Introduction

This demo board features six multi-channel RGB linear drivers: AL5887/AL5887Q (36 channels), AL58818/AL58818Q (18 channels), and AL58812/AL58812Q (12 channels). The main goal is to show vivid LED effects by communicating through a digitial interface (I2C or SPI). This demo board describes a built-in MCU with pre-loaded programming code to light up three separate rings of RGB LEDs independently, with the ability to select jumpers. Users may also hook up to their own LEDs through external connectors and the external interface connector to perform their own programming (refer to page 3 - Figure 3).

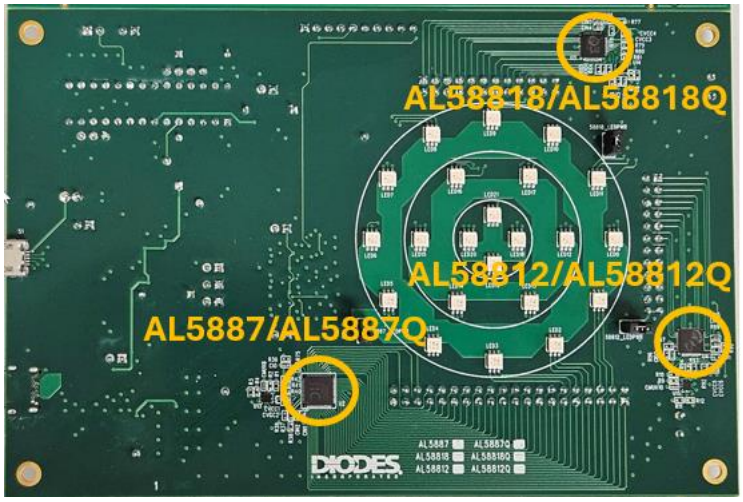


Figure 1: Top View of the Demo Board

General Description

The AL5887/AL5887Q, AL58818/AL58818Q, and AL58812/AL58812Q are comprised of 36/18/12 programmable LED current channels each with internal 12-bit PWM for color and brightness control through SPI or I2C digital interfaces. The devices are ideal for up to 12/6/4 RGB LED-module lighting applications, and have three programmable banks (A, B, C) for software control of each color. An external resistor can set up the global output current of all 36/18/12 channels. Each channel current can digitally be configured up to 70mA under the thermal limitation of the package.

Features of the AL5887/AL5887Q, AL58818/AL58818Q, and AL58812/AL58812Q are controlled via the SPI/I2C digital interface. A dedicated pin, INT_SEL, selects either the SPI or I2C protocols. The devices have a 30kHz, 12-bit PWM generator for each channel, as well as channel/module independent color-mixing and brightness-control registers to enable vivid LED effects with zero audible noise. Users can benefit from these devices' ultra-low shutdown IQ Power Saving Mode and easy software programming.

The device operates over the -40°C to +125°C ambient temperature range. The AL5887/AL5887Q are available in the wettable W-QFN6060-52/SWP (Type A1) package, and the AL58818/AL58818Q and AL58812/AL58812Q are available in W-QFN5050-40/SWP package.

Applications

- Automotive interior light
- Electric vehicle charging stations
- Infotainment displays
- Automotive tail lights
- Charge status indicator
- RGB LED lighting

Key Features

- 2.7 to 5.5V Operating supply voltage
- Maximum of up to 70mA per Channel Current
- OUT Pins Voltage Max. 5.5V
- Device to Device and Channel to Channel Current Accuracy: < 2% at 7mA to 70mA, and < 3.5% at 1mA to 7mA
- 12-Bit (4096 Steps), 30kHz PWM Generator Integrated for Each Channel
- PWM Phase Shifting
- 6-Bit Global Current Dimming
- Independent Color-Mixing Register per Channel
- Independent Brightness-Control Register per RGB Module

Hardware Description

The AL5887/AL5587Q, AL58818/AL58818Q, and AL58812/AL58812Q evaluation board is shown below:

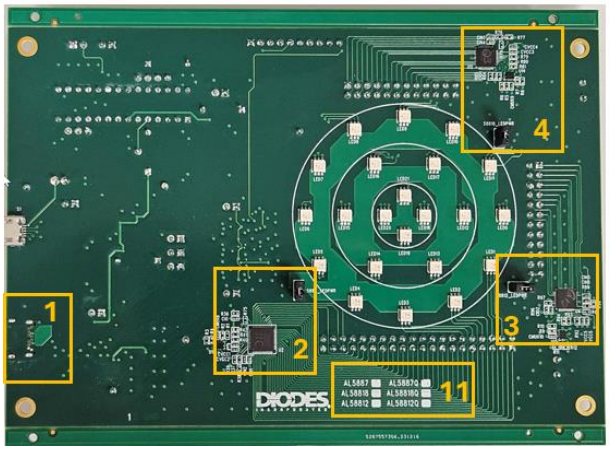


Figure 2: Top View

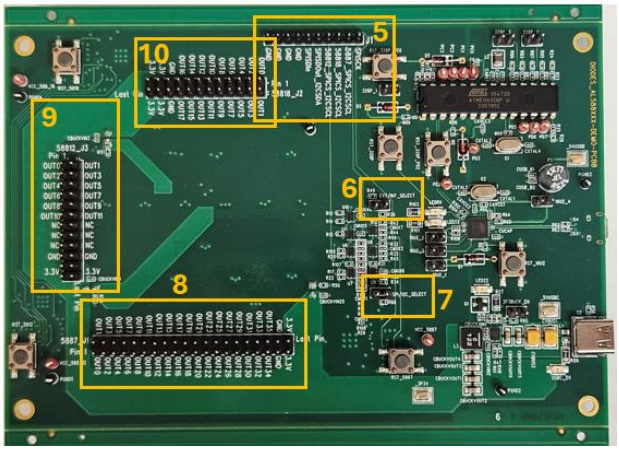
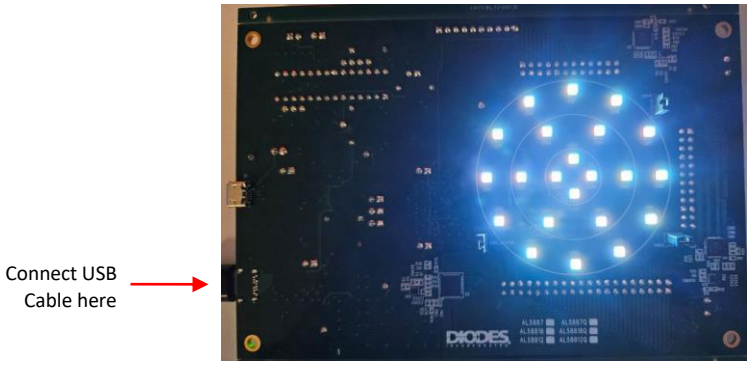


Figure 3: Bottom View

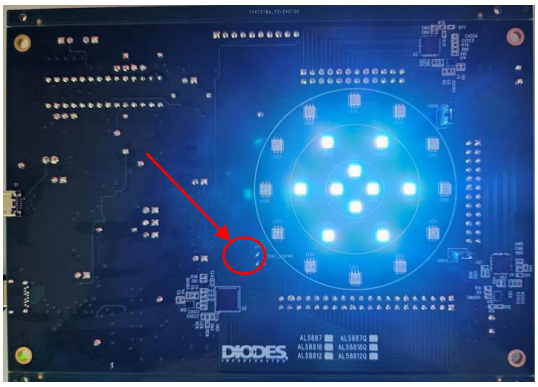
Section	Description
1	USB Type C connector for input power
2	AL5887/AL5887Q IC and jumper to disable/enable LEDs
3	AL58818/AL58818Q IC and jumper to disable/enable LEDs
4	AL58812/AL58812Q IC and jumper to disable/enable LEDs
5	External I2C/SPI interface connector
6	Ext/Int select interface jumper
7	SPI/I2C select interface jumper
8	External LEDs connector for AL5887/AL5887Q
9	External LEDs connector for AL58812/AL58812Q
10	External LEDs connector for AL58818/AL58818Q
11	Checkbox for different P/Ns

Quick Start Guide

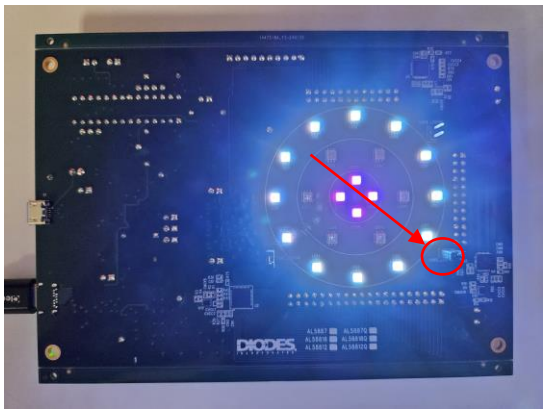
1. There is a built-in MCU onboard loaded with pre-assigned code to light up all the LEDs onboard.
2. Connect the USB interface (type C) cable to Box #1, as shown in Figure 1. Then all 3 rings of LEDs (22 RGB LEDs) will light up.



3. Remove the jumper in Box #2, as shown in Figure 1. This will disable the 12 RGB LEDs in the outer ring that is controlled by the AL5887/AL5887Q.

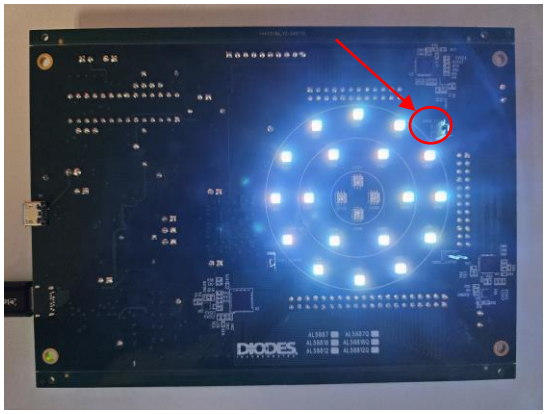


4. Remove the jumper in Box #3, as shown in Figure 1. This will disable the 6 RGB LEDs in the middle ring that is controlled by the AL58812/AL58812Q.



Quick Start Guide (continued)

5. Remove the jumper in Box #4, as shown in Figure 1. This will disable the 4 RGB LEDs in the inner ring that is controlled by the AL58818/AL58818Q.



6. If preferred, the user can connect their own LEDs to the AL5887/AL5887Q by using the external jumpers provided in Box #8, as shown in Figure 2 (remember to remove the jumper in Box #2 to disable onboard LEDs).
7. If preferred, the user can connect their own LEDs to the AL58812/AL58812Q by using the external jumpers provided in Box #9, as shown in Figure 2 (remember to remove the jumper in Box #3 to disable onboard LEDs).
8. If preferred, the user can connect their own LEDs to the AL58818/AL58818Q by using the external jumpers provided in Box #10, as shown in Figure 2 (remember to remove the jumper in Box #4 to disable onboard LEDs).

External I2C/SPI Interface Connection

1. Customers can connect their own I2C/SPI interface to communicate to the AL5887/AL5887Q, AL58818/AL58818Q, or AL58812/AL58812Q onboard through the external interface connector, as shown in Box #5 in Figure 2 (remember to insert the jumper shown in Box #6 and #7 to select either I2C or SPI). Example programming code is provided on page 8 for reference.

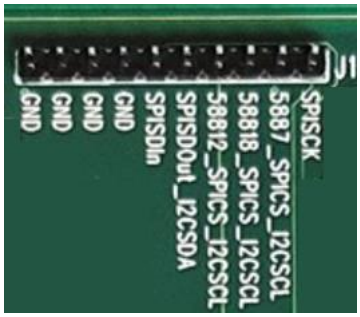


Figure 3: Box #5 - External I2C/SPI Connector Pinout

Evaluation Board Layout

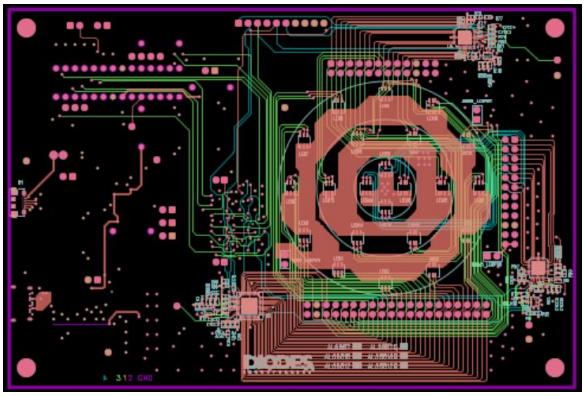


Figure 4: PCB Top Layer View

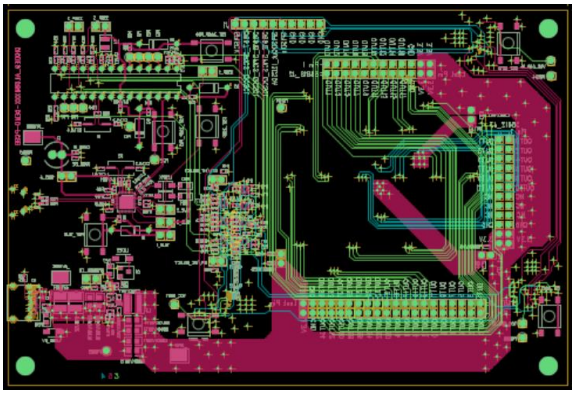
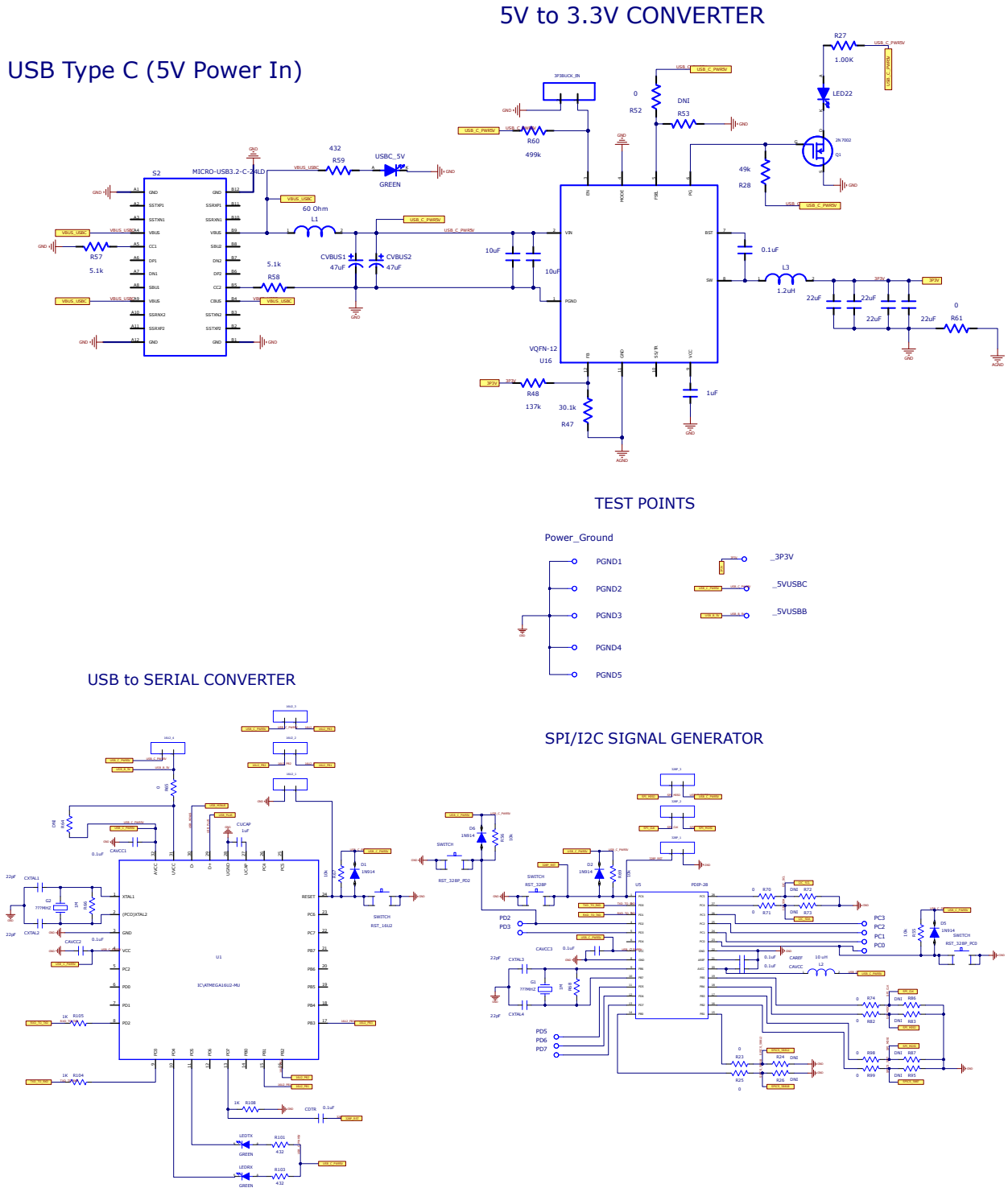


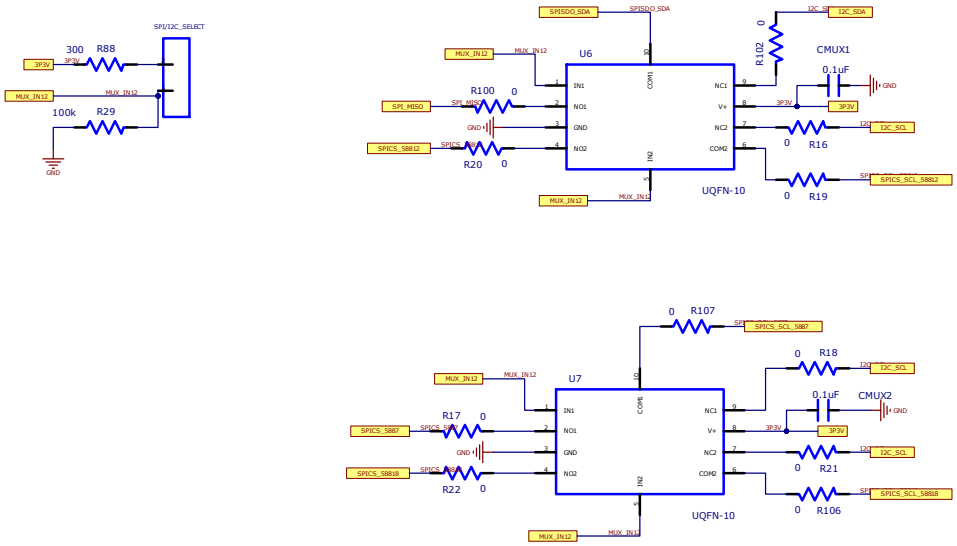
Figure 5: PCB Bottom Layer View

Schematic

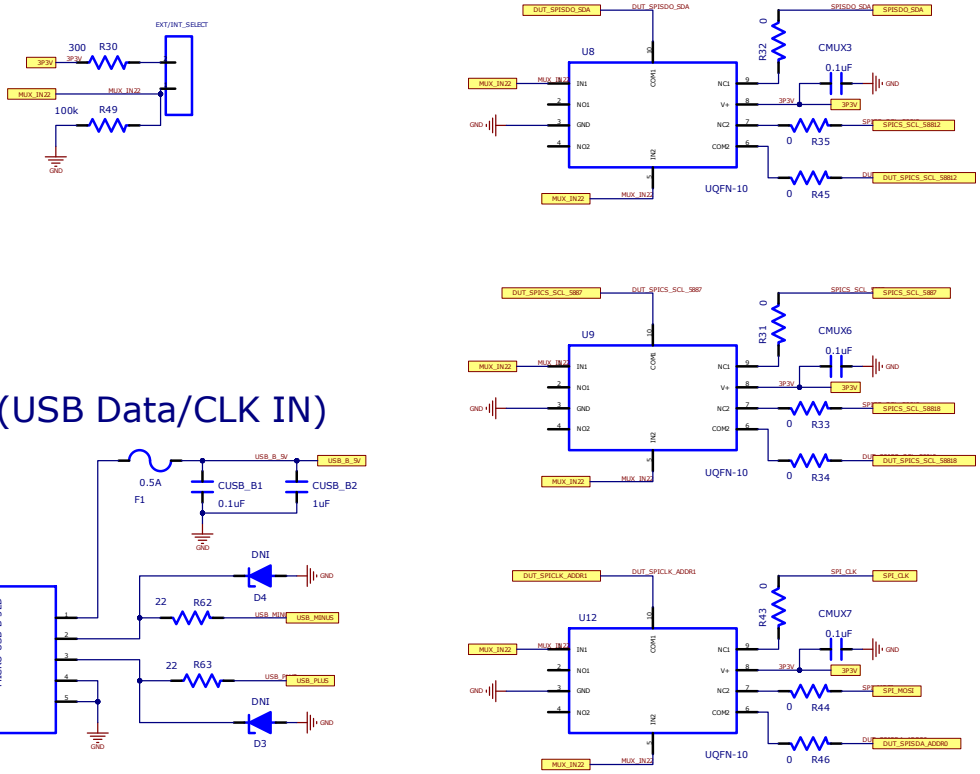


Schematic (continued)

SPI/I2C COMMS SELECTION MUXES/JUMPER

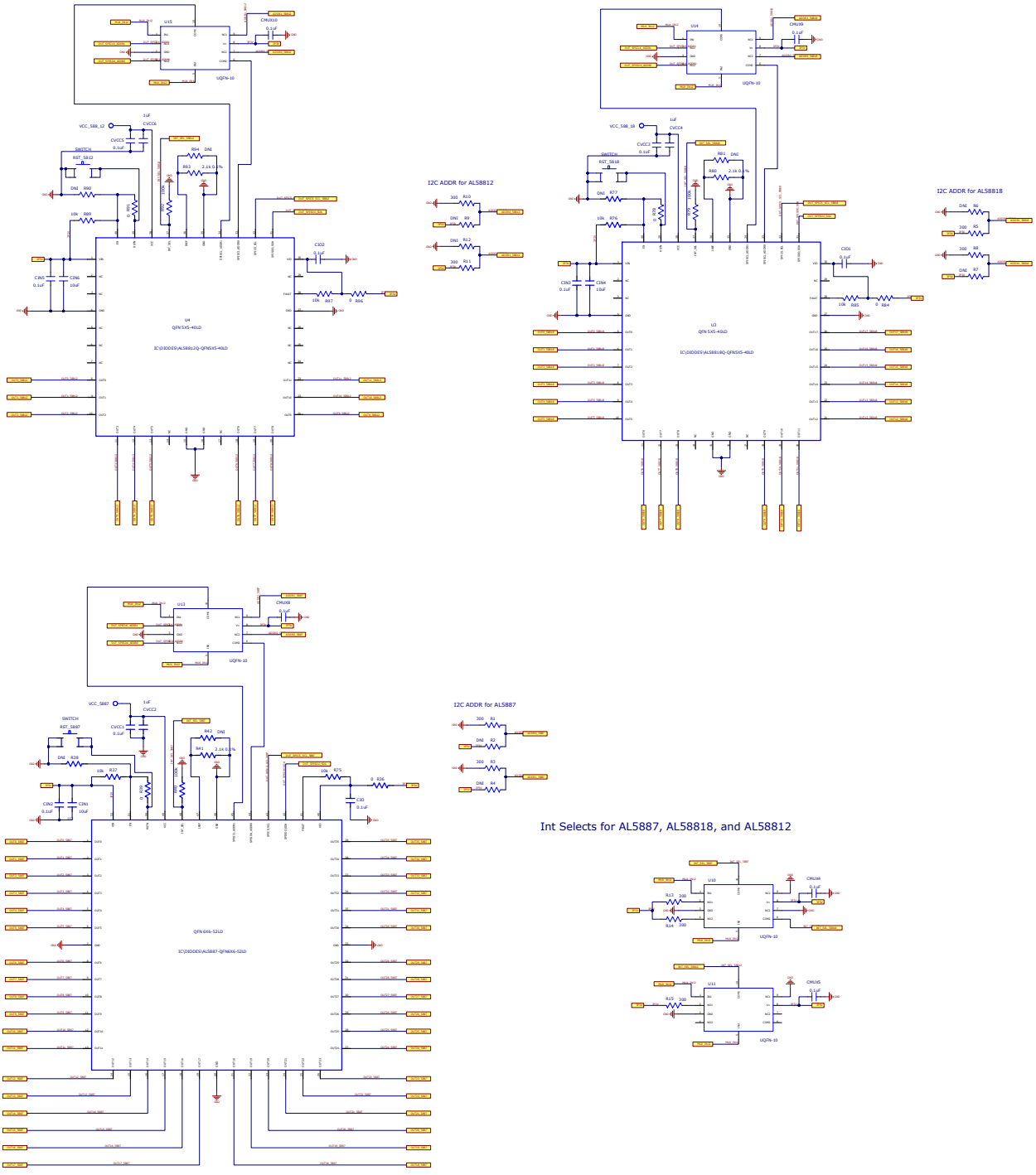


EXTERNAL / INTERNAL DIG COMMS SELECTION MUXES/JUMPER



USB Type B (USB Data/CLK IN)

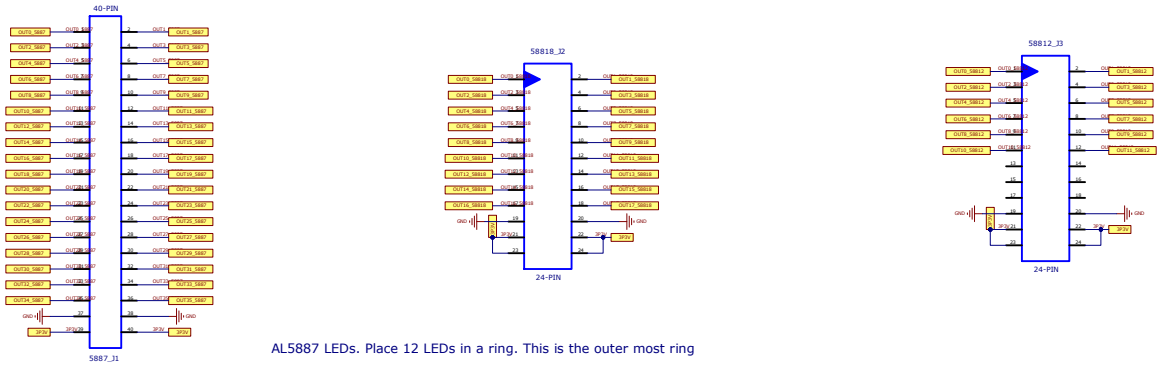
Schematic (continued)



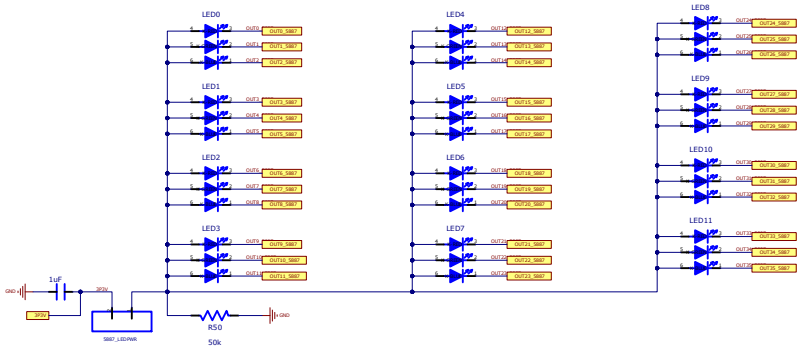
Schematic (continued)

Headers for external LED Display Driving

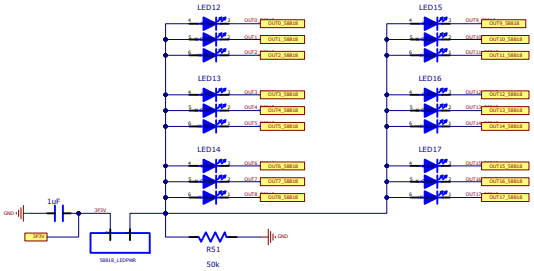
NOTE TO LAYOUT DESIGNER, Use Net names on each header pin as silkscreen to the PCB



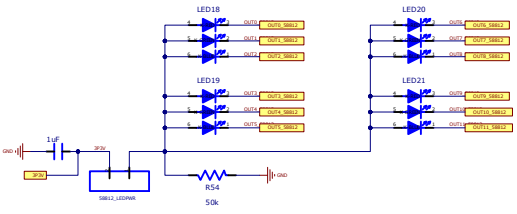
AL5887 LEDs. Place 12 LEDs in a ring. This is the outer most ring



AL58818 LEDs. Place 6 LEDs in a ring. This is the middle ring



AL58812 LEDs. Place 4 LEDs in a ring. This is the inner most ring



Bill of Materials

Location	Description	MFR	P/N	Package
CBUCKVIN1, CAREF, CAVCC, CAVCC1-CAVCC3, CDTR, CIN2, CIN3, CIN5, CIO, CIO1, CIO2, CMUX1-CMUX10, CUSB_B1, CVCC1, CVCC3, CVCC5	CAP CER 0.1UF 6.3V X5R	KYOCERA AVX	04026D104KAT4A	402
CBUCKVIN2-4 CBUCKVIN25 CVCC2 CUSB_B2 CVCC4 CUCAP CVCC6	CAP CER 1UF 6.3V X5R	Taiyo Yuden	JMK105BJ105KV-F	402
CBUCKVOUT1-4	CAP CER 22UF 6.3V X5R	Samsung Electro-Mechanics	CL21A226MQQNNNE	805
CBUCKVOUT5-6	CAP CER 10UF 6.3V X5R	Samsung Electro-Mechanics	CL21A106KQFNNNE	805
CIN1 CIN6 CIN4	CAP CER 10UF 6.3V X5R	Samsung Electro-Mechanics	CL05A106MQ5NUNC	402
CXTAL1-4	CAP CER 22PF 50V C0G/NP0	KYOCERA AVX	KGM05ACG1H220FH	402
CVBUS1-2	CAP TANT 47UF 10% 10V	KYOCERA AVX	TAJB476K010RNJ	1411 (3528 metric)
G1-2	CRYSTAL 16.0000MHZ 20PF	ECS Inc.	ECS-160-20-3X-TR	SMD
D1-2 D5-6	DIODE, GENERAL, 1N914, 100V, DO-35	DIODES	1N4448-WS-7	-
F1	Fuses with Leads - Through Hole 125V 1A MICRO Very Fast Acting	LITTLEFUSE	0273001.H	-
L1	Ferrite Bead, SMT, 60 Ohm	Murata	BLM21PG600SH1D	-
L2	INDUCTOR, 10 uH, PMI Power Multilayer Inductor	WURTH ELEKRONIK	74479887310A	-
L3	INDUCTOR, SMT, 1.2uH	COILCRAFT	XGL5020-122MEC	-
LED22 LEDRX LEDTX USBC_5V	LED, SMD GREEN DIFFUSED	Lumex Opto/Components Inc.	SML-LX1206GW-TR	1206
Q1	MOSFET N-CHANNEL 60V 150mA	DIODES	2N7002Q	SOT-23
U1	8-Bit Microcontroller	ATMEL	ATMEGA16U2-MU	SMD-32
U4	**AL58812/AL58812Q, I2C/SPI 12-CHANNEL RGB LED DRIVER**	**DIODES**	**AL58812/AL58812Q**	**QFN5050-40**
U3	**AL58818/AL58818Q, I2C/SPI 18-CHANNEL RGB LED DRIVER**	**DIODES**	**AL58818/AL58818Q**	**QFN5050-40**
U2	**AL5887/AL5887Q, I2C/SPI 36-CHANNEL RGB LED DRIVER**	**DIODES**	**AL5887/AL5887Q**	**QFN6060-52**
U6-15	**Low Voltage Dual SPDT Analog Switch**	**DIODES**	**PI5A23157ZUAEX**	**UQFN-10**
U5	Low-Power CMOS 8-bit Microcontroller w/ Arduino Bootloader	ATMEL	ATMEGA328P-PU Arduino Bootloader	THD-28
U16	**SYNCHRONOUS BUCK CONVERTER**	**DIODES**	**AP62800**	**SMD-12**
LED0-21	SMD Tricolor White Surface LED	ANY	ASMT-YTD2-0BB02	SMD-6

Bill of Materials (continued)

Location	Description	MFR	P/N	Package
S1	MICO USB TYPE B RECEPTACLE	Amphenol FCi	10118194	USB-5LD
RST_5812 RST_5818 RST_5887 RST_16U1-4	SWITCH, PUSH-BUTTON	TE	FSM2JSMA	SMD-4PIN
S2	USB3.2 Gen2 TYPE C RECEPTACLE	WWW.GCT.CO	USB4056	USB-24LD
PGND1-5	TESTPOINT, CLIP, BLACK .075"DIA	KEYSTONE	5001	THD-1PIN
PC0-3 PD2-3 PD5-7 VCC_5887 VCC_588_12 VCC_588_18	TESTPOINT, CLIP, RED .075"DIA	Lumex Opto/Components Inc.	SML-LX1206GW-TR	THD-1PIN
_3P3V _5VUSBB _5VUSBC	TESTPOINT, CLIP-LEAD	KEYSTONE	5016	SMT
R16-R22, R31-R36, R39, R43-R46, R52, R61, R65, R78, R84, R91, R96, R100, R102, R106-R107, R23, R25, R70, R71, R74, R82, R98, R99	RES SMD 0 OHM JUMPER 1/10W	Panasonic Electronic Components	ERJ-2GE0R00X	0402
R27	RES SMD 1K OHM 0.1% 1/8W	YAGEO	RT0805BRD071KL	0805
R29 R40 R49 R79 R92	RES SMD 100K OHM 0.1% 1/16W	YAGEO	RT0402BRD07100KL	0402
R55, R56, R75, R76, R67, R85, R89, R97, R69, R37	RES SMD 10K OHM 0.1% 1/16W	YAGEO	RT0402BRE0710KL	0402
R48	RES 137K OHM 0.1% 1/10W	TE Connectivity Passive Product	RP73PF1E137KBTD	0402
R104, R105, R108	RES SMD 1K OHM 0.1% 1/16W	YAGEO	RT0402BRE071KL	0402
R66 R68	RES 1M OHM 1% 1/16W	Walsin Technology Corporation	WR04X1004FTL	0402
R41 R80 R93	RES SMD 2.1K OHM 0.1% 1/16W	Susumu	RG1005P-2101-B-T5	0402
R62-63	RES 22 OHM 5% 1/16W	Walsin Technology Corporation	WR04X220 JTL	0402
R47	RES SMD 30.1KOHM 0.1% 1/16W	YAGEO	RT0402BRE0730K1L	0402
R1 R3 R5 R8 R10-11 R13-15 R30 R88	RES SMD 300 OHM 0.1% 1/16W	YAGEO	RT0402BRD07300RL	0402
R59 R101 R103	RES SMD 432 OHM 0.1% 1/16W	YAGEO	RT0402BRD07432RL	0402
R60	RES 499K OHM 0.1% 1/16W	YAGEO	RC0402BR-07499KL	0402
R28	RES SMD 48.7KOHM 0.1% 1/16W	YAGEO	RT0402BRE0748K7L	0402
R57-58	RES SMD 5.1K OHM 0.1% 1/16W	YAGEO	RT0402BRD075K1L	0402
R50-51 R54	RES SMD 49.9KOHM 0.1% 1/16W	YAGEO	RT0402BRE0749K9L	0402
J1	Headers & Wire Housings Classic PCB Header Strips, 0.100" pitch	SAMTEC	TSW-110-07-T-S	THD-10
58812_J3 58818_J2	CONN., HEADER, 12X2-PIN, 100cc	SAMTEC	TSW-112-07-S-D	THD-24
5887_J1	CONN., HEADER, 40-PIN 2-ROW, .100cc	SAMTEC	TSW-120-07-T-D	THD-40

Bill of Materials (continued)

Location	Description	MFR	P/N	Package
16U2_1-4 328P_1-3 3P3BUCK_EN 58812_LEDPWR 58818_LEDPWR 5887_LEDPWR EXT/INT_SELECT SPI/I2C_SELECT	CONN., HEADER, 2-PIN 1-ROW, .100cc	SAMTEC	TSW-102-07-T-S	THD-2
D3, D4, R24, R26, R72, R73, R83, R86, R87, R95, R2, R4, R6, R7, R9, R12, R38, R42, R53, R64, R77, R81, R90, R94	**Do Not Install components**	-	-	-

Example "C" Code Pre-Loaded in the MCU to Light Up All 3 RGB LED Rings

```
/*    Author: Diodes INC    */
/*       Date: 3/1/2024       */
/* Company: Diodes Incorporated */
/*******************************************************************************/

  #include<Wire.h>
  #define I2C_Addr 0x30 // I2C address
  #define I2C_Addr0 0x30 // I2C address
  #define I2C_Addr1 0x31 // I2C address
  #define I2C_Addr2 0x32 // I2C address
  #define I2C_Addr3 0x33 // I2C address
  #define I2C_AddrU 0x1c // I2C address

  // main function that allows us to communicate with the chip
  void writeByte(uint8_t deviceAddress, uint8_t registerAddress, uint8_t registerData) {
    Wire.beginTransmission(deviceAddress);  // sends device address and starts communication
    Wire.write(registerAddress);            // sends register address
    Wire.write(registerData);              // sends register data
    Wire.endTransmission();                 // stops communication
  }

  // put your setup code here, to run once:
  void setup() {
    Wire.begin();
    Wire.setClock(200000); // set I2C to run at 200kHz
    initialize();
  }

  // put your main code here, to run repeatedly:
  void loop() {
    mode1(); // change this to whatever mode is desired
  }

  void initialize() {
    // setup the board ADDRESS30
    writeByte(I2C_Addr0, 0x00, 0x40); // write a 1 to CHIP_EN
    writeByte(I2C_Addr0, 0x38, 0xFF); // write a 1 to CHIP_EN
    writeByte(I2C_Addr0, 0x00, 0x40); // write a 1 to CHIP_EN
      for (uint8_t i = 0x08; i <= 0x13; i++) { // start at first brightness register and go to the last
      writeByte(I2C_Addr0, i, 0x80); // write all brightness to half
    }
    for (uint8_t i = 0x14; i <= 0x37; i++) { // start at first color register and go to the last
      writeByte(I2C_Addr0, i, 0x00); // write all color to 0
    }
    // setup the board ADDRESS31
    writeByte(I2C_Addr1, 0x00, 0x40); // write a 1 to CHIP_EN
    writeByte(I2C_Addr1, 0x38, 0xFF); // write a 1 to CHIP_EN
    writeByte(I2C_Addr1, 0x00, 0x40); // write a 1 to CHIP_EN
    for (uint8_t i = 0x08; i <= 0x13; i++) { // start at first brightness register and go to the last
      writeByte(I2C_Addr1, i, 0x80); // write all brightness to half
    }
    for (uint8_t i = 0x14; i <= 0x37; i++) { // start at first color register and go to the last
      writeByte(I2C_Addr1, i, 0x00); // write all color to 0
    }
    // setup the board ADDRESS32
    writeByte(I2C_Addr2, 0x00, 0x40); // write a 1 to CHIP_EN
    writeByte(I2C_Addr2, 0x38, 0xFF); // write a 1 to CHIP_EN
    writeByte(I2C_Addr2, 0x00, 0x40); // write a 1 to CHIP_EN
    for (uint8_t i = 0x08; i <= 0x13; i++) { // start at first brightness register and go to the last
      writeByte(I2C_Addr2, i, 0x80); // write all brightness to half
    }
    for (uint8_t i = 0x14; i <= 0x37; i++) { // start at first color register and go to the last
      writeByte(I2C_Addr2, i, 0x00); // write all color to 0
    }
  }
```

```
/*****************************************************************************************************************************************************/

/* Spin and Fade */

void mode1() {
  for (uint8_t i = 0; i < 12 ; i++) {
    writeByte(I2C_Addr0, 0x14 + i * 3, 0x80); // write half color to red leds
    delay(10); // add a 0.1s delay before turning on the next LED
  }
    for (uint8_t i = 0; i < 12 ; i++) {
    writeByte(I2C_Addr1, 0x14 + i * 3, 0x80); // write half color to red leds
    delay(10); // add a 0.1s delay before turning on the next LED
    }
    for (uint8_t i = 0; i < 12 ; i++) {
    writeByte(I2C_Addr2, 0x14 + i * 3, 0x80); // write half color to red leds
    delay(10); // add a 0.1s delay before turning on the next LED
    }
  for (uint8_t j = 0; j < 12; j++) {
    writeByte(I2C_Addr0, 0x16 + j * 3, 0x80); // write half color to blue leds
    delay(10);
  }
    for (uint8_t j = 0; j < 12; j++) {
    writeByte(I2C_Addr1, 0x16 + j * 3, 0x80); // write half color to blue leds
    delay(10);
    }
    for (uint8_t j = 0; j < 12; j++) {
    writeByte(I2C_Addr2, 0x16 + j * 3, 0x80); // write half color to blue leds
    delay(10);
  }
  for (uint8_t k = 0; k < 12; k++) {
    writeByte(I2C_Addr0, 0x15 + k * 3, 0x80); // write half color to green leds
    delay(10);
  }
    for (uint8_t k = 0; k < 12; k++) {
    writeByte(I2C_Addr1, 0x15 + k * 3, 0x80); // write half color to green leds
    delay(10);
    }
    for (uint8_t k = 0; k < 12; k++) {
    writeByte(I2C_Addr2, 0x15 + k * 3, 0x80); // write half color to green leds
    delay(10);
  }
  for (uint8_t m = 1; m <= 16; m++) {
    uint8_t brightness = 128 - m * 8; // start decreasing the brightness
    for (uint8_t n = 0x08; n <= 0x13; n++) {
      writeByte(I2C_Addr0, n, brightness);// write updated brightness to brightness registers
      writeByte(I2C_Addr1, n, brightness);// write updated brightness to brightness registers
      writeByte(I2C_Addr2, n, brightness);// write updated brightness to brightness registers
    }
    delay(100);
  }
  for (uint8_t p = 0x14; p <= 0x37; p++) {
    //writeByte(I2C_Addr0, p, 0x00);
    //writeByte(I2C_Addr1, p, 0x00);
    //writeByte(I2C_Addr2, p, 0x00);
    writeByte(I2C_AddrU, p, 0x00);
  }
  for (uint8_t q = 0x08; q <= 0x13; q++) {
    //writeByte(I2C_Addr0, q, 0x80);
    //writeByte(I2C_Addr1, q, 0x80);
    //writeByte(I2C_Addr2, q, 0x80);
    writeByte(I2C_AddrU, q, 0x80);
  }
  delay(500);
}

/*****************************************************************************************************************************************************/

/* Color Wheel */

int R_colors[] = {0xFF, 0xFF, 0xFF, 0x80, 0x00, 0x00, 0x00, 0x00, 0x00, 0x80, 0xFF, 0xFF}; // array of colors used in red LEDs
```

```
int G_colors[] = {0x00, 0x80, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0x80, 0x00, 0x00, 0x00, 0x00}; // array of colors used in green LEDs
int B_colors[] = {0x00, 0x00, 0x00, 0x00, 0x00, 0x80, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0x80}; // array of colors used in blue LEDs

void mode2() {
  for (uint8_t i = 0; i < 12; i++) {
    // modulo division allows us to wrap around the array without seg faulting
    writeByte(I2C_Addr, 0x14, R_colors[i % 12]); // initially will access first value of R_Colors, 0xFF, then second, and so on
    writeByte(I2C_Addr, 0x15, G_colors[i % 12]); // initially will access first value of G_Colors, 0x80
    writeByte(I2C_Addr, 0x16, B_colors[i % 12]); // initially will access first value of B_Colors, 0x00
    writeByte(I2C_Addr, 0x17, R_colors[(i + 1) % 12]); // initially will access second value of R_Colors, 0xFF, then third, and so on
    writeByte(I2C_Addr, 0x18, G_colors[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x19, B_colors[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x1A, R_colors[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x1B, G_colors[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x1C, B_colors[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x1D, R_colors[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x1E, G_colors[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x1F, B_colors[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x20, R_colors[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x21, G_colors[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x22, B_colors[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x23, R_colors[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x24, G_colors[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x25, B_colors[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x26, R_colors[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x27, G_colors[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x28, B_colors[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x29, R_colors[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x2A, G_colors[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x2B, B_colors[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x2C, R_colors[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x2D, G_colors[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x2E, B_colors[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x2F, R_colors[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x30, G_colors[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x31, B_colors[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x32, R_colors[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x33, G_colors[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x34, B_colors[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x35, R_colors[(i + 11) % 12]);
    writeByte(I2C_Addr, 0x36, G_colors[(i + 11) % 12]);
    writeByte(I2C_Addr, 0x37, B_colors[(i + 11) % 12]);
    delay(200);
  }
}
/*****************************************************************************************************************************************************/

/* Smooth */

void mode3() {
  //ADDRESS 30
  for (uint8_t i = 0x00; i <= 0xFE; i += 1) { // increase color value slowly
    for (uint8_t g = 0x15; g <= 0x36; g += 3) { // write to all green LEDs
      writeByte(I2C_Addr0, g, i);
    }
    for (uint8_t r = 0x14; r <= 0x35; r += 3) { // write to all red LEDs
      writeByte(I2C_Addr0, r, 0xFE - i); // decrease color value slowly
    }
    delay(2);
  }
  for (uint8_t i = 0x00; i <= 0xFE; i += 1) {
    for (uint8_t b = 0x16; b <= 0x37; b += 3) {
      writeByte(I2C_Addr0, b, i);
    }
    for (uint8_t g = 0x15; g <= 0x36; g += 3) {
      writeByte(I2C_Addr0, g, 0xFE - i);
    }
    delay(2);
  }
  for (uint8_t i = 0x00; i <= 0xFE; i += 1) {
```

```
  for (uint8_t r = 0x14; r <= 0x35; r += 3) {
    writeByte(I2C_Addr0, r, i);
  }
  for (uint8_t b = 0x16; b <= 0x37; b += 3) {
    writeByte(I2C_Addr0, b, 0xFE - i);
  }
  delay(2);
 }
 //ADDRESS 31
 for (uint8_t i = 0x00; i <= 0xFE; i += 1) { // increase color value slowly
  for (uint8_t g = 0x15; g <= 0x36; g += 3) { // write to all green LEDs
    writeByte(I2C_Addr1, g, i);
  }
  for (uint8_t r = 0x14; r <= 0x35; r += 3) { // write to all red LEDs
    writeByte(I2C_Addr1, r, 0xFE - i); // decrease color value slowly
  }
  delay(2);
 }
 for (uint8_t i = 0x00; i <= 0xFE; i += 1) {
  for (uint8_t b = 0x16; b <= 0x37; b += 3) {
    writeByte(I2C_Addr1, b, i);
  }
  for (uint8_t g = 0x15; g <= 0x36; g += 3) {
    writeByte(I2C_Addr1, g, 0xFE - i);
  }
  delay(2);
 }
 for (uint8_t i = 0x00; i <= 0xFE; i += 1) {
  for (uint8_t r = 0x14; r <= 0x35; r += 3) {
    writeByte(I2C_Addr1, r, i);
  }
  for (uint8_t b = 0x16; b <= 0x37; b += 3) {
    writeByte(I2C_Addr1, b, 0xFE - i);
  }
  delay(2);
 }
 //ADDRESS 32
 for (uint8_t i = 0x00; i <= 0xFE; i += 1) { // increase color value slowly
  for (uint8_t g = 0x15; g <= 0x36; g += 3) { // write to all green LEDs
    writeByte(I2C_Addr2, g, i);
  }
  for (uint8_t r = 0x14; r <= 0x35; r += 3) { // write to all red LEDs
    writeByte(I2C_Addr2, r, 0xFE - i); // decrease color value slowly
  }
  delay(2);
 }
 for (uint8_t i = 0x00; i <= 0xFE; i += 1) {
  for (uint8_t b = 0x16; b <= 0x37; b += 3) {
    writeByte(I2C_Addr2, b, i);
  }
  for (uint8_t g = 0x15; g <= 0x36; g += 3) {
    writeByte(I2C_Addr2, g, 0xFE - i);
  }
  delay(2);
 }
 for (uint8_t i = 0x00; i <= 0xFE; i += 1) {
  for (uint8_t r = 0x14; r <= 0x35; r += 3) {
    writeByte(I2C_Addr2, r, i);
  }
  for (uint8_t b = 0x16; b <= 0x37; b += 3) {
    writeByte(I2C_Addr2, b, 0xFE - i);
  }
  delay(2);
 }
}
/*****************************************************************************************************************************************************/

/* PAC-Man */

void mode4() {
```

```
  // turn LEDs 0-4 to yellow
  writeByte(I2C_Addr, 0x14, 0xFF);
  writeByte(I2C_Addr, 0x15, 0xFF);
  writeByte(I2C_Addr, 0x16, 0x00);
  writeByte(I2C_Addr, 0x17, 0xFF);
  writeByte(I2C_Addr, 0x18, 0xFF);
  writeByte(I2C_Addr, 0x19, 0x00);
  writeByte(I2C_Addr, 0x1A, 0xFF);
  writeByte(I2C_Addr, 0x1B, 0xFF);
  writeByte(I2C_Addr, 0x1C, 0x00);
  writeByte(I2C_Addr, 0x1D, 0xFF);
  writeByte(I2C_Addr, 0x1E, 0xFF);
  writeByte(I2C_Addr, 0x1F, 0x00);
  writeByte(I2C_Addr, 0x20, 0xFF);
  writeByte(I2C_Addr, 0x21, 0xFF);
  writeByte(I2C_Addr, 0x22, 0x00);

  // turn LEDs 8-11 to yellow
  writeByte(I2C_Addr, 0x2C, 0xFF);
  writeByte(I2C_Addr, 0x2D, 0xFF);
  writeByte(I2C_Addr, 0x2E, 0x00);
  writeByte(I2C_Addr, 0x2F, 0xFF);
  writeByte(I2C_Addr, 0x30, 0xFF);
  writeByte(I2C_Addr, 0x31, 0x00);
  writeByte(I2C_Addr, 0x32, 0xFF);
  writeByte(I2C_Addr, 0x33, 0xFF);
  writeByte(I2C_Addr, 0x34, 0x00);
  writeByte(I2C_Addr, 0x35, 0xFF);
  writeByte(I2C_Addr, 0x36, 0xFF);
  writeByte(I2C_Addr, 0x37, 0x00);

  // create blue pellet at LED 6
  writeByte(I2C_Addr, 0x26, 0x00);
  writeByte(I2C_Addr, 0x27, 0x00);
  writeByte(I2C_Addr, 0x28, 0xFF);

  // create the closing effect
  delay(1000);
  writeByte(I2C_Addr, 0x23, 0xFF);
  writeByte(I2C_Addr, 0x24, 0xFF);
  writeByte(I2C_Addr, 0x25, 0x00);
  writeByte(I2C_Addr, 0x29, 0xFF);
  writeByte(I2C_Addr, 0x2A, 0xFF);
  writeByte(I2C_Addr, 0x2B, 0x00);
  delay(500);
  writeByte(I2C_Addr, 0x26, 0xFF);
  writeByte(I2C_Addr, 0x27, 0xFF);
  writeByte(I2C_Addr, 0x28, 0x00);

  // create the opening effect
  delay(500);
  writeByte(I2C_Addr, 0x26, 0x00);
  writeByte(I2C_Addr, 0x27, 0x00);
  writeByte(I2C_Addr, 0x28, 0x00);
  delay(500);
  writeByte(I2C_Addr, 0x23, 0x00);
  writeByte(I2C_Addr, 0x24, 0x00);
  writeByte(I2C_Addr, 0x25, 0x00);
  writeByte(I2C_Addr, 0x29, 0x00);
  writeByte(I2C_Addr, 0x2A, 0x00);
  writeByte(I2C_Addr, 0x2B, 0x00);
  delay(500);
}
/*****************************************************************************************************************************************/

/* Snake */

void mode5() {
  // create first green dot and first apple
  writeByte(I2C_Addr, 0x14, 0x00);
```

```
writeByte(I2C_Addr, 0x15, 0xFF);
writeByte(I2C_Addr, 0x16, 0x00);
writeByte(I2C_Addr, 0x23, 0xFF);
writeByte(I2C_Addr, 0x24, 0x00);
writeByte(I2C_Addr, 0x25, 0x00);

// erase green dot to create moving effect
delay(200);
writeByte(I2C_Addr, 0x14, 0x00);
writeByte(I2C_Addr, 0x15, 0x00);
writeByte(I2C_Addr, 0x16, 0x00);
writeByte(I2C_Addr, 0x17, 0x00);
writeByte(I2C_Addr, 0x18, 0xFF);
writeByte(I2C_Addr, 0x19, 0x00);

/* Repeat above process- erase last dot and move fist dot until snake hits an apple */
delay(200);
writeByte(I2C_Addr, 0x17, 0x00);
writeByte(I2C_Addr, 0x18, 0x00);
writeByte(I2C_Addr, 0x19, 0x00);
writeByte(I2C_Addr, 0x1A, 0x00);
writeByte(I2C_Addr, 0x1B, 0xFF);
writeByte(I2C_Addr, 0x1C, 0x00);

delay(200);
writeByte(I2C_Addr, 0x1A, 0x00);
writeByte(I2C_Addr, 0x1B, 0x00);
writeByte(I2C_Addr, 0x1C, 0x00);
writeByte(I2C_Addr, 0x1D, 0x00);
writeByte(I2C_Addr, 0x1E, 0xFF);
writeByte(I2C_Addr, 0x1F, 0x00);

delay(200);
writeByte(I2C_Addr, 0x1D, 0x00);
writeByte(I2C_Addr, 0x1E, 0x00);
writeByte(I2C_Addr, 0x1F, 0x00);
writeByte(I2C_Addr, 0x20, 0x00);
writeByte(I2C_Addr, 0x21, 0xFF);
writeByte(I2C_Addr, 0x22, 0x00);

delay(200);
writeByte(I2C_Addr, 0x23, 0x00);
writeByte(I2C_Addr, 0x24, 0xFF);
writeByte(I2C_Addr, 0x25, 0x00);

delay(200);
writeByte(I2C_Addr, 0x14, 0xFF);
writeByte(I2C_Addr, 0x15, 0x00);
writeByte(I2C_Addr, 0x16, 0x00);
writeByte(I2C_Addr, 0x1D, 0x00);
writeByte(I2C_Addr, 0x1E, 0xFF);
writeByte(I2C_Addr, 0x1F, 0x00);
writeByte(I2C_Addr, 0x23, 0x00);
writeByte(I2C_Addr, 0x24, 0x00);
writeByte(I2C_Addr, 0x25, 0x00);

delay(200);
writeByte(I2C_Addr, 0x23, 0x00);
writeByte(I2C_Addr, 0x24, 0x00);
writeByte(I2C_Addr, 0x25, 0x00);
writeByte(I2C_Addr, 0x20, 0x00);
writeByte(I2C_Addr, 0x21, 0x00);
writeByte(I2C_Addr, 0x22, 0x00);
writeByte(I2C_Addr, 0x1A, 0x00);
writeByte(I2C_Addr, 0x1B, 0xFF);
writeByte(I2C_Addr, 0x1C, 0x00);

delay(200);
writeByte(I2C_Addr, 0x17, 0x00);
writeByte(I2C_Addr, 0x18, 0xFF);
```

```
writeByte(I2C_Addr, 0x19, 0x00);
writeByte(I2C_Addr, 0x1D, 0x00);
writeByte(I2C_Addr, 0x1E, 0x00);
writeByte(I2C_Addr, 0x1F, 0x00);

delay(200);
writeByte(I2C_Addr, 0x14, 0x00);
writeByte(I2C_Addr, 0x15, 0xFF);
writeByte(I2C_Addr, 0x16, 0x00);

delay(200);
writeByte(I2C_Addr, 0x2F, 0xFF);
writeByte(I2C_Addr, 0x30, 0x00);
writeByte(I2C_Addr, 0x31, 0x00);
writeByte(I2C_Addr, 0x35, 0x00);
writeByte(I2C_Addr, 0x36, 0xFF);
writeByte(I2C_Addr, 0x37, 0x00);
writeByte(I2C_Addr, 0x1A, 0x00);
writeByte(I2C_Addr, 0x1B, 0x00);
writeByte(I2C_Addr, 0x1C, 0x00);

delay(200);
writeByte(I2C_Addr, 0x17, 0x00);
writeByte(I2C_Addr, 0x18, 0x00);
writeByte(I2C_Addr, 0x19, 0x00);
writeByte(I2C_Addr, 0x32, 0x00);
writeByte(I2C_Addr, 0x33, 0xFF);
writeByte(I2C_Addr, 0x34, 0x00);

delay(200);
writeByte(I2C_Addr, 0x2F, 0x00);
writeByte(I2C_Addr, 0x30, 0xFF);
writeByte(I2C_Addr, 0x31, 0x00);

delay(200);
writeByte(I2C_Addr, 0x29, 0xFF);
writeByte(I2C_Addr, 0x2A, 0x00);
writeByte(I2C_Addr, 0x2B, 0x00);
writeByte(I2C_Addr, 0x14, 0x00);
writeByte(I2C_Addr, 0x15, 0x00);
writeByte(I2C_Addr, 0x16, 0x00);
writeByte(I2C_Addr, 0x2C, 0x00);
writeByte(I2C_Addr, 0x2D, 0xFF);
writeByte(I2C_Addr, 0x2E, 0x00);

delay(200);
writeByte(I2C_Addr, 0x29, 0x00);
writeByte(I2C_Addr, 0x2A, 0xFF);
writeByte(I2C_Addr, 0x2B, 0x00);
writeByte(I2C_Addr, 0x1A, 0xFF);
writeByte(I2C_Addr, 0x1B, 0x00);
writeByte(I2C_Addr, 0x1C, 0x00);

delay(200);
writeByte(I2C_Addr, 0x29, 0x00);
writeByte(I2C_Addr, 0x2A, 0x00);
writeByte(I2C_Addr, 0x2B, 0x00);
writeByte(I2C_Addr, 0x14, 0x00);
writeByte(I2C_Addr, 0x15, 0xFF);
writeByte(I2C_Addr, 0x16, 0x00);

delay(200);
writeByte(I2C_Addr, 0x2B, 0x00);
writeByte(I2C_Addr, 0x2C, 0x00);
writeByte(I2C_Addr, 0x2D, 0x00);
writeByte(I2C_Addr, 0x17, 0x00);
writeByte(I2C_Addr, 0x18, 0xFF);
writeByte(I2C_Addr, 0x19, 0x00);

delay(200);
```

```
writeByte(I2C_Addr, 0x1A, 0x00);
writeByte(I2C_Addr, 0x1B, 0xFF);
writeByte(I2C_Addr, 0x1C, 0x00);
writeByte(I2C_Addr, 0x23, 0xFF);
writeByte(I2C_Addr, 0x24, 0x00);
writeByte(I2C_Addr, 0x25, 0x00);

delay(200);
writeByte(I2C_Addr, 0x1D, 0x00);
writeByte(I2C_Addr, 0x1E, 0xFF);
writeByte(I2C_Addr, 0x1F, 0x00);
writeByte(I2C_Addr, 0x2F, 0x00);
writeByte(I2C_Addr, 0x30, 0x00);
writeByte(I2C_Addr, 0x31, 0x00);

delay(200);
writeByte(I2C_Addr, 0x20, 0x00);
writeByte(I2C_Addr, 0x21, 0xFF);
writeByte(I2C_Addr, 0x22, 0x00);
writeByte(I2C_Addr, 0x32, 0x00);
writeByte(I2C_Addr, 0x33, 0x00);
writeByte(I2C_Addr, 0x34, 0x00);

delay(200);
writeByte(I2C_Addr, 0x23, 0x00);
writeByte(I2C_Addr, 0x24, 0xFF);
writeByte(I2C_Addr, 0x25, 0x00);
writeByte(I2C_Addr, 0x29, 0xFF);
writeByte(I2C_Addr, 0x2A, 0x00);
writeByte(I2C_Addr, 0x2B, 0x00);

delay(200);
writeByte(I2C_Addr, 0x26, 0x00);
writeByte(I2C_Addr, 0x27, 0xFF);
writeByte(I2C_Addr, 0x28, 0x00);
writeByte(I2C_Addr, 0x35, 0x00);
writeByte(I2C_Addr, 0x36, 0x00);
writeByte(I2C_Addr, 0x37, 0x00);

delay(200);
writeByte(I2C_Addr, 0x29, 0x00);
writeByte(I2C_Addr, 0x2A, 0xFF);
writeByte(I2C_Addr, 0x2B, 0x00);
writeByte(I2C_Addr, 0x2F, 0xFF);
writeByte(I2C_Addr, 0x30, 0x00);
writeByte(I2C_Addr, 0x31, 0x00);

delay(200);
writeByte(I2C_Addr, 0x14, 0x00);
writeByte(I2C_Addr, 0x15, 0x00);
writeByte(I2C_Addr, 0x16, 0x00);
writeByte(I2C_Addr, 0x2C, 0x00);
writeByte(I2C_Addr, 0x2D, 0xFF);
writeByte(I2C_Addr, 0x2E, 0x00);

delay(200);
writeByte(I2C_Addr, 0x2F, 0x00);
writeByte(I2C_Addr, 0x30, 0xFF);
writeByte(I2C_Addr, 0x31, 0x00);
writeByte(I2C_Addr, 0x14, 0xFF);
writeByte(I2C_Addr, 0x15, 0x00);
writeByte(I2C_Addr, 0x16, 0x00);

delay(200);
writeByte(I2C_Addr, 0x17, 0x00);
writeByte(I2C_Addr, 0x18, 0x00);
writeByte(I2C_Addr, 0x19, 0x00);
writeByte(I2C_Addr, 0x32, 0x00);
writeByte(I2C_Addr, 0x33, 0xFF);
writeByte(I2C_Addr, 0x34, 0x00);
```

```
  delay(200);
  writeByte(I2C_Addr, 0x1A, 0x00);
  writeByte(I2C_Addr, 0x1B, 0x00);
  writeByte(I2C_Addr, 0x1C, 0x00);
  writeByte(I2C_Addr, 0x35, 0x00);
  writeByte(I2C_Addr, 0x36, 0xFF);
  writeByte(I2C_Addr, 0x37, 0x00);

  delay(200);
  writeByte(I2C_Addr, 0x14, 0x00);
  writeByte(I2C_Addr, 0x15, 0xFF);
  writeByte(I2C_Addr, 0x16, 0x00);
  writeByte(I2C_Addr, 0x1A, 0xFF);
  writeByte(I2C_Addr, 0x1B, 0x00);
  writeByte(I2C_Addr, 0x1C, 0x00);

  delay(200);
  writeByte(I2C_Addr, 0x1D, 0x00);
  writeByte(I2C_Addr, 0x1E, 0x00);
  writeByte(I2C_Addr, 0x1F, 0x00);
  writeByte(I2C_Addr, 0x17, 0x00);
  writeByte(I2C_Addr, 0x18, 0xFF);
  writeByte(I2C_Addr, 0x19, 0x00);

  delay(200);
  writeByte(I2C_Addr, 0x1A, 0x00);
  writeByte(I2C_Addr, 0x1B, 0xFF);
  writeByte(I2C_Addr, 0x1C, 0x00);
  writeByte(I2C_Addr, 0x1D, 0xFF);
  writeByte(I2C_Addr, 0x1E, 0x00);
  writeByte(I2C_Addr, 0x1F, 0x00);

  delay(200);
  writeByte(I2C_Addr, 0x1D, 0x00);
  writeByte(I2C_Addr, 0x1E, 0xFF);
  writeByte(I2C_Addr, 0x1F, 0x00);

  // Victory signal
  delay(1000);
  for (int i = 0; i < 3; i++) {
    for (uint8_t r = 0x14; r <= 0x37; r++) {
      writeByte(I2C_Addr, r, 0xFF);
    }
    delay(250);
    for (uint8_t r = 0x14; r <= 0x37; r++) {
      writeByte(I2C_Addr, r, 0x00);
    }
    delay(250);
  }
  delay(1000);

}
/*****************************************************************************************************************************************************/

/* Colorful Spinner */

void mode6() {
  int R_colors[] = {0xFF, 0xFF, 0xFF, 0x80, 0x00, 0x00, 0x00, 0x00, 0x00, 0x80, 0xFF, 0xFF};
  int G_colors[] = {0x00, 0x80, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0x80, 0x00, 0x00, 0x00, 0x00};
  int B_colors[] = {0x00, 0x00, 0x00, 0x00, 0x00, 0x80, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0x80};
  int brightnesses[] = {0xF9, 0xE2, 0xCC, 0xB7, 0xA0, 0x8D, 0x80, 0x62, 0x50, 0x35, 0x1D, 0x10}; // array of brightness values

  writeByte(I2C_Addr, 0x14, R_colors[0]);
  writeByte(I2C_Addr, 0x15, G_colors[0]);
  writeByte(I2C_Addr, 0x16, B_colors[0]);
  writeByte(I2C_Addr, 0x17, R_colors[1]);
  writeByte(I2C_Addr, 0x18, G_colors[1]);
  writeByte(I2C_Addr, 0x19, B_colors[1]);
  writeByte(I2C_Addr, 0x1A, R_colors[2]);
```

```
  writeByte(I2C_Addr, 0x1B, G_colors[2]);
  writeByte(I2C_Addr, 0x1C, B_colors[2]);
  writeByte(I2C_Addr, 0x1D, R_colors[3]);
  writeByte(I2C_Addr, 0x1E, G_colors[3]);
  writeByte(I2C_Addr, 0x1F, B_colors[3]);
  writeByte(I2C_Addr, 0x20, R_colors[4]);
  writeByte(I2C_Addr, 0x21, G_colors[4]);
  writeByte(I2C_Addr, 0x22, B_colors[4]);
  writeByte(I2C_Addr, 0x23, R_colors[5]);
  writeByte(I2C_Addr, 0x24, G_colors[5]);
  writeByte(I2C_Addr, 0x25, B_colors[5]);
  writeByte(I2C_Addr, 0x26, R_colors[6]);
  writeByte(I2C_Addr, 0x27, G_colors[6]);
  writeByte(I2C_Addr, 0x28, B_colors[6]);
  writeByte(I2C_Addr, 0x29, R_colors[7]);
  writeByte(I2C_Addr, 0x2A, G_colors[7]);
  writeByte(I2C_Addr, 0x2B, B_colors[7]);
  writeByte(I2C_Addr, 0x2C, R_colors[8]);
  writeByte(I2C_Addr, 0x2D, G_colors[8]);
  writeByte(I2C_Addr, 0x2E, B_colors[8]);
  writeByte(I2C_Addr, 0x2F, R_colors[9]);
  writeByte(I2C_Addr, 0x30, G_colors[9]);
  writeByte(I2C_Addr, 0x31, B_colors[9]);
  writeByte(I2C_Addr, 0x32, R_colors[10]);
  writeByte(I2C_Addr, 0x33, G_colors[10]);
  writeByte(I2C_Addr, 0x34, B_colors[10]);
  writeByte(I2C_Addr, 0x35, R_colors[11]);
  writeByte(I2C_Addr, 0x36, G_colors[11]);
  writeByte(I2C_Addr, 0x37, B_colors[11]);
  for (uint8_t i = 0; i < 12; i++) {
    writeByte(I2C_Addr, 0x08, brightnesses[i % 12]);
    writeByte(I2C_Addr, 0x09, brightnesses[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x0A, brightnesses[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x0B, brightnesses[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x0C, brightnesses[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x0D, brightnesses[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x0E, brightnesses[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x0F, brightnesses[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x10, brightnesses[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x11, brightnesses[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x12, brightnesses[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x13, brightnesses[(i + 11) % 12]);
    delay(175);
  }
}
/*****************************************************************************************************************************************************/

/* Red Spinner */

void mode7() {
  for (uint8_t i = 0; i < 12 ; i++) {
    writeByte(I2C_Addr, 0x14 + i * 3, 0x80);
  }
  int brightnesses[] = {0xF9, 0xE2, 0xCC, 0xB7, 0xA0, 0x8D, 0x80, 0x62, 0x50, 0x35, 0x1D, 0x10};
  for (uint8_t i = 0; i < 12; i++) {
    writeByte(I2C_Addr, 0x08, brightnesses[i % 12]);
    writeByte(I2C_Addr, 0x09, brightnesses[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x0A, brightnesses[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x0B, brightnesses[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x0C, brightnesses[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x0D, brightnesses[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x0E, brightnesses[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x0F, brightnesses[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x10, brightnesses[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x11, brightnesses[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x12, brightnesses[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x13, brightnesses[(i + 11) % 12]);
    delay(175);
  }
}
```

```
/*****************************************************************************************************************************************************/

/* Newton's Cradle */

void mode8() {
  for (uint8_t i = 0; i < 12 ; i++) {
    writeByte(I2C_Addr, 0x14 + i * 3, 0xFF);
  }
  for (uint8_t j = 0; j < 12; j++) {
    writeByte(I2C_Addr, 0x16 + j * 3, 0x80);
  }
  for (uint8_t k = 0; k < 12; k++) {
    writeByte(I2C_Addr, 0x15 + k * 3, 0x00);
  }

  // use increased delay values to create illusion of gravity- 'higher' the LEDs get, the harder it is to 'lift' them

  // lift up one side
  delay(100);
  writeByte(I2C_Addr, 0x23, 0x00);
  writeByte(I2C_Addr, 0x24, 0x00);
  writeByte(I2C_Addr, 0x25, 0x00);
  delay(250);
  writeByte(I2C_Addr, 0x20, 0x00);
  writeByte(I2C_Addr, 0x21, 0x00);
  writeByte(I2C_Addr, 0x22, 0x00);
  delay(375);
  writeByte(I2C_Addr, 0x1D, 0x00);
  writeByte(I2C_Addr, 0x1E, 0x00);
  writeByte(I2C_Addr, 0x1F, 0x00);
  delay(500);
  writeByte(I2C_Addr, 0x1A, 0x00);
  writeByte(I2C_Addr, 0x1B, 0x00);
  writeByte(I2C_Addr, 0x1C, 0x00);
  delay(725);
  writeByte(I2C_Addr, 0x17, 0x00);
  writeByte(I2C_Addr, 0x18, 0x00);
  writeByte(I2C_Addr, 0x19, 0x00);

  // dropping down same side
  delay(725);
  writeByte(I2C_Addr, 0x17, 0xFF);
  writeByte(I2C_Addr, 0x18, 0x00);
  writeByte(I2C_Addr, 0x19, 0x80);
  delay(500);
  writeByte(I2C_Addr, 0x1A, 0xFF);
  writeByte(I2C_Addr, 0x1B, 0x00);
  writeByte(I2C_Addr, 0x1C, 0x80);
  delay(375);
  writeByte(I2C_Addr, 0x1D, 0xFF);
  writeByte(I2C_Addr, 0x1E, 0x00);
  writeByte(I2C_Addr, 0x1F, 0x80);
  delay(250);
  writeByte(I2C_Addr, 0x20, 0xFF);
  writeByte(I2C_Addr, 0x21, 0x00);
  writeByte(I2C_Addr, 0x22, 0x80);
  delay(125);
  writeByte(I2C_Addr, 0x23, 0xFF);
  writeByte(I2C_Addr, 0x24, 0x00);
  writeByte(I2C_Addr, 0x25, 0x80);

  // lift up other side
  delay(100);
  writeByte(I2C_Addr, 0x26, 0x00);
  writeByte(I2C_Addr, 0x27, 0x00);
  writeByte(I2C_Addr, 0x28, 0x00);
  delay(200);
  writeByte(I2C_Addr, 0x29, 0x00);
  writeByte(I2C_Addr, 0x2A, 0x00);
  writeByte(I2C_Addr, 0x2B, 0x00);
```

```
  delay(350);
  writeByte(I2C_Addr, 0x2C, 0x00);
  writeByte(I2C_Addr, 0x2D, 0x00);
  writeByte(I2C_Addr, 0x2E, 0x00);
  delay(450);
  writeByte(I2C_Addr, 0x2F, 0x00);
  writeByte(I2C_Addr, 0x30, 0x00);
  writeByte(I2C_Addr, 0x31, 0x00);
  delay(650);
  writeByte(I2C_Addr, 0x32, 0x00);
  writeByte(I2C_Addr, 0x33, 0x00);
  writeByte(I2C_Addr, 0x34, 0x00);

  // dropping down other side
  delay(650);
  writeByte(I2C_Addr, 0x32, 0xFF);
  writeByte(I2C_Addr, 0x33, 0x00);
  writeByte(I2C_Addr, 0x34, 0x80);
  delay(500);
  writeByte(I2C_Addr, 0x2F, 0xFF);
  writeByte(I2C_Addr, 0x30, 0x00);
  writeByte(I2C_Addr, 0x31, 0x80);
  delay(375);
  writeByte(I2C_Addr, 0x2C, 0xFF);
  writeByte(I2C_Addr, 0x2D, 0x00);
  writeByte(I2C_Addr, 0x2E, 0x80);
  delay(250);
  writeByte(I2C_Addr, 0x29, 0xFF);
  writeByte(I2C_Addr, 0x2A, 0x00);
  writeByte(I2C_Addr, 0x2B, 0x80);
  delay(125);
  writeByte(I2C_Addr, 0x26, 0xFF);
  writeByte(I2C_Addr, 0x27, 0x00);
  writeByte(I2C_Addr, 0x28, 0x80);
}
/*****************************************************************************************************************************************************/

/* Time Bomb */

void mode9() {
  for (int i = 500; i >= 0; i -= 20) { // slowly decrease time between blinking on and off
    delay(i);
    for (uint8_t i = 0; i < 12 ; i++) {
      writeByte(I2C_Addr, 0x14 + i * 3, 0xFF);
    }
    delay(i);
    for (uint8_t i = 0; i < 12 ; i++) {
      writeByte(I2C_Addr, 0x14 + i * 3, 0x00);
    }
  }
  delay(1000);
}
/*****************************************************************************************************************************************************/

/* 4th of July */

void mode10() {
  int R_colors[] = {0xFF, 0xFF, 0x00, 0xFF, 0xFF, 0x00, 0xFF, 0xFF, 0x00, 0xFF, 0xFF, 0x00};
  int G_colors[] = {0x00, 0xFF, 0x00, 0x00, 0xFF, 0x00, 0x00, 0xFF, 0x00, 0x00, 0xFF, 0x00};
  int B_colors[] = {0x00, 0xFF, 0xFF, 0x00, 0xFF, 0xFF, 0x00, 0xFF, 0xFF, 0x00, 0xFF, 0xFF};

  for (uint8_t i = 0; i < 12; i++) {
    writeByte(I2C_Addr, 0x14, R_colors[i % 12]);
    writeByte(I2C_Addr, 0x15, G_colors[i % 12]);
    writeByte(I2C_Addr, 0x16, B_colors[i % 12]);
    writeByte(I2C_Addr, 0x17, R_colors[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x18, G_colors[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x19, B_colors[(i + 1) % 12]);
    writeByte(I2C_Addr, 0x1A, R_colors[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x1B, G_colors[(i + 2) % 12]);
```

```
    writeByte(I2C_Addr, 0x1C, B_colors[(i + 2) % 12]);
    writeByte(I2C_Addr, 0x1D, R_colors[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x1E, G_colors[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x1F, B_colors[(i + 3) % 12]);
    writeByte(I2C_Addr, 0x20, R_colors[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x21, G_colors[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x22, B_colors[(i + 4) % 12]);
    writeByte(I2C_Addr, 0x23, R_colors[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x24, G_colors[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x25, B_colors[(i + 5) % 12]);
    writeByte(I2C_Addr, 0x26, R_colors[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x27, G_colors[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x28, B_colors[(i + 6) % 12]);
    writeByte(I2C_Addr, 0x29, R_colors[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x2A, G_colors[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x2B, B_colors[(i + 7) % 12]);
    writeByte(I2C_Addr, 0x2C, R_colors[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x2D, G_colors[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x2E, B_colors[(i + 8) % 12]);
    writeByte(I2C_Addr, 0x2F, R_colors[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x30, G_colors[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x31, B_colors[(i + 9) % 12]);
    writeByte(I2C_Addr, 0x32, R_colors[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x33, G_colors[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x34, B_colors[(i + 10) % 12]);
    writeByte(I2C_Addr, 0x35, R_colors[(i + 11) % 12]);
    writeByte(I2C_Addr, 0x36, G_colors[(i + 11) % 12]);
    writeByte(I2C_Addr, 0x37, B_colors[(i + 11) % 12]);
    delay(350);
  }
  for (int i = 0; i < 3; i++) { // blink leds three times
    delay(300);
    for (uint8_t j = 0x08; j <= 0x13; j++) {
      writeByte(I2C_Addr, j, 0x80);
    }
    delay(300);
    for (uint8_t j = 0x08; j <= 0x13; j++) {
      writeByte(I2C_Addr, j, 0x00);
    }
  }
  delay(300);
  // firework show
  for (int i = 0; i < 12; i++) {
    uint8_t temp = random(0x08, 0x14); // random brightness register selection
    writeByte(I2C_Addr, temp, 0x80); // turn the selected LED to half brightness
    for (uint8_t m = 1; m <= 16; m++) {
      uint8_t brightness = 128 - m * 8; // start decreasing the brightness
      writeByte(I2C_Addr, temp, brightness);
      delay(50);
    }
    delay(100);
  }
  for (uint8_t q = 0x08; q <= 0x13; q++) {
    writeByte(I2C_Addr, q, 0x80);
  }
  delay(500);
}
/*****************************************************************************************************************************************************/

/* Heartbeat */

void mode11() {
  for (uint8_t i = 0; i < 12 ; i++) {
    writeByte(I2C_Addr, 0x14 + i * 3, 0xFF);
  }
  for (uint8_t j = 0; j < 12; j++) {
    writeByte(I2C_Addr, 0x16 + j * 3, 0x80);
  }
  for (uint8_t k = 0; k < 12; k++) {
    writeByte(I2C_Addr, 0x15 + k * 3, 0x00);
```

```
  }
  for (uint8_t m = 1; m <= 12; m++) {
   uint8_t brightness = 128 - m * 8;
   for (uint8_t q = 0x08; q <= 0x13; q++) {
    writeByte(I2C_Addr, q, brightness);
   }
   delay(20);
  }
  delay(25);
  for (uint8_t m = 1; m <= 12; m++) {
   uint8_t brightness = 128 - m * 8;
   for (uint8_t q = 0x08; q <= 0x13; q++) {
    writeByte(I2C_Addr, q, brightness);
   }
   delay(50);
  }
  delay(250);
}

void mode12() {
  uint8_t t = 250;
  writeByte(I2C_Addr, 0x01, 0x86); // Set EN_LOG to OFF
  writeByte(I2C_Addr, 0x02, 0xFF); // Set ALL RGB to Bank mode
  writeByte(I2C_Addr, 0x03, 0x0F); // Set ALL RGB to Bank mode
  writeByte(I2C_Addr, 0x04, 0xf0); // Set Bank Brightness to medium
  writeByte(I2C_Addr, 0x05, 0x00); // SET BANK A Color to 0
  writeByte(I2C_Addr, 0x06, 0x00); // SET BANK B Color to 0
  writeByte(I2C_Addr, 0x07, 0x00); // SET BANK C Color to 0
  delay(200);

  for (uint8_t r = 0; r <= t; r++) {
   writeByte(I2C_Addr, 0x05, r); //analogWrite(bluePin,blue)
   delay(0);
   for (uint8_t g = 0; g <= t; g++) {
    writeByte(I2C_Addr, 0x06, g); //analogWrite(greenPin,green)
    delay(0);
    for (uint8_t b = 0; b <= t; b++) {
     writeByte(I2C_Addr, 0x07, b); //analogWrite(redPin,red)
     delay(0);
    }
   }
  }
}

void mode13() {
  uint8_t t = 0x32;
  uint8_t TIME = 40;
  // writeByte(I2C_Addr, 0x01, 0xA6); // Set EN_LOG to OFF
  writeByte(I2C_Addr, 0x02, 0xFF); // Set ALL RGB to Bank mode
  writeByte(I2C_Addr, 0x03, 0x0F); // Set ALL RGB to Bank mode
  writeByte(I2C_Addr, 0x04, 0xf0); // Set Bank Brightness to medium
  writeByte(I2C_Addr, 0x05, t); // SET BANK A Color to FF
  writeByte(I2C_Addr, 0x06, 0x00); // SET BANK B Color to 0
  writeByte(I2C_Addr, 0x07, 0x00); // SET BANK C Color to 0
  delay(50);

   for (uint8_t r = 0x00; r <= t; r++)
  {
   uint8_t m = t - r;
   writeByte(I2C_Addr, 0x05, m); // red from 255 to 0
   writeByte(I2C_Addr, 0x07, r); // blue concurrently from 0 to 255
   delay(TIME);
  }
  for (uint8_t g = 0x00; g <= t; g++)
  {
   uint8_t m = t - g;
   writeByte(I2C_Addr, 0x07, m); // blue from 255 to 0
   writeByte(I2C_Addr, 0x06, g); //green from 0 to 255 concurrently
   delay(TIME);
  }
```

```
  for (uint8_t b = 0; b <= t; b++)
  {
    uint8_t m = t - b;
    writeByte(I2C_Addr, 0x06, m); //Green from 255 to 0
    writeByte(I2C_Addr, 0x05, b); // red from 0 to 255 concurrently
    delay(TIME);
  }
}

void mode14() {
  uint8_t t = 0x32;
  uint8_t TIME = 40;
  // writeByte(I2C_Addr, 0x01, 0xA6); // Set EN_LOG to OFF
  writeByte(I2C_Addr, 0x02, 0xFF); // Set ALL RGB to Bank mode
  writeByte(I2C_Addr, 0x03, 0x0F); // Set ALL RGB to Bank mode
  writeByte(I2C_Addr, 0x04, 0xf0); // Set Bank Brightness to medium
  writeByte(I2C_Addr, 0x05, t); // SET BANK A Color to FF
  writeByte(I2C_Addr, 0x06, 0x00); // SET BANK B Color to 0
  writeByte(I2C_Addr, 0x07, 0x00); // SET BANK C Color to 0
  delay(50);

    for (uint8_t r = 0x00; r <= t; r++)
  {
    uint8_t m = t - r;
    // writeByte(I2C_Addr, 0x05, m); //
    writeByte(I2C_Addr, 0x05, r+7); // red
    delay(TIME);
  }
 // for (uint8_t g = 0x00; g <= t; g++)
 // {
 //   uint8_t m = t - g;
 //   writeByte(I2C_Addr, 0x07, m); // blue from 255 to 0
 //   writeByte(I2C_Addr, 0x06, g); //green from 0 to 255 concurrently
 //   delay(TIME);
//  }
//  for (uint8_t b = 0; b <= t; b++)
//  {
//    uint8_t m = t - b;
//    writeByte(I2C_Addr, 0x06, m); //Green from 255 to 0
//    writeByte(I2C_Addr, 0x05, b); // red from 0 to 255 concurrently
//    delay(TIME);
//  }
}
/*****************************************************************************************************************************************************/
```

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