DESCRIPTION

The IS31LT3138 is a linear programmable current regulator consisting of 18 output channels capable of up to 100mA each. It has a UART interface compatible with CANFD PHY for communication with a master microcontroller or ECU. It uses a command and response protocol mastered by the host microcontroller to read and write the registers to and from one or multiple IS31LT3138 devices.

Each output can individually support 12-bit PWM dimming and 7-bit DC current adjustment. The outputs can be combined to provide higher current drive capability to max 1.8A.

For added system reliability, the IS31LT3138 integrates fault detection circuitry for open/short string, single LED short, and over temperature conditions. Faults are recorded in registers which can be accessed by an external MCU. To optimize EMI performance, the IS31LT3138 features spread spectrum on the internal PWM and LED channel outputs have programmable slew rate control and phase delay to mitigate EMI and power supply inrush current.

QUICK START

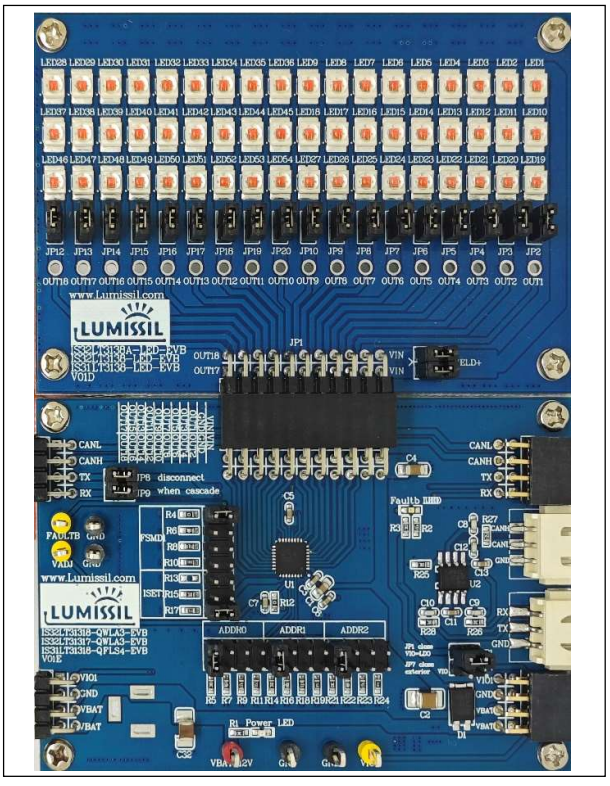

Figure 1: Photo of IS31LT3138- Evaluation Board

FEATURES

- Wide input voltage supply from 4.5V to 16V
- Maximum output voltage 16V
- UART Communication Interface
  - UART interface compatible with CANFD physical layer, 1MHz maximum.
  - UART communication with CRC to ensure robustness of communication
  - Support up to max. 64 addressable devices
  - Watch dog timer
  - Support Fail safe mode
- 18 channels capable of 100mA each
  - ±4.5% @ 100mA bit-to-bit output current mismatch
  - ±5% @ 100mA device-to-device output current accuracy
- Combined for higher current capability with same current accuracy
  - Minimum headroom voltage of 0.5V (Max.) at 100mA
- Individual PWM dimming to each channel
  - 4096 steps (12-bit) PWM duty cycle setting
    - 7+5-bit at 24kHz
    - 12-bit at 244Hz
    - 8-bit at 24kHz
  - Phase delay minimizes inrush current (6 groups)
- Slew rate control and spread spectrum optimize EMI performance
- 64 steps (6-bit) global current setting
- Individual 128 steps (7-bit) DC current adjustment to each channel
- DC Binning support (ADJR pin)
- Fault protection with reporting
  - Fail safe modes selection
  - LED string open/short detect
  - Single LED short detect
  - Programmable fault reporting delay time
  - Programmable over temperature current roll off
  - Thermal shutdown
  - CRC error detection
  - ISET short to GND
- Operating temperature range (-40°C ~ +125°C)
- QFN-32 (5mm×5mm) package
- RoHS & Halogen-Free Compliance
- TSCA Compliance

RECOMMENDED EQUIPMENT

- 12.0V, 3A power supply

ABSOLUTE MAXIMUM RATINGS

- ≤ 20V power supply

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

ORDERING INFORMATION

Part No.	Temperature Range	Package
IS31LT3138-QFLS4-EB	-40°C to +125°C (Industrial)	QFN-32, 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 IS31LT3138 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.

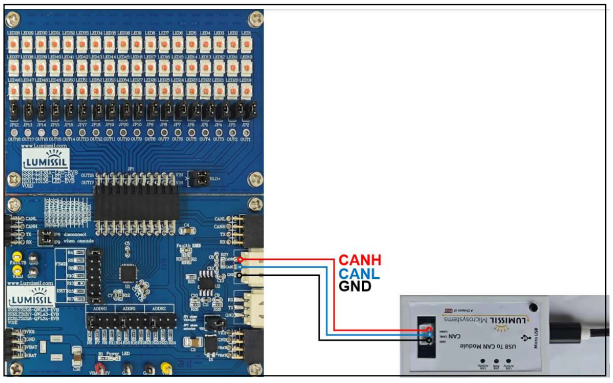

Figure 2: Photo of CAN Module Connected to Evaluation Board

1) Short JP1 header, short FSMD R4 (0Ω) header, short ISET R17 (33kΩ) header
2) Cascade open JP8 and JP9 header, otherwise please short them
3) Short ADDR0 R5 (10kΩ), ADDR1 R14 (10kΩ), ADDR2 R21 (10kΩ) header
4) LED board short LED power header
5) LED board short JP1~JP9, short JP37~JP45 header
6) Connect the 12V DC power to VBAT / GND header or plug in the 12V Power adapter input to Power adapter interface (CN 12V).
7) Connect the EVB CANH, CANL, GND header to CAN Module CANH, CANL and GND header
8) Turn on the power supply. If the EVB no response, please check for circuit fault.

EVALUATION BOARD OPERATION

The IS31LT3138 ADDR0, ADDR1, ADDR2 for the device address to select jumpers, through different combinations can be set different device addresses, the default device address is 0x80 (R5, R14, R21). ISET is IS31LT3138 current setting item, R15 (10kΩ) corresponding to the channel output maximum 100mA current, R17 (33kΩ) corresponding to the channel output maximum 30mA current, the default connection to R17. FSMD is the IS31LT3138 fail-safe mode selection, the default connection R4 (0Ω) is normal mode, R6, R8, R10 is different FSMD mode. Short R6 the device will enter fail-safe Mode 1 and the outputs will be determined by the DEFAULT registers (07h~13h). Short R8 the device will enter fail-safe Mode 2 and all outputs will be forced into completely off. Short R10 the device will enter fail-safe Mode 3 and all outputs will be forced into fully on (with 98% PWM duty cycle).

SOFTWARE SUPPORT

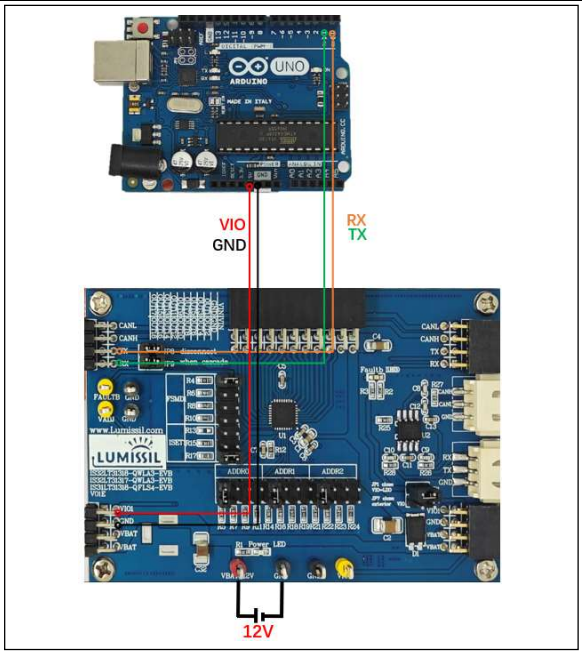

Figure 3: Photo of Arduino UNO Connected to Evaluation Board

The steps listed below are an example of using the Arduino for 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 IS31LT3138 test firmware (sketch) from the Lumissil website http://www.lumissil.com/products/led-driver/fxled.

1) Connect the 4 pins from Arduino board to IS31LT3138 EVB:
   a) Arduino GND to IS31LT3138 EVB GND.
   b) Arduino TX (1) to IS31LT3138 EVB RX.
   c) Arduino RX (0) to IS31LT3138 EVB TX.
   d) Short JP1, open JP7 header. (LDO = VIO).
   e) If Arduino uses 3.3V MCU VCC, connect 3.3V to IS31LT3138 EVB VIO, if Arduino use 5.0V MCU VCC, connect 5.0V to EVB VIO. (Arduino UNO MCU VCC is 5V, so VIO can be 5V)
2) Use the test code in appendix I or download the test firmware (sketch) from the Lumissil website, a.txt file and copy the code to Arduino IDE, compile, and upload to Arduino.
   f) Run the Arduino code as appendix I.
   g) In EVB code, the ADDR (ADDR0, ADDR1, ADDR2) pin is all pulled low via 10kΩ, so the device address is 0x80. When the Different combinations result in different device addresses, the specific combinations are shown in the datasheet table.

Please refer to the datasheet to get more information about IS31LT3138.

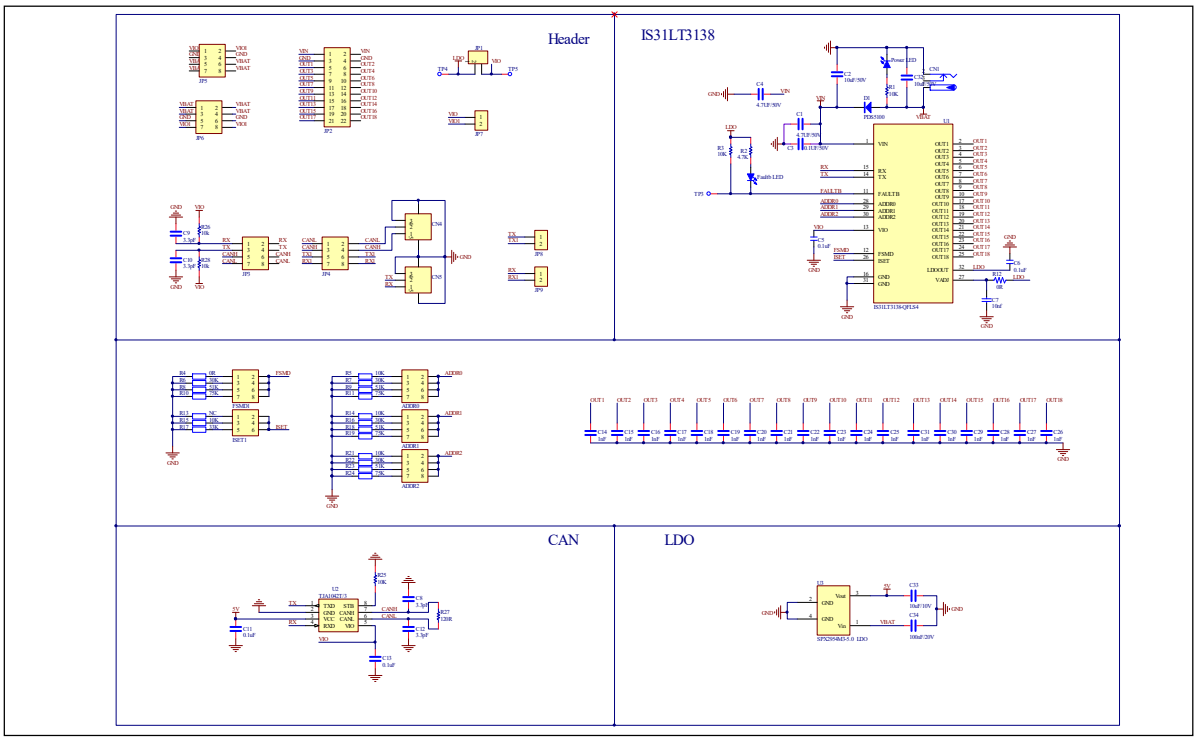

Figure 4: IS31LT3138-QFLS4 Application Schematic

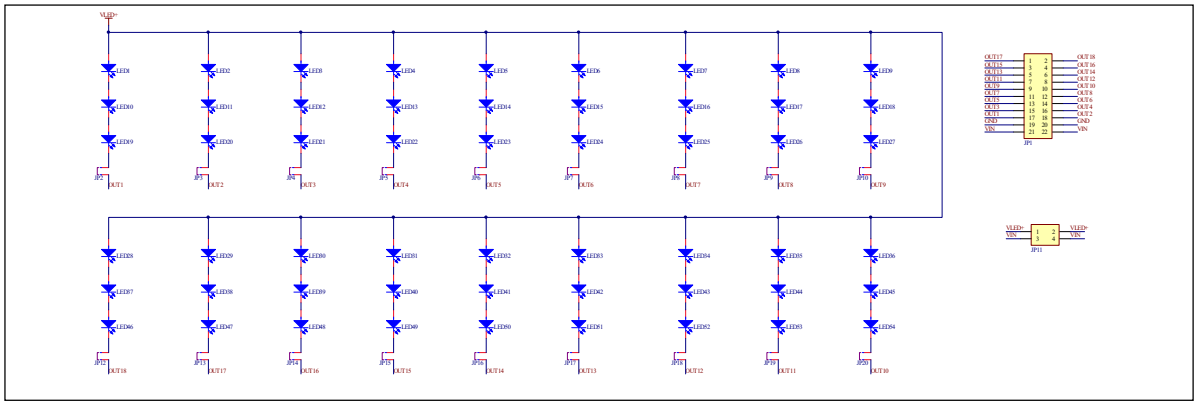

Figure 5: 18 channel LED Application Schematic

BILL OF MATERIALS

Name	Symbol	Description	Qty	Supplier	Part No.
LED Driver	U1	18 channel-LED Driver	1	Lumissil	IS31LT3138
CAN Transceive	U2	Transceiver	1	NXP	TJA1042T/3
LDO	U3	LDO	1	MaxLinear	SPX2954M3-5.0
Schottky Diodes	D1	Diode,5A,100V, PowerDI-5	1	DIODES	PDS5100
DC power Outlet	CN1	DC-005, 12V	1	CIKI	DC-005-A
Connector	CN4, CN5	CAN Connector, XH2.54	2	XUNPU	WAFER-XH2.54-3PWB
Resistor	R1,R3,R5, R14,R15,R21, R25,R26,R28	RES,10k,1/16W, ±5%, SMD	9	Yageo	RC0603JR-072KL
Resistor	R2	RES,4.7k,1/16W, ±5%, SMD	1	Yageo	RC0603JR-074K7KL
Resistor	R4, R12	RES,0R,1/16W, ±5%, SMD	2	Yageo	RC0603JR-0700RL
Resistor	R13	NC	1		
Resistor	R6, R7, R16, R22	RES,30k,1/16W, ±1%, SMD	4	Yageo	RC0603JR-0730KL
Resistor	R17	RES,33k,1/10W, ±1%, SMD	1	Yageo	RC0603JR-0733KL
Resistor	R8, R9, R18, R23	RES,51k,1/10W, ±1%, SMD	4	Yageo	RC0603JR-0751KL
Resistor	R10, R11, R19, R24	RES,75k,1/10W, ±1%, SMD	4	Yageo	RC0603JR-0775KL
Resistor	R27	RES,120R,1/10W, ±5%, SMD	1	Yageo	RC0603JR-07120RL
Capacitor	C8, C9, C10, C12	CAP,3.3pF,50V, ±8%, SMD	4	Yageo	CQ0603CRNPO9BN3R3
Capacitor	C14~C31	CAP,1nF,16V, ±5%, SMD	18	Yageo	CC0603JRX7R7BB102
Capacitor	C7	CAP,10nF,16V, ±10%, SMD	1	Yageo	CC0603KRX7R7BB103
Capacitor	C3,C5,C6, C11,C13,C34	CAP,0.1μF,16V, ±20%, SMD	6	Yageo	CC0603MRX7R7BB104
Capacitor	C1	CAP,4.7μF,50V, ±20%, SMD	1	Yageo	CC0805KKX5R9BB475
Capacitor	C4	CAP,4.7μF,50V, ±10%, SMD	1	Yageo	CC1206KKX5R9BB475
Capacitor	C33	CAP,10μF,50V, ±20%, SMD	1	Yageo	CC0603MRX7R7BB105
Capacitor	C2, C32	CAP,4.7μF,50V, ±20%, SMD	2	Yageo	CC1210KFX7R9BB475
LED	FAULTB LED	Diode, LED Green, SMD	1	Everlight	19-213/GHC-YR1S2M/3T
LED	Power LED	Diode, LED Read, SMD	1	Everlight	19-213/R6C-AN2Q1B/3T

Bill of Materials, refer to Figure 3 above.

FxLED 3×18 NUM ARRAY

Name	Symbol	Description	Qty	Supplier	Part No.
LED	LED1~LED54	Diode, LED Yellow, SMD	54	LEIRI photoelectricity	C35Y590-120

Bill of Materials, refer to Figure 4 above.

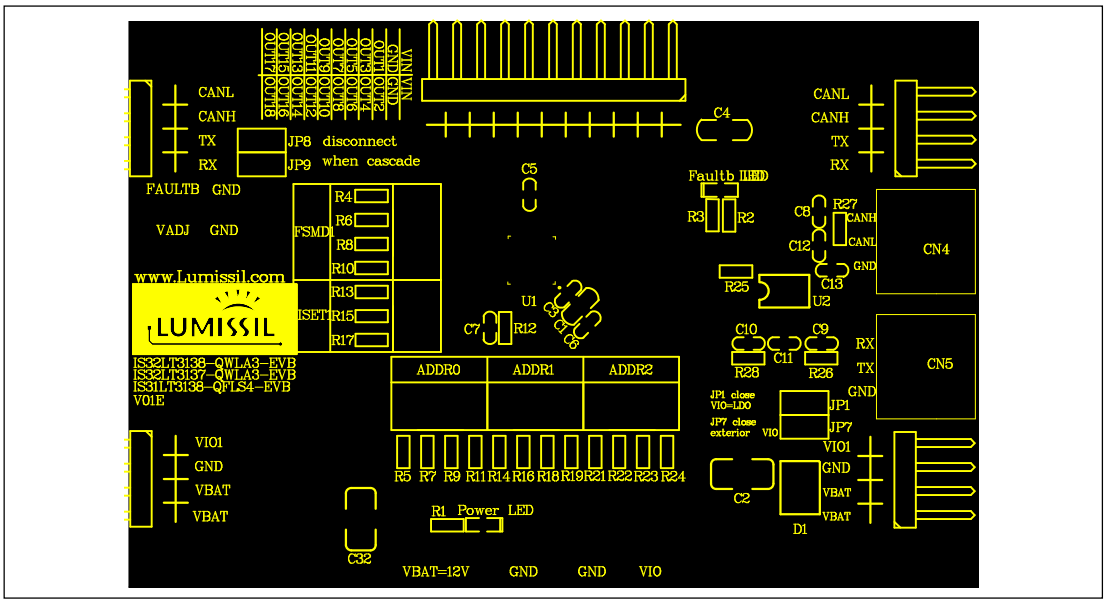

Figure 6: Board Component Placement Guide - Top Layer

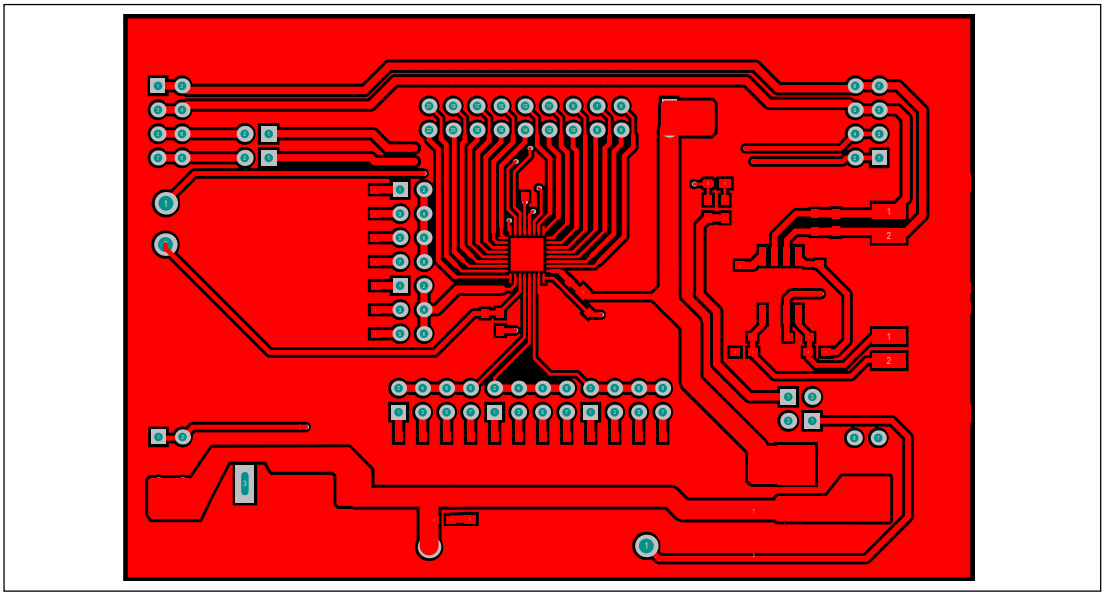

Figure 7: Board PCB Layout - Top Layer

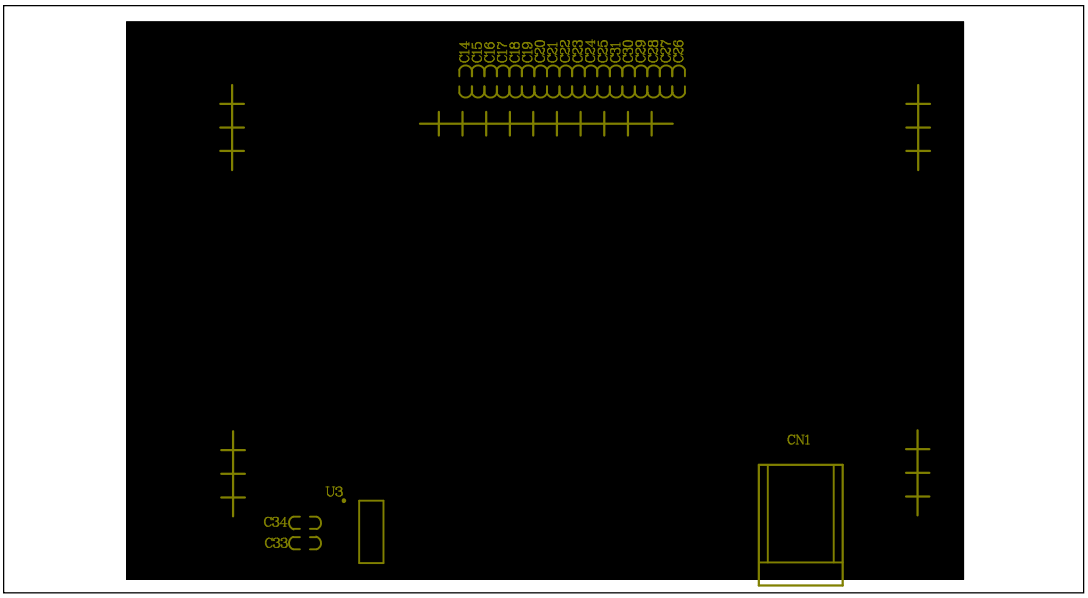

Figure 8: Board Component Placement Guide - Bottom Layer

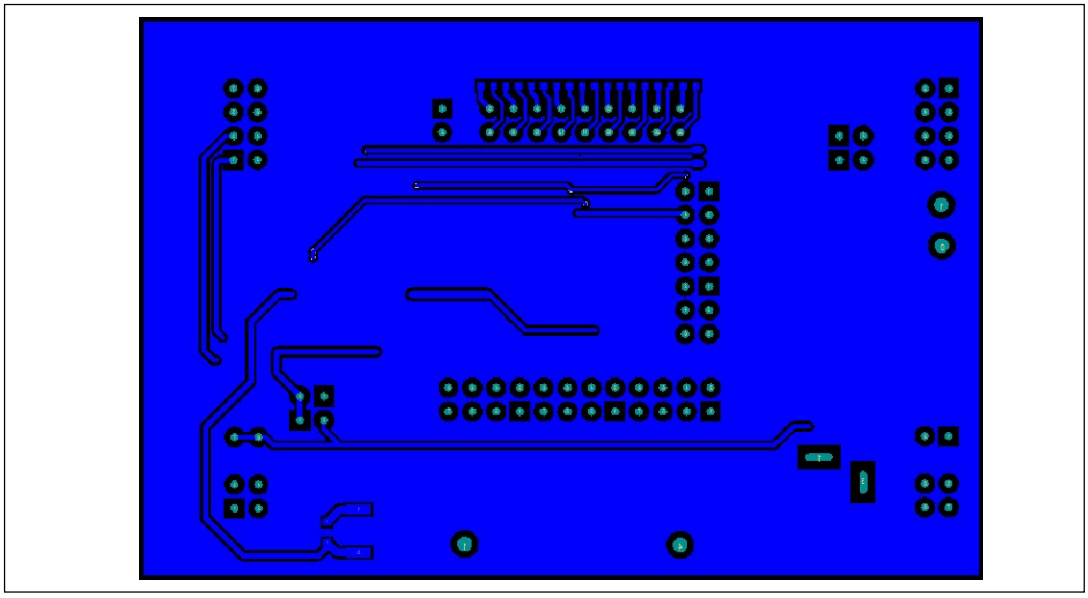

Figure 9: Board PCB Layout - Bottom Layer

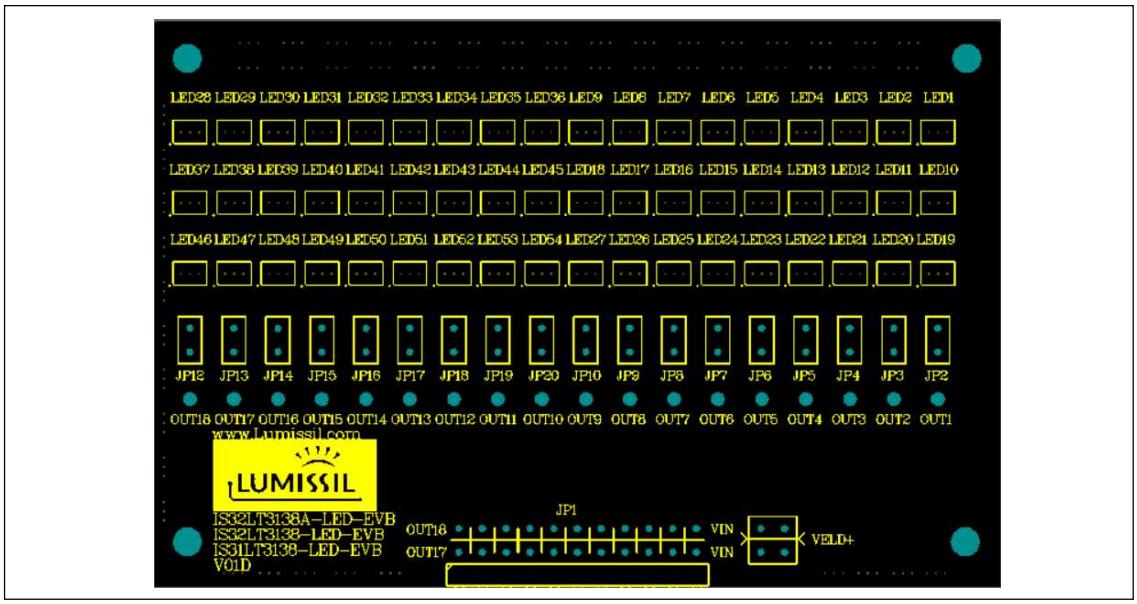

Figure 10: LED Board Component Placement Guide - Top Layer

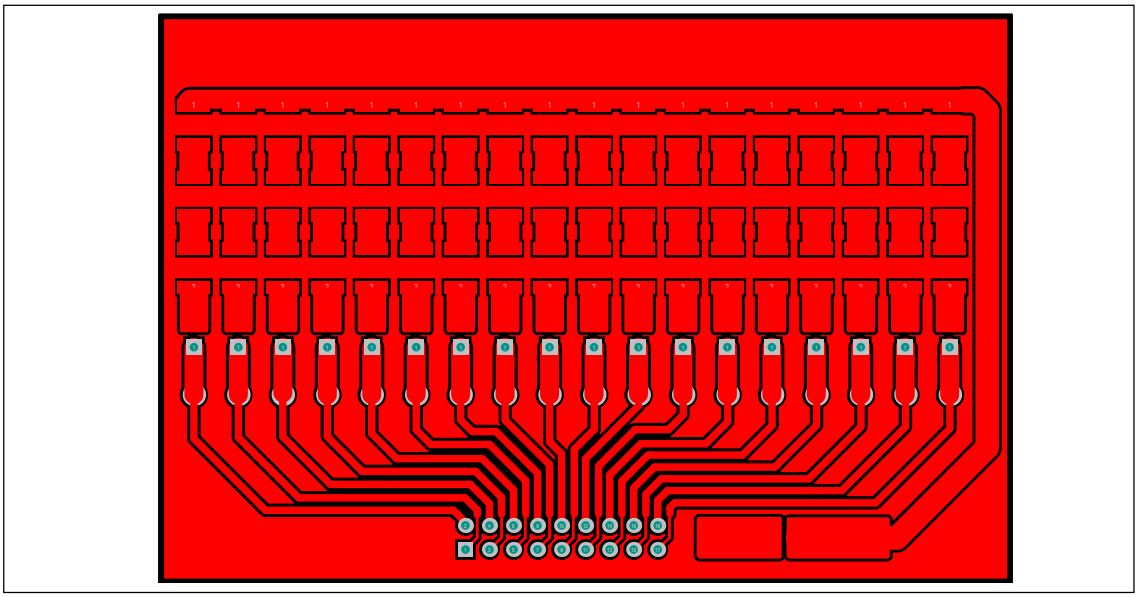

Figure 11: LED Board PCB Layout - Top Layer

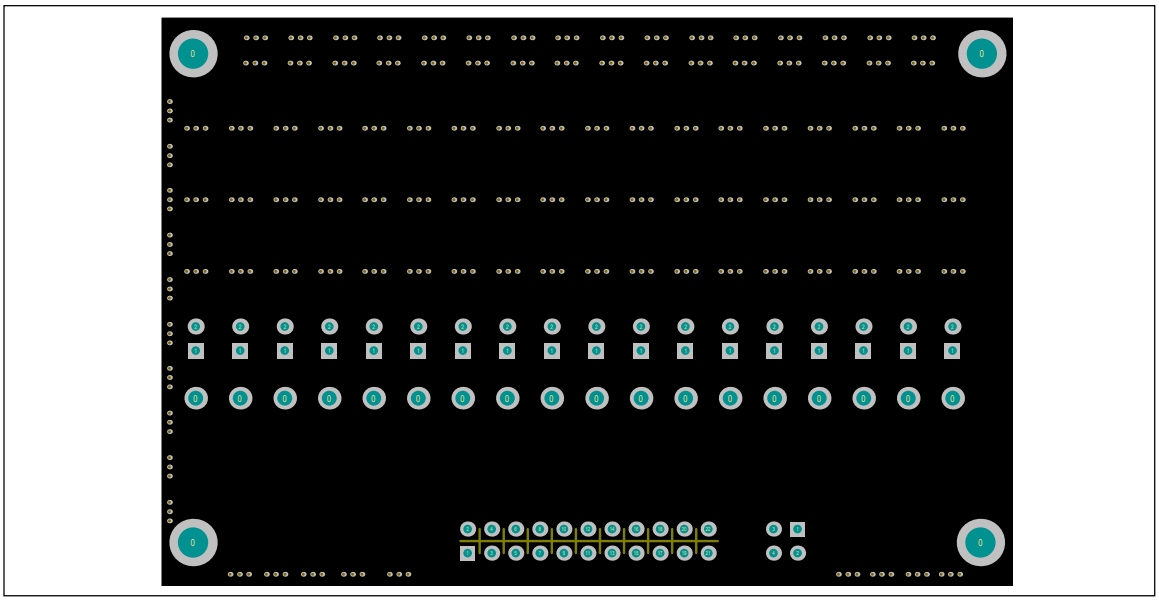

Figure 12: LED Board Component Placement Guide - Bottom Layer

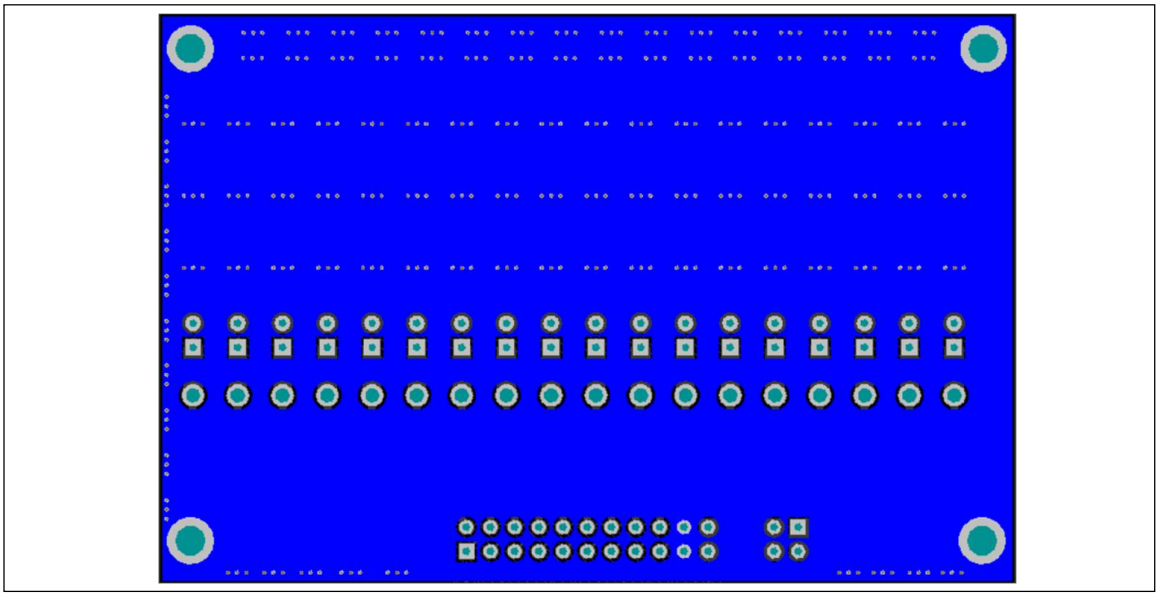

Figure 13: LED Board PCB Layout - Bottom Layer

REVISION HISTORY

Revision	Detail Information	Date
A	Initial release	2024.01.05

APPENDIX Ⅰ: IS31LT3138 Arduino Test Code V01A

```
#include<Wire.h>
#include<avr/pgmspace.h>
#define Addr_10K_10K_10K 0x80 //DeviceAddress
uint8_t i,j;
uint8_t send_table[6];
const PROGMEM byte PWM_Gama64[48]=
{
0x00,0x01,0x02,0x03,0x04,0x05,0x06,0x07,
0x08,0x09,0x0b,0x0d,0x0f,0x11,0x13,0x16,
0x1a,0x1c,0x1d,0x1f,0x22,0x25,0x28,0x2e,
0x34,0x38,0x3c,0x40,0x44,0x48,0x4b,0x4f,
0x55,0x5a,0x5f,0x64,0x69,0x6d,0x72,0x77,
0x7d,0x80,0x88,0x8d,0x94,0x9a,0xa0,0xa7,
};
void setup()
{
   Bus_reset();
   Init_3138();
}
void loop()
{
IS31LT3138_Test_mode1();//breath mode
}

void Bus_reset(void)
{
   pinMode(1,OUTPUT);
   digitalWrite(1,LOW);
   delay(1); //delay 1s,Reset Signal>150us is OK
   Serial.begin(115200);//UART 115200
   send_table[0] = 0X55;
   Serial.write(send_table,1);
}
uint16_t crc_16_ibm (uint8_t *buf, uint8_t len)//CRC calibration
{
   uint16_t crc = 0;
   uint16_t I;
   while (len--)
   {
      crc ^= *buf++;
      for (I = 0; I < 8; I++)
      {
         crc = (crc >> 1) ^ ((crc & 1) ? 0xa001 : 0);
      }
```

```
  }
  return crc;
}
void Update(void)
{
  uint16_t crc;
  send_table[0] = 0X98;
  send_table[1] = 0X80;
  crc = crc_16_ibm(send_table,2);
  send_table[2] = (uint8_t)crc;
  send_table[3] = (uint8_t)(crc>>8);
  Serial.write(send_table,4);
}
void URAT_WriteByte(int DeviceAddress, int WriteAddress, int SendByte)//URAT agreement
{
  uint16_t crc;
  send_table[0]=0X80;
  send_table[1]=DeviceAddress;
  send_table[2]=WriteAddress;
  send_table[3]=SendByte;
  crc = crc_16_ibm(send_table,4);
  send_table[4] = (uint8_t)crc;
  send_table[5] = (uint8_t)(crc>>8);
  Serial.write(send_table,6);
}
void Init_3138(void)
{
  URAT_WriteByte(Addr_10K_10K_10K,0x01,0x3f);// set GCC
   for(i=0x14;i<0x26;i++)
 {
  URAT_WriteByte(Addr_10K_10K_10K,i,0x7f);//set SL
 }
  Update();
}
void IS31LT3138_Test_mode1(void)//breath mode
{
  for (j=0;j<48;j++)//all LED ramping up
  {
  for(i=0x26;i<0x40;i+=3)
  {
   URAT_WriteByte(Addr_10K_10K_10K,i,pgm_read_byte_near(&PWM_Gama64[j]));//set all PWM
   URAT_WriteByte(Addr_10K_10K_10K,i+1,pgm_read_byte_near(&PWM_Gama64[j]));//set all PWM
   URAT_WriteByte(Addr_10K_10K_10K,i+2,pgm_read_byte_near(&PWM_Gama64[j]));//set all PWM
  }
   Update();
   delay(30);//30ms
```

```
  }

 delay(500);//keep on 500ms

 for (j=48;j>0;j--)//all LED ramping down
 {
 for(i=0x26;i<0x40;i+=3)
 {
    URAT_WriteByte(Addr_10K_10K_10K,i,pgm_read_byte_near(&PWM_Gama64[j-1]));//set all PWM
    URAT_WriteByte(Addr_10K_10K_10K,i+1,pgm_read_byte_near(&PWM_Gama64[j-1]));//set all PWM
    URAT_WriteByte(Addr_10K_10K_10K,i+2,pgm_read_byte_near(&PWM_Gama64[j-1]));//set all PWM
 }
    Update();
    delay(30);// 30ms
 }
}
```