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 diming 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

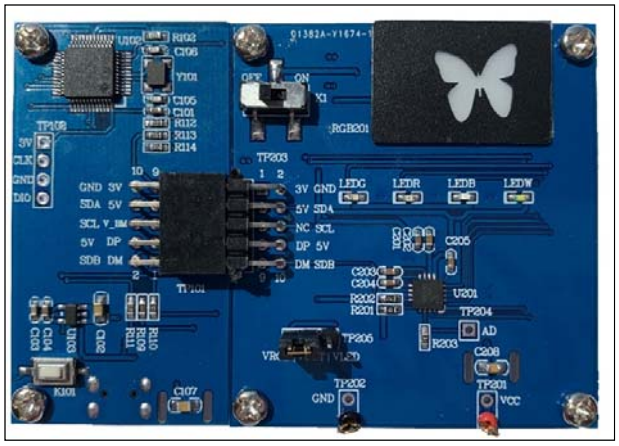

Figure 1: Photo of IS31FL3197-QFLS2 Evaluation Board

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_A = -40°C ~ +85°C

RECOMMENDED EQUIPMENT

- Micro USB power supply
- CR2032 battery

ABSOLUTE MAXIMUM RATINGS

- V_{CC} ≤ 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 contacts Lumissil's analog marketing team at analog@Lumissil.com or (408) 969-6600.

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.

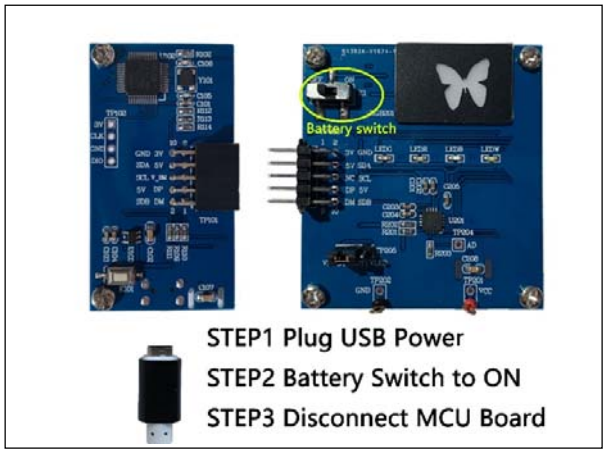

Figure 2: RGBW Board disconnect from MCU board

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. Also download the Wire.h library from 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.

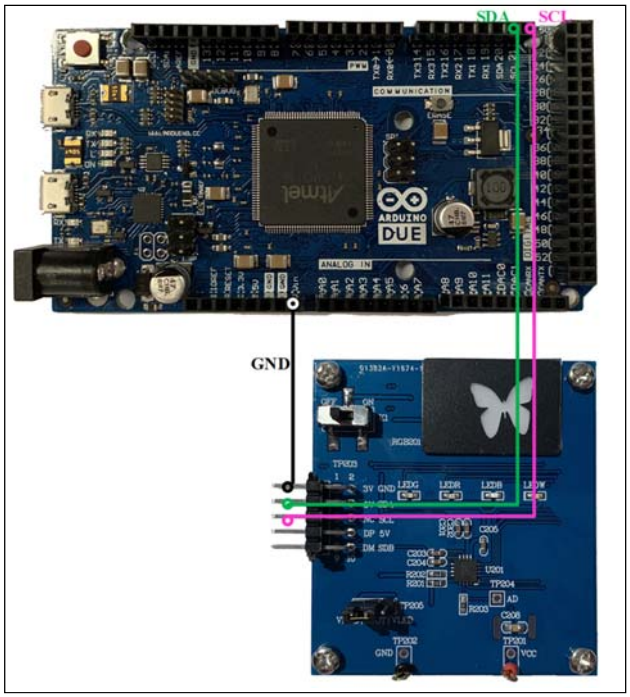

Figure 3: Arduino DUE connect to RGBW Board

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.

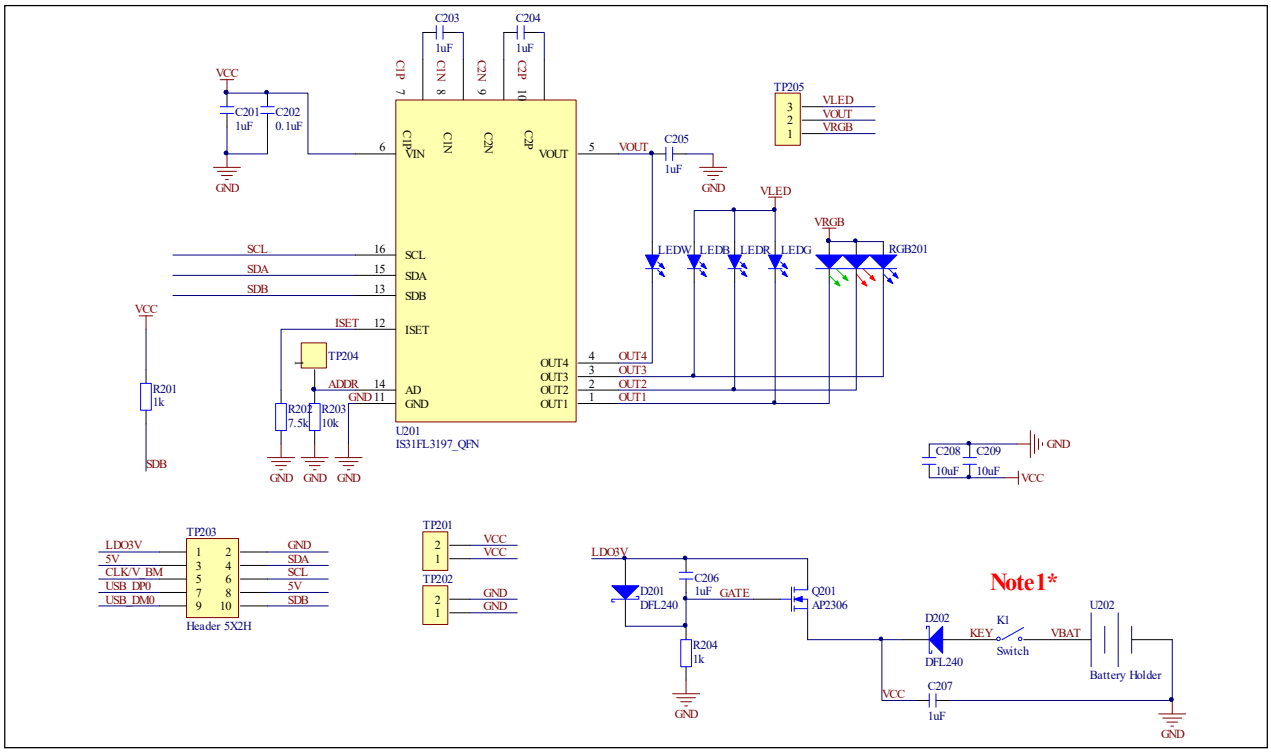

Figure 4: IS31FL3197 RGBW Board Schematic

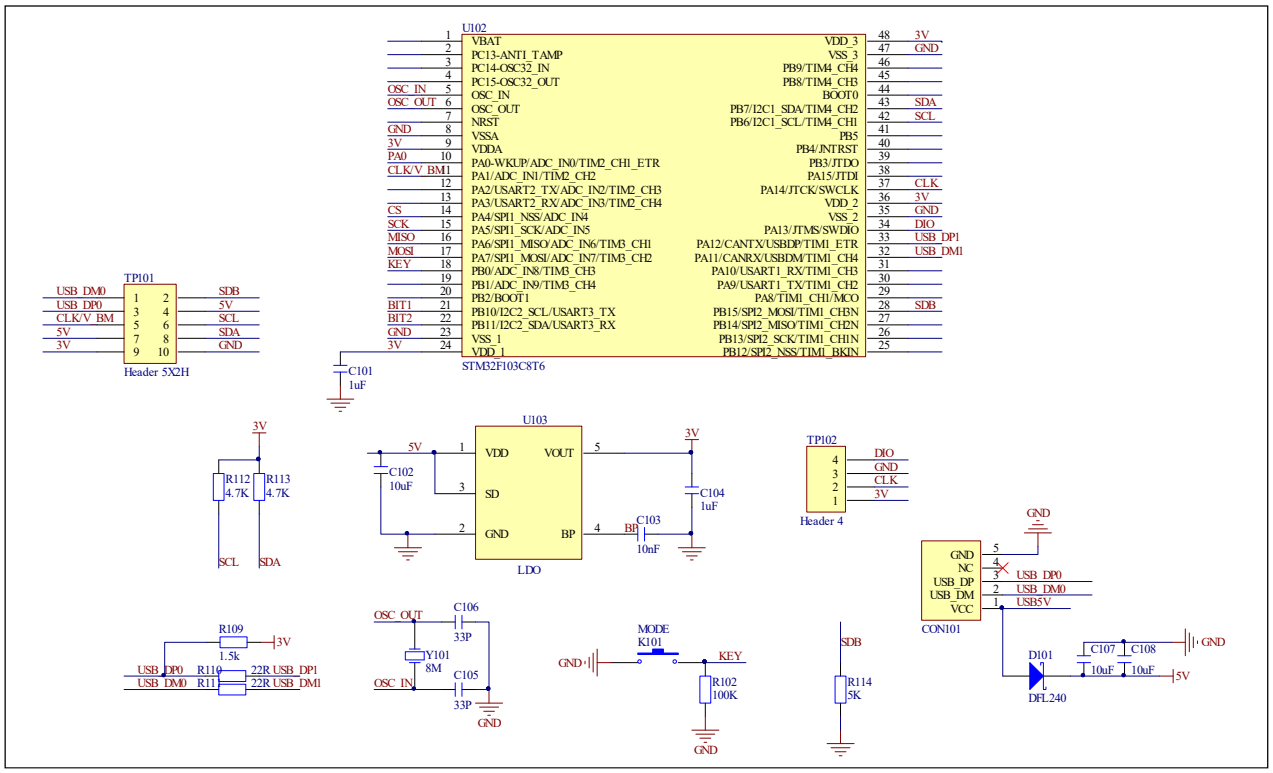

Figure 5: MCU Board Schematic

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 MOSFETs	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-A23/2D
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.

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, 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.

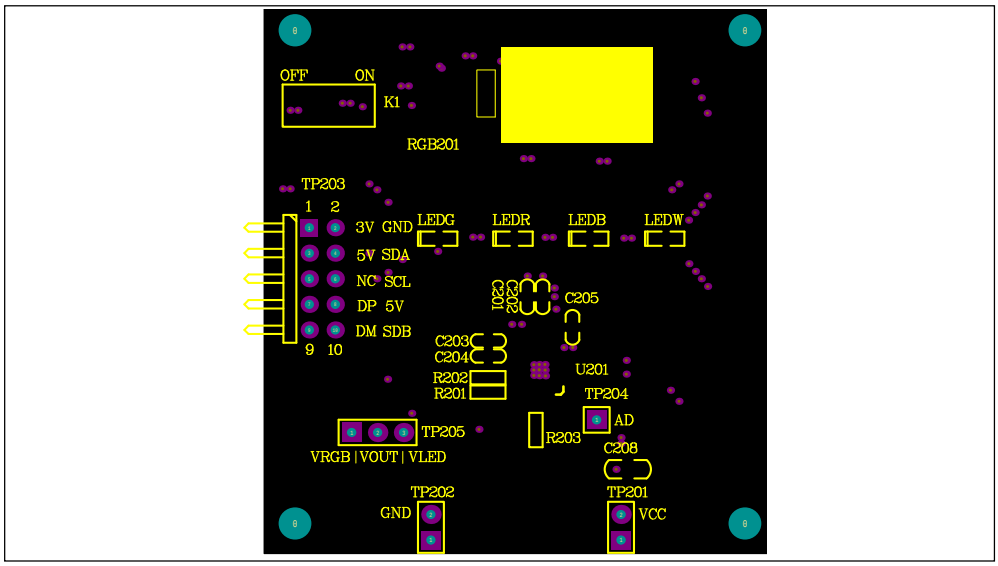

Figure 6: Board Component Placement Guide - Top Layer

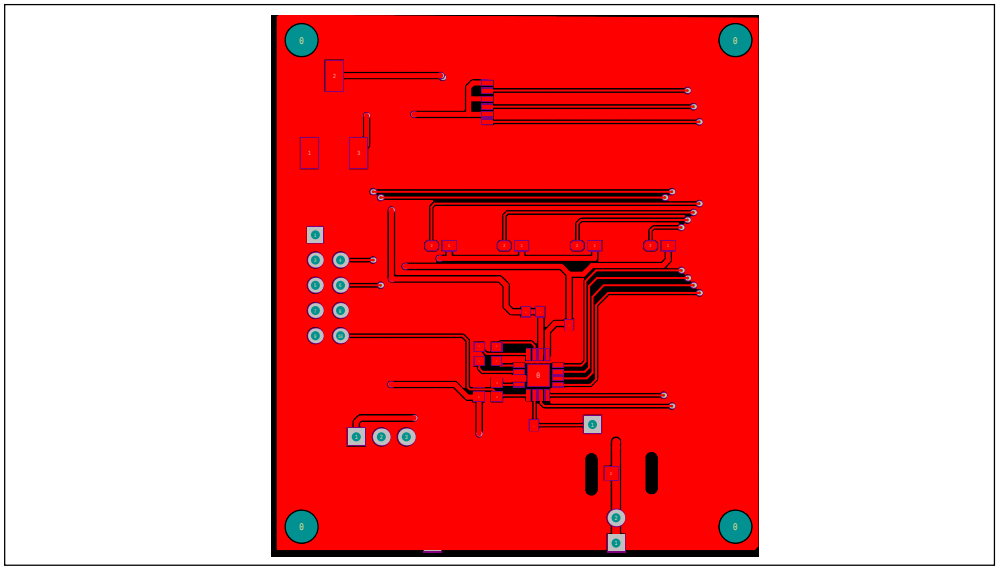

Figure 7: Board PCB Layout - Top Layer

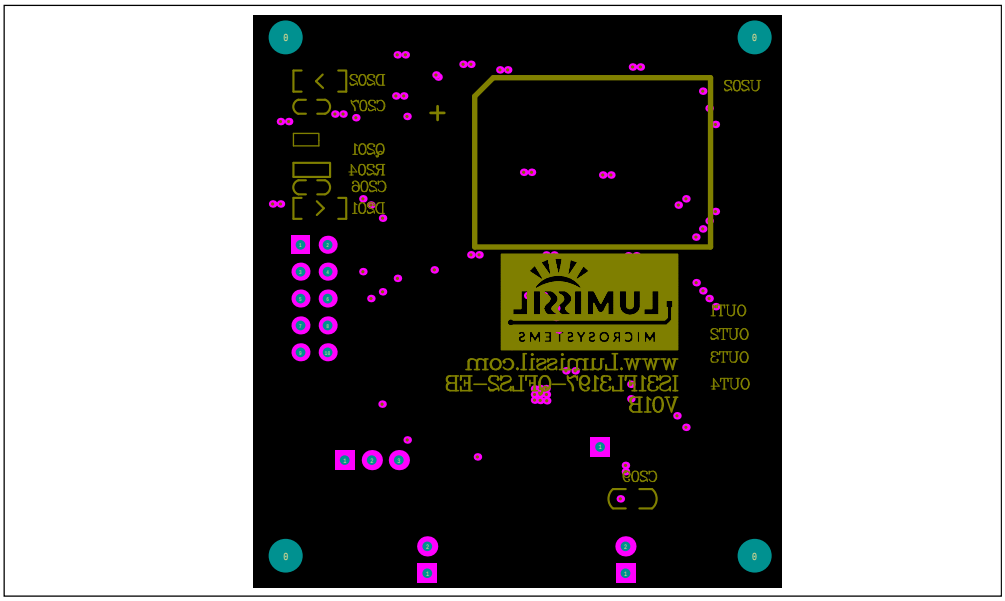

Figure 8: Board Component Placement Guide - Bottom Layer

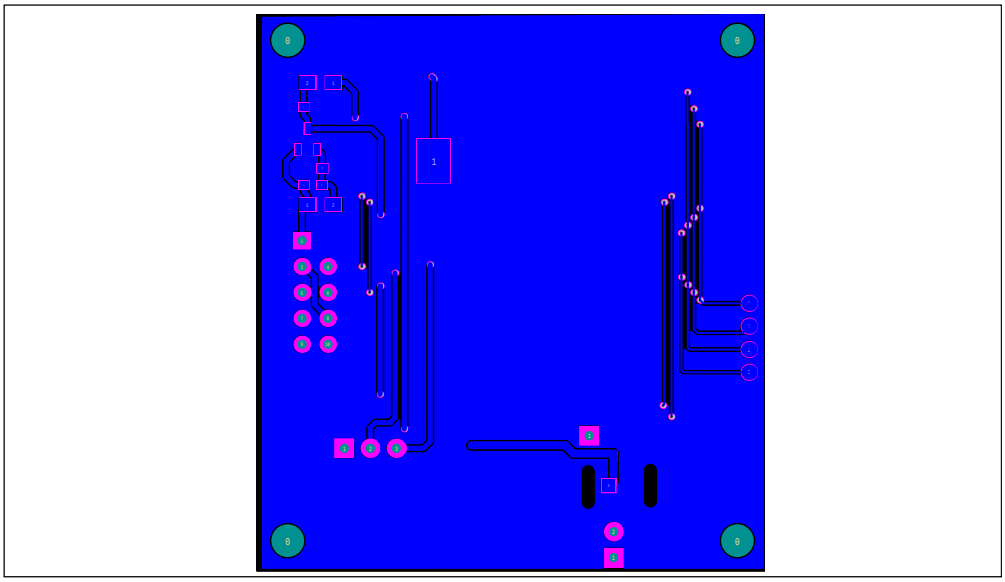

Figure 9: Board PCB Layout - Bottom Layer

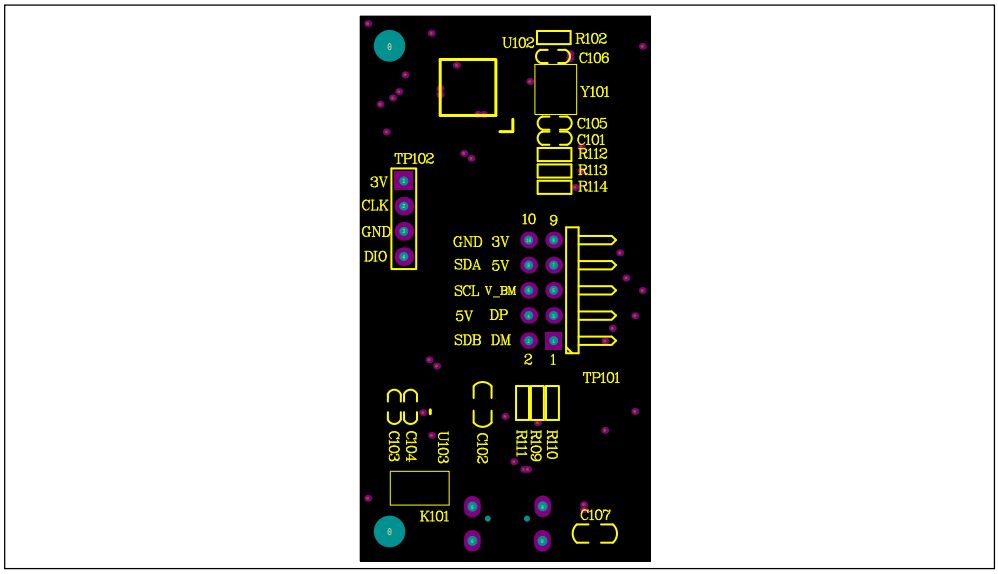

Figure 10: Board Component Placement Guide - Top Layer

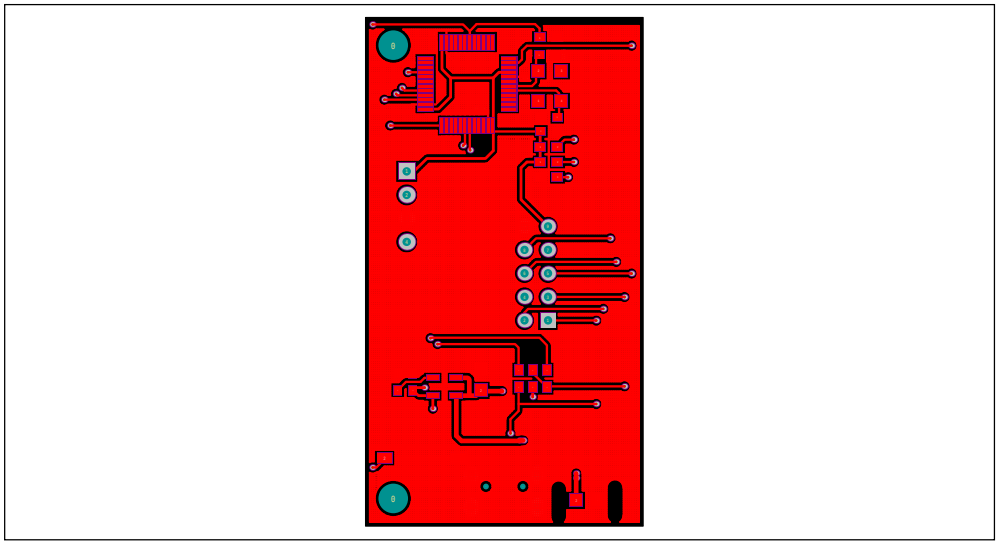

Figure 11: Board PCB Layout - Top Layer

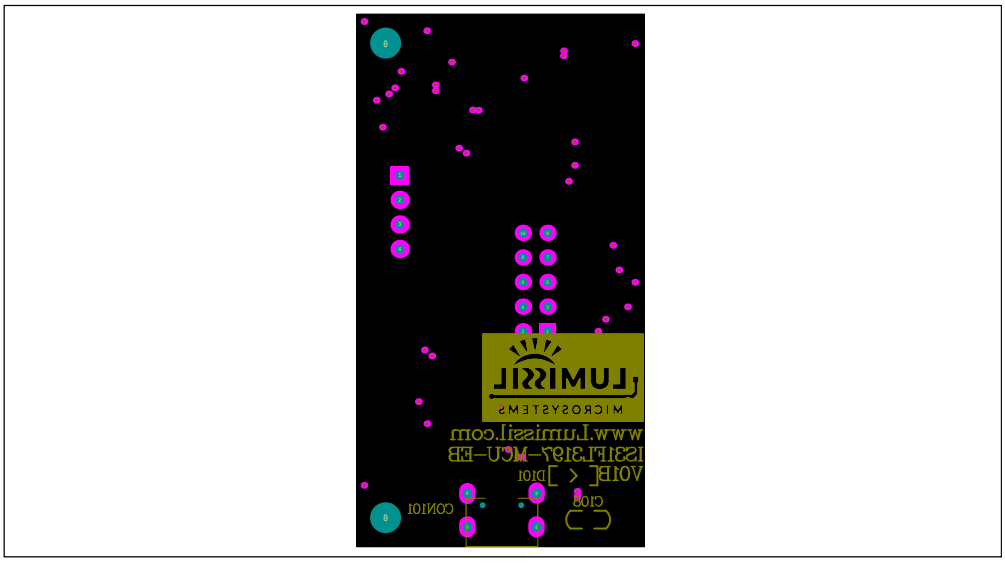

Figure 12: Board Component Placement Guide - Bottom Layer

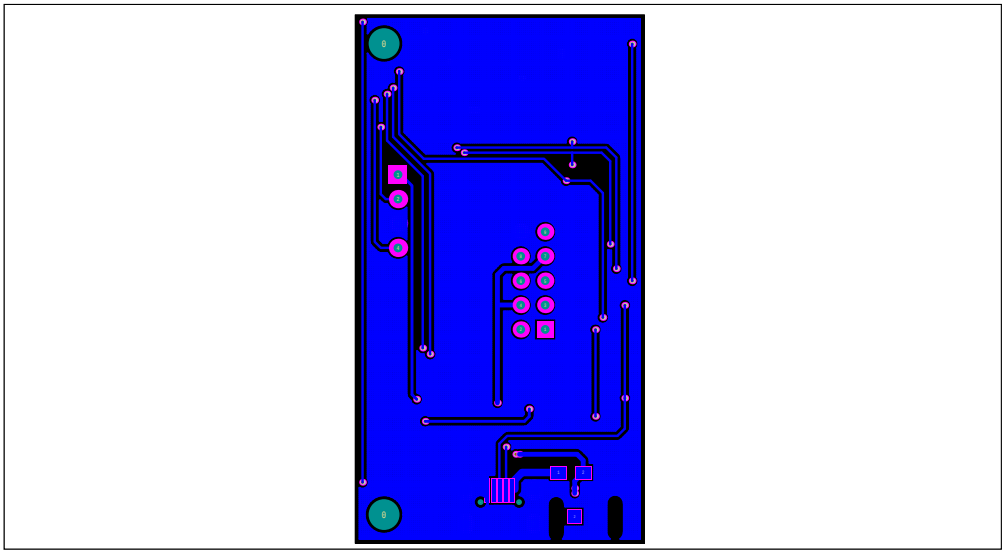

Figure 13: Board PCB Layout - Bottom Layer

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a.) the risk of injury or damage has been minimized;
b.) the user assume all such risks; and
c.) potential liability of Lumissil Microsystems is adequately protected under the circumstances

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);


   //Pettern 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);

   //updata
```