------------------------|-----|-----------|---------------------|
| LED Driver     | U201                            | 4CH FxLED Driver               | 1   | Lumissil  | IS31FL3197          |
| Battery Holder | U202                            | CR2032 Battery Holder (Note 1) | 1   | Q&J       | CR2032-BS-6-1       |
| MOSFETs        | Q201                            | N-Channel Power MOSFET         | 1   | APEC      | AP2306              |
| Diode          | D201,D202                       | Diode, SMD                     | 2   | DIODES    | DFLS240             |
| LED            | LEDB                            | Diode, LED Blue, SMD           | 1   | Everlight | 19-217/BHC-AN1P2/3T |
| LED            | LEDG                            | Diode, LED Green, SMD          | 1   | Everlight | 19-217/GHC-YR1S2/3T |
| LED            | LEDR                            | Diode, LED Red, SMD            | 1   | Everlight | 19-217/R6C-P1Q2/3T  |
| LED            | LEDW                            | Diode, LED White, SMD          | 1   | Everlight | GT-197              |
| LED            | RGB201                          | Diode, LED RGB, SMD            | 1   | Everlight | 99-235/RSGBB7C-ADDR |
| Resistor       | R201,R204                       | RES,1k,1/10W,±5%, SMD          | 2   | Yageo     | RC0603JR-071KL      |
| Resistor       | R202                            | RES,7.5k,1/10W,±5%,SMD         | 1   | Yageo     | RC0603JR-077K5L     |
| Resistor       | R203                            | RES,10k,1/10W,±5%,SMD          | 1   | Yageo     | RC0603JR-0710KL     |
| Capacitor      | C201,C203, C204,C205, C206,C207 | CAP, 1µF,16V,±10%,SMD          | 6   | Yageo     | CC0603KRX7R7BB105   |
| Capacitor      | C202                            | CAP,100nF,16V,±20%,SMD         | 1   | Yageo     | CC0603MRX7R7BB104   |
| Capacitor      | C208,C209                       | CAP,10µF,16V,±20%,SMD          | 2   | Yageo     | CC0805MRX5R7BB106   |
| Switch         | K1                              | Toggle Switch                  | 1   | HRO       | K3-1235S            |
| Header         | TP203                           | 5×2 Connection Jumper          | 1   |           |                     |
| Header         | TP204                           | ADDR Pin                       | 1   |           |                     |
| Header         | TP205                           | RGB/LEDs select Jumper         | 1   |           |                     |
| Diffuser       |                                 | RGB Butterfly                  | 1   |           | Customized          |

Bill of Materials, refer to Figure 4 above.

Note 1: IS31FL3197 Eval Board powered by a CR2032 button battery when it running without USB power supply. CR2032 button battery not included in IS31FL3197 Eval Board.

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE



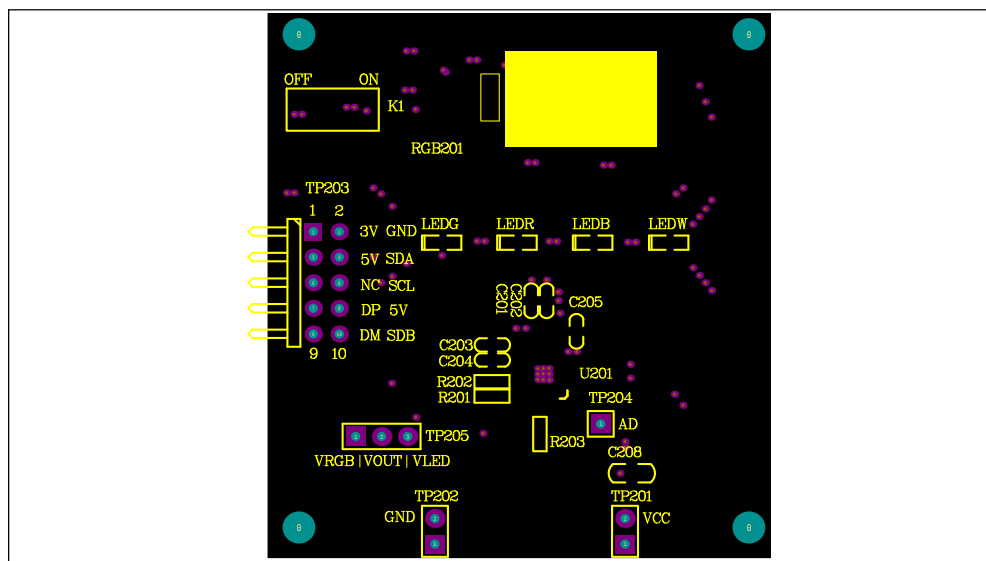
## BILL OF MATERIALS (CONTINUED)

### STM32F103C8T6

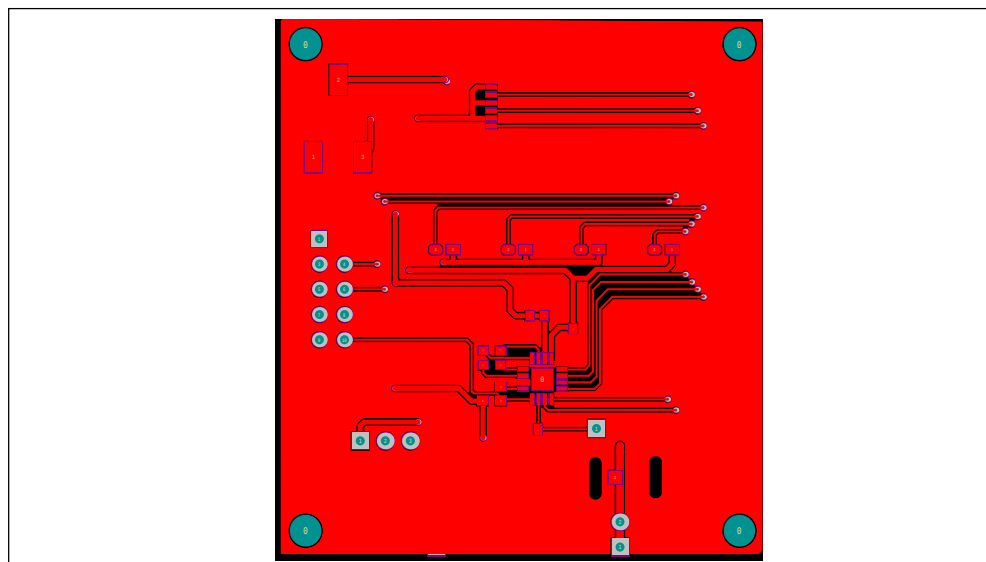
| Name      | Symbol             | Description            | Qty | Supplier | Part No.          |
|-----------|--------------------|------------------------|-----|----------|-------------------|
| MCU       | U102               | Microcontroller        | 1   | STM      | STM32F103C8T6     |
| LDO       | U103               | 3.0V LDO               | 1   | SGMICRO  | SGM2019-3.0YN5G   |
| Diode     | D101               | Diode, SMD             | 1   | DIODES   | DFLS240           |
| Crystal   | Y101               | Crystal, 8MHz          | 1   | HLX      | HC-49S            |
| Resistor  | R102               | RES,100k,1/10W,±5%,SMD | 1   | Yageo    | RC0603JR-07100KL  |
| Resistor  | R109               | RES,1.5k,1/10W,±5%,SMD | 1   | Yageo    | RC0603JR-071K5L   |
| Resistor  | R110,R111          | RES,22R,1/10W,±5%,SMD  | 2   | Yageo    | RC0603JR-0722RL   |
| Resistor  | R112,R113          | RES,4.7k,1/10W,±5%,SMD | 2   | Yageo    | RC0603JR-074K7L   |
| Resistor  | R114               | RES,5k,1/10W,±5%,SMD   | 1   | Yageo    | RC0603JR-0705KL   |
| Capacitor | C101,C104          | CAP, 1µF,16V,±10%,SMD  | 2   | Yageo    | CC0603KRX7R7BB105 |
| Capacitor | C102,C107,<br>C108 | CAP,10µF,16V,±20%,SMD  | 3   | Yageo    | CC0805MRX5R7BB106 |
| Capacitor | C103               | CAP,10nF,16V,±10%,SMD  | 1   | Yageo    | CC0603KPX7R7BB103 |
| Capacitor | C105,C106          | CAP,33pF,50V,±5%,SMD   | 2   | Yageo    | CQ0603JRNPO9BN360 |
| Header    | TP101              | 5×2 Connection Jumper  | 1   |          |                   |
| Button    | K101               | Button SMD             | 1   |          |                   |

Bill of Materials, refer to Figure 5 above.

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE



**Figure 6: Board Component Placement Guide - Top Layer**



**Figure 7: Board PCB Layout - Top Layer**

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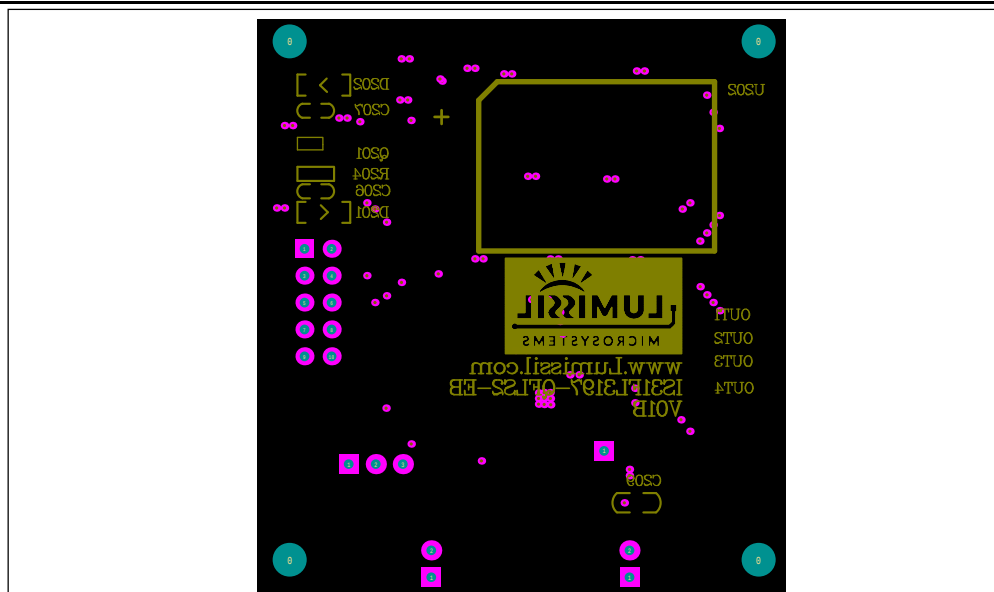


Figure 8: Board Component Placement Guide - Bottom Layer

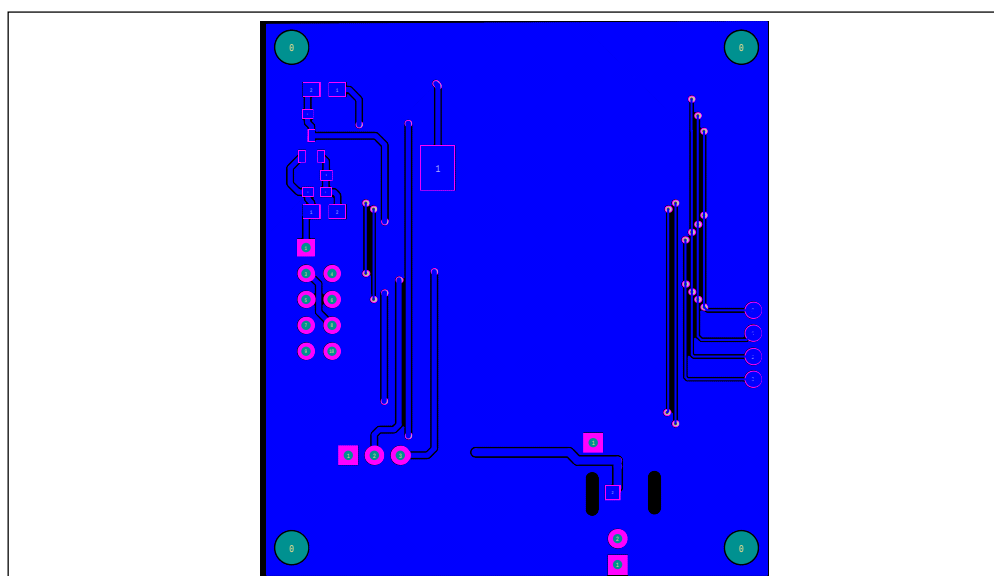


Figure 9: Board PCB Layout - Bottom Layer

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE

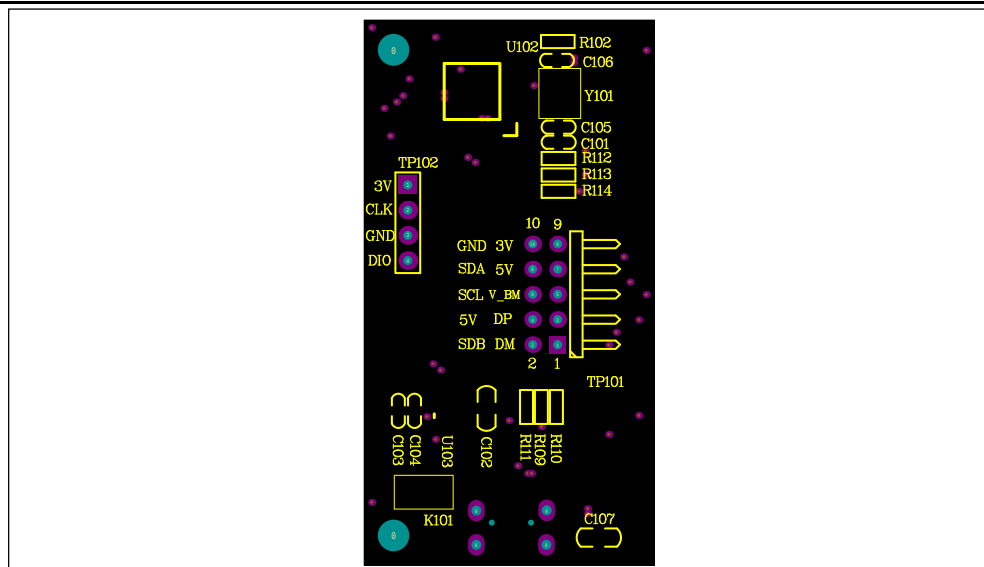


Figure 10: Board Component Placement Guide - Top Layer

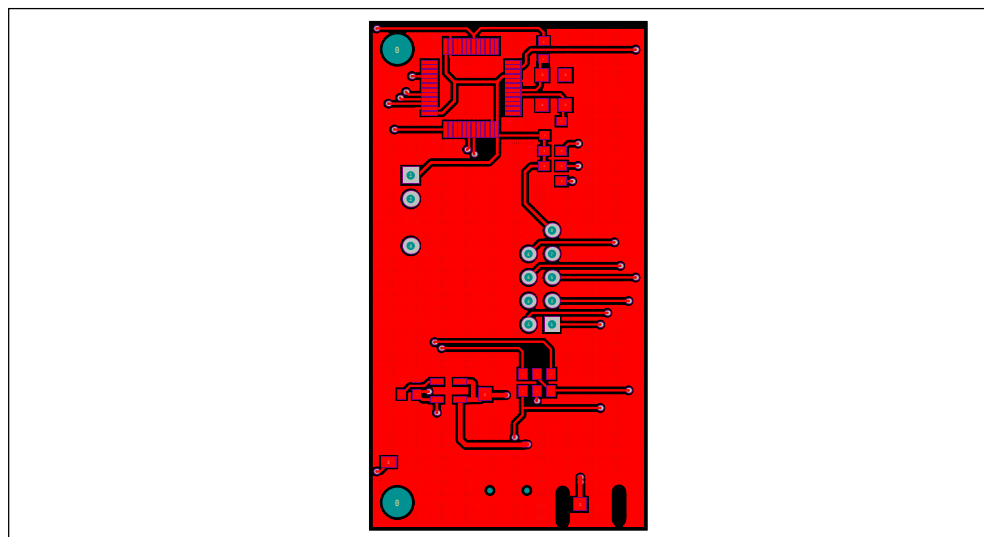
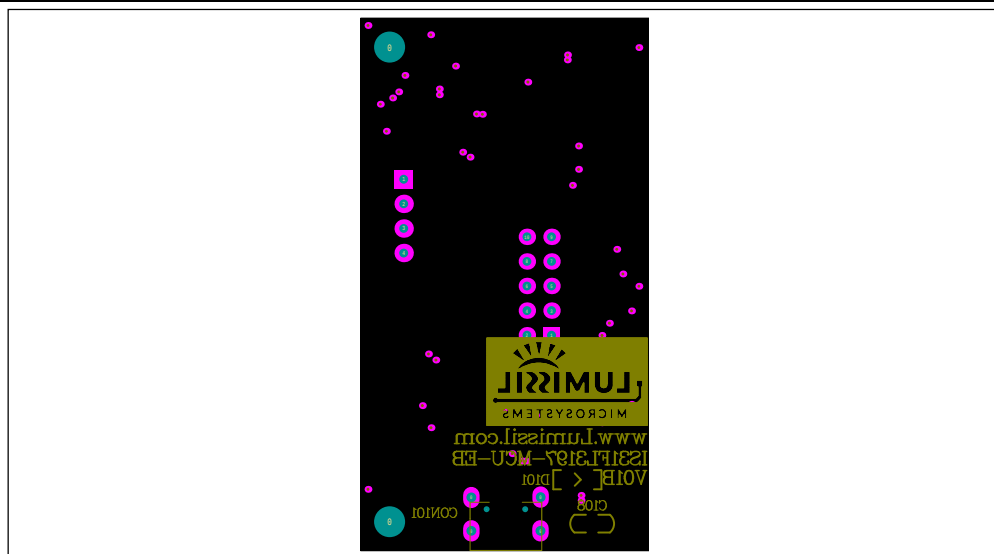
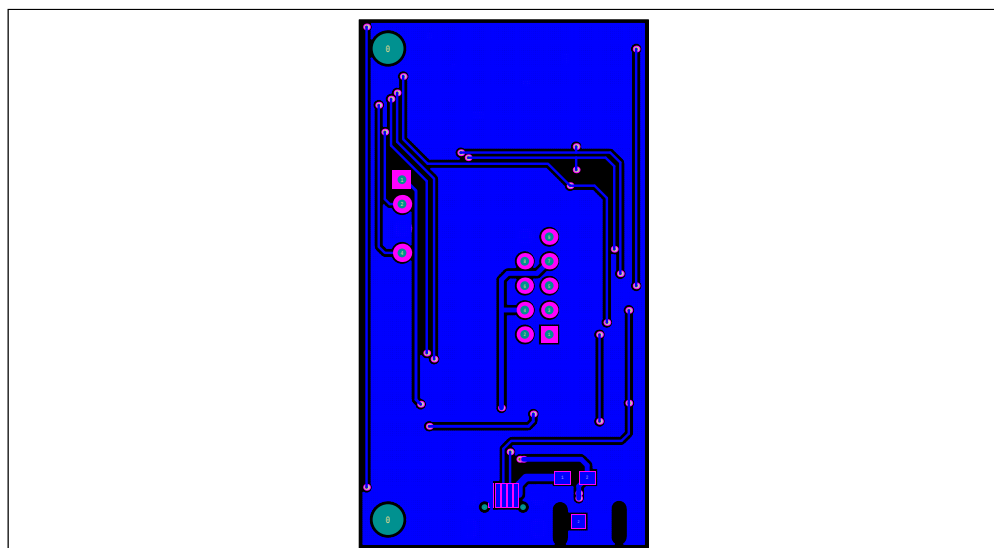


Figure 11: Board PCB Layout - Top Layer

# CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE



**Figure 12: Board Component Placement Guide - Bottom Layer**



**Figure 13: Board PCB Layout - Bottom Layer**

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- b.) the user assume all such risks; and
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## REVISION HISTORY

| Revision | Detail Information | Data       |
|----------|--------------------|------------|
| A        | Initial release    | 2020.07.31 |
| B        | Update the BOM     | 2021.05.08 |

## APPENDIX I : IS31FL3197 Arduino Test Code V01A

```
#include<Wire.h>
#include<avr/pgmspace.h>
#define Addr_GND 0xA0 //Default RGBW board connection, Connect TP204 to SCL, SDA or VCC for different address

void setup() {

    // put your setup code here, to run once:
    Wire.begin();
    Wire.setClock(40000); //I2C 400kHz
    // pinMode(4,OUTPUT); //SDB
    // digitalWrite(4,HIGH); //SDB_HIGH
    //delay(100); //keep 0.5s
    Init_FL3197();
    IS31FL3197_mode1(); //breath mode
}

void loop() {
    // put your main code here, to run repeatedly:
    // Init_FL3197();
}

void IS_IIC_WriteByte(uint8_t Dev_Add, uint8_t Reg_Add, uint8_t Reg_Dat)
{
    Wire.beginTransmission(Dev_Add/2);
    Wire.write(Reg_Add); // sends regaddress
    Wire.write(Reg_Dat); // sends regaddress
    Wire.endTransmission(); // stop transmitting
}

void Init_FL3197(void)
{
    IS_IIC_WriteByte(Addr_GND, 0x01, 0xF1); //normal operation
    IS_IIC_WriteByte(Addr_GND, 0x02, 0x15); //LED mode choose
    IS_IIC_WriteByte(Addr_GND, 0x03, 0x00); //Charge Pump Setting-1
    IS_IIC_WriteByte(Addr_GND, 0x05, 0x00); //Current Band Setting
}

void IS31FL3197_mode1(void) //Crossfade mode
{
    //out1 color
    IS_IIC_WriteByte(Addr_GND, 0x10, 0x80);
    IS_IIC_WriteByte(Addr_GND, 0x11, 0x00);
    IS_IIC_WriteByte(Addr_GND, 0x12, 0xF0);
    IS_IIC_WriteByte(Addr_GND, 0x13, 0x80);

    //out2 color
    IS_IIC_WriteByte(Addr_GND, 0x14, 0x80);
    IS_IIC_WriteByte(Addr_GND, 0x15, 0xF0);
    IS_IIC_WriteByte(Addr_GND, 0x16, 0x00);

    //out3 color
    IS_IIC_WriteByte(Addr_GND, 0x17, 0x40);
    IS_IIC_WriteByte(Addr_GND, 0x18, 0xF0);
    IS_IIC_WriteByte(Addr_GND, 0x19, 0x80);

    //Pattern time and cycle
    IS_IIC_WriteByte(Addr_GND, 0x22, 0x66);
    IS_IIC_WriteByte(Addr_GND, 0x23, 0x66);
    IS_IIC_WriteByte(Addr_GND, 0x24, 0x66);

    //loop setting
    IS_IIC_WriteByte(Addr_GND, 0x27, 0x07);
    IS_IIC_WriteByte(Addr_GND, 0x28, 0x15);
    IS_IIC_WriteByte(Addr_GND, 0x29, 0x00);
    IS_IIC_WriteByte(Addr_GND, 0x2A, 0x00);

    //Crossfade setting
    IS_IIC_WriteByte(Addr_GND, 0x26, 0x06);

    //update
```

## CHARGE PUMP RGBW LED DRIVER WITH PROGRAMMABLE SELF-RUNNING PATTERNS EVALUATION BOARD GUIDE

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```
IS_IIC_WriteByte(Addr_GND,0x2B,0x00);  
IS_IIC_WriteByte(Addr_GND,0x2C,0x00);  
IS_IIC_WriteByte(Addr_GND,0x2D,0x00);  
  
IS_IIC_WriteByte(Addr_GND,0x25,0x07);  
  
}
```