# LP5024EVM User's Guide

This user's guide describes the characteristics, setup, and use of the LP5024EVM Evaluation Module (EVM). This EVM helps the user evaluate the features of the Texas Instruments LP5024, which is an $I^2C$ bus-controlled, 24-channel, constant-current LED driver. This user's guide includes setup instructions, a schematic diagram, a bill of materials, printed-circuit board layout drawings, and software instructions.

The LP5024EVM can be converted for testing the LP5018 device by removing the factory-installed device (U1) and replacing it with the LP5018 counterpart. Then when testing, select the corresponding LP5018 tag from the menu on the GUI home page (Figure 4) for the evaluation.

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# 1 What You Get

The LP5024EVM kit (Figure 1) contains:.

- USB2ANY
  - Ribbon cable
  - USB cable
- LP5024EVM

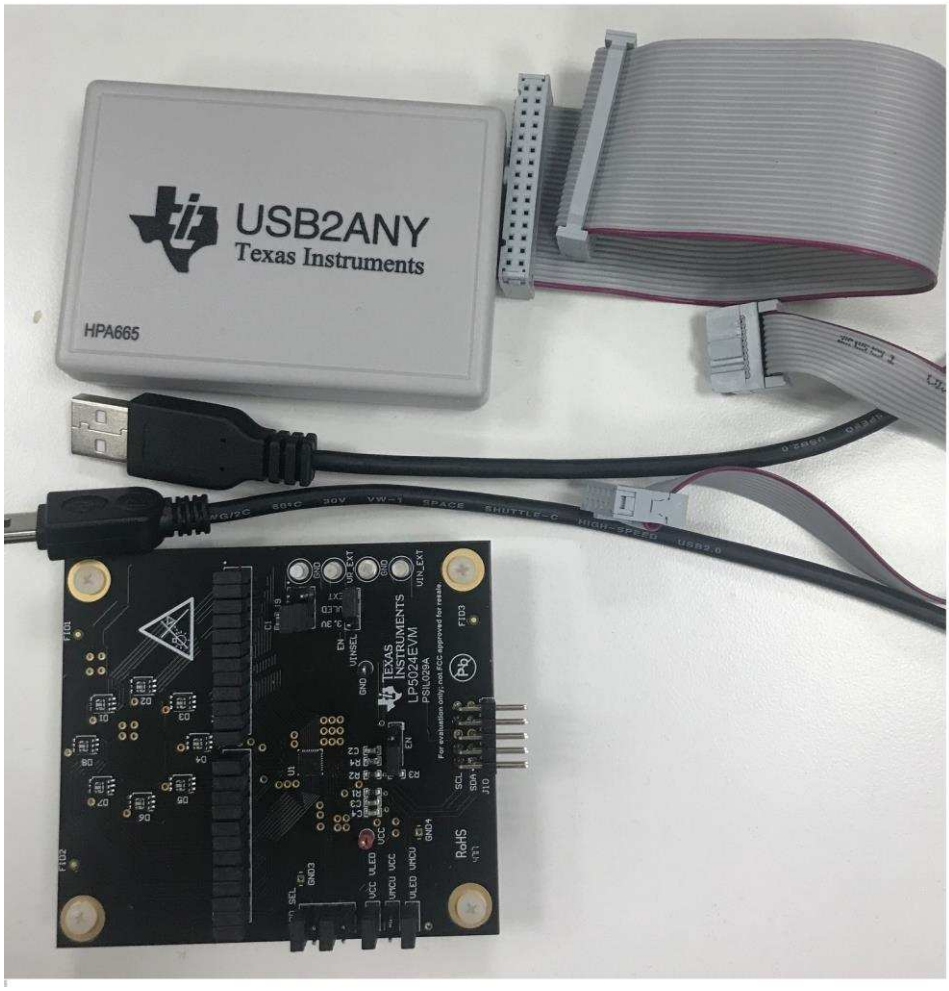


**Figure 1. LP5024EVM Kit**



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Figure 2 shows the key connectors used to operate LP5024EVM.

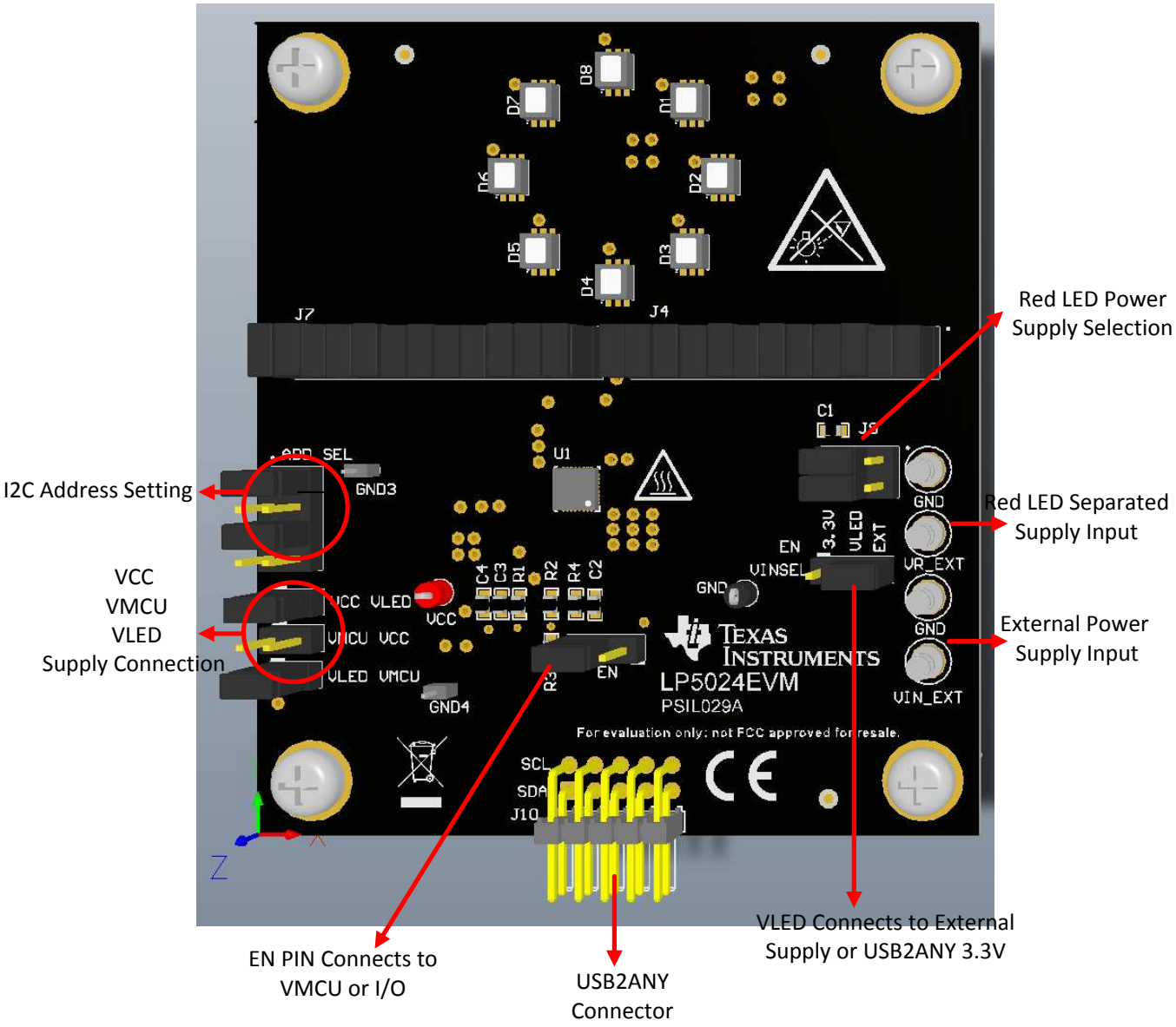


**Figure 2. LP5024EVM Key Connectors**

**Table 1. LP5024EVM Parameters**

| PARAMETER | RANGE |
|---|---|
| VCC | 3 V–5.5 V |
| VLED | 3 V–5.5 V |
| VMCU | 1.8 V, 3.3 V, 5 V |
| Channel current | 35 mA (maximum) |

Note: Channel current is set at 20 mA when the LED supply voltage is 5 V. Although the LP5024 device can withstand 6-V maximum LED supply voltage with 35 mA per channel, make sure that the PCB board thermal performance can meet the power dissipation requirement, because increased LED supply voltage increases channel output current.


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## 2 What You Need In Addition

A PC on which to install the LP50 EVM GUI (click here to download software)

DC supply or USB port for LED supply

## 3 How to Get Started

### 3.1 Hardware Setup

Figure 3 shows the hardware setup of the LP5024EVM.

- Connect a 5-V power supply to TP1 (VIN_EXT) and TP6 (GND).
- Using the USB cable, connect the USB2ANY module to the PC.
- Using the ribbon cable, connect the USB2ANY module to the LP5024EVM.

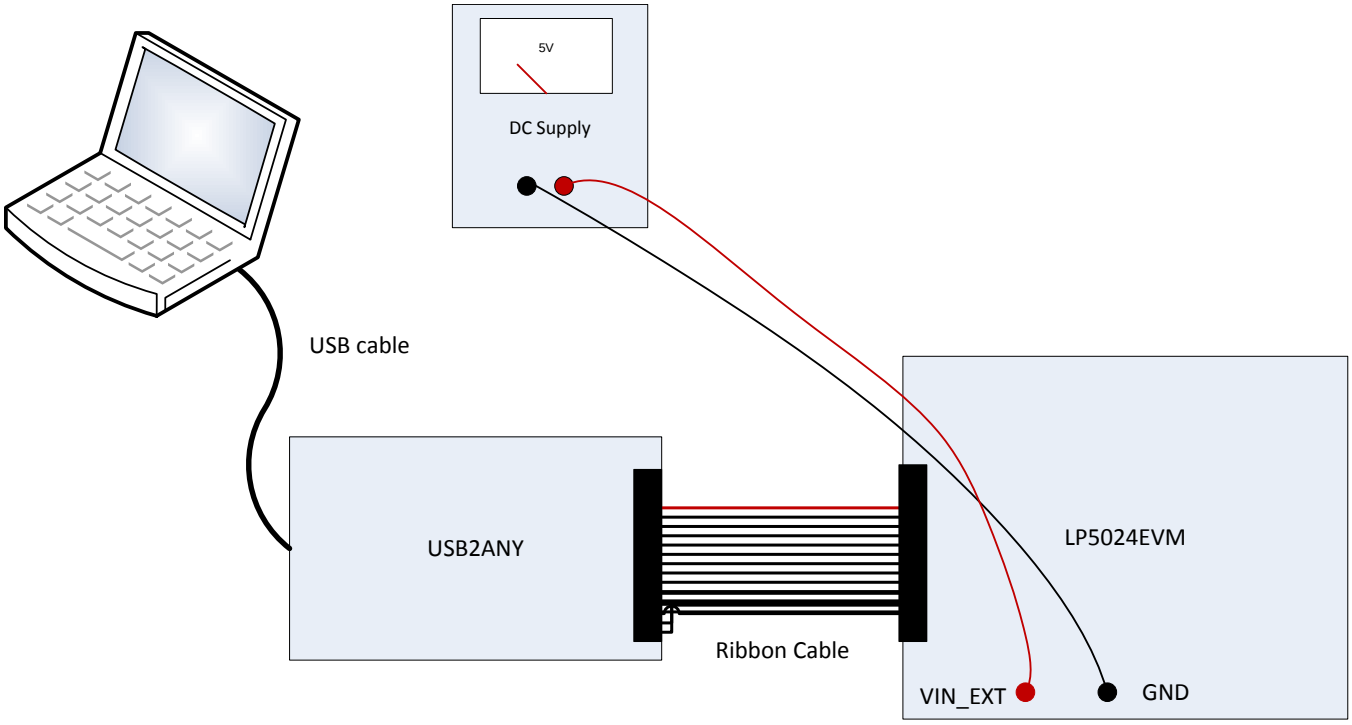


**Figure 3. LP5024EVM Hardware Setup**

### 3.2 Software Installation

Download the GUI software from the product folder. After downloading, install the LP5024EVM GUI on the PC. A shortcut to the GUI is found on the desktop. A shortcut can also be found in the startup menu under the Texas Instruments folder. Figure 5 shows the landing page of the LP50 EVM GUI. The landing page contains the LP50xx introduction information and LP5024EVM information. Clicking the menu icon (≡) shows more information.



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**Figure 4. LP50 Family GUI Home Page**

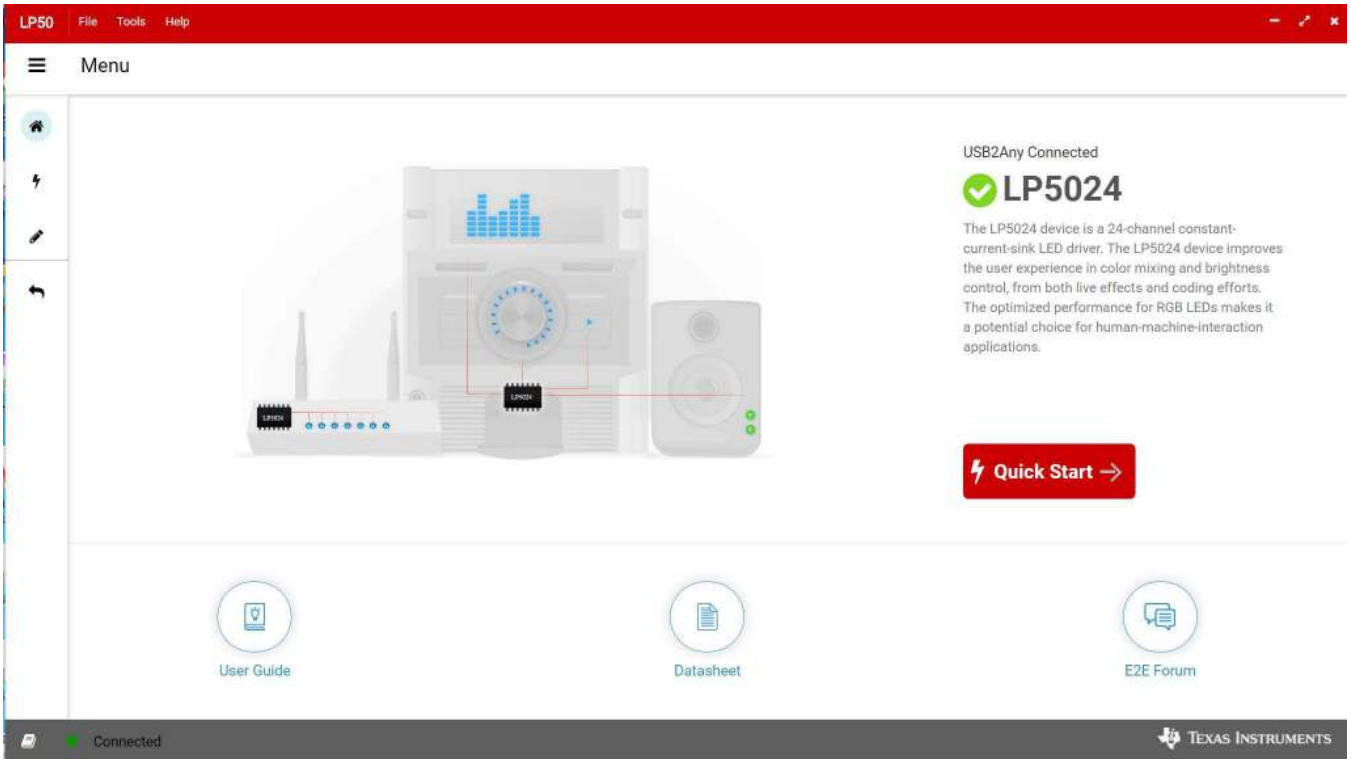


**Figure 5. Landing Page of LP5024EVM GUI**


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### 3.3 GUI Function

Click the Quick Start button in the lower-right corner. The GUI displays a detailed LED control panel as shown in Figure 6.

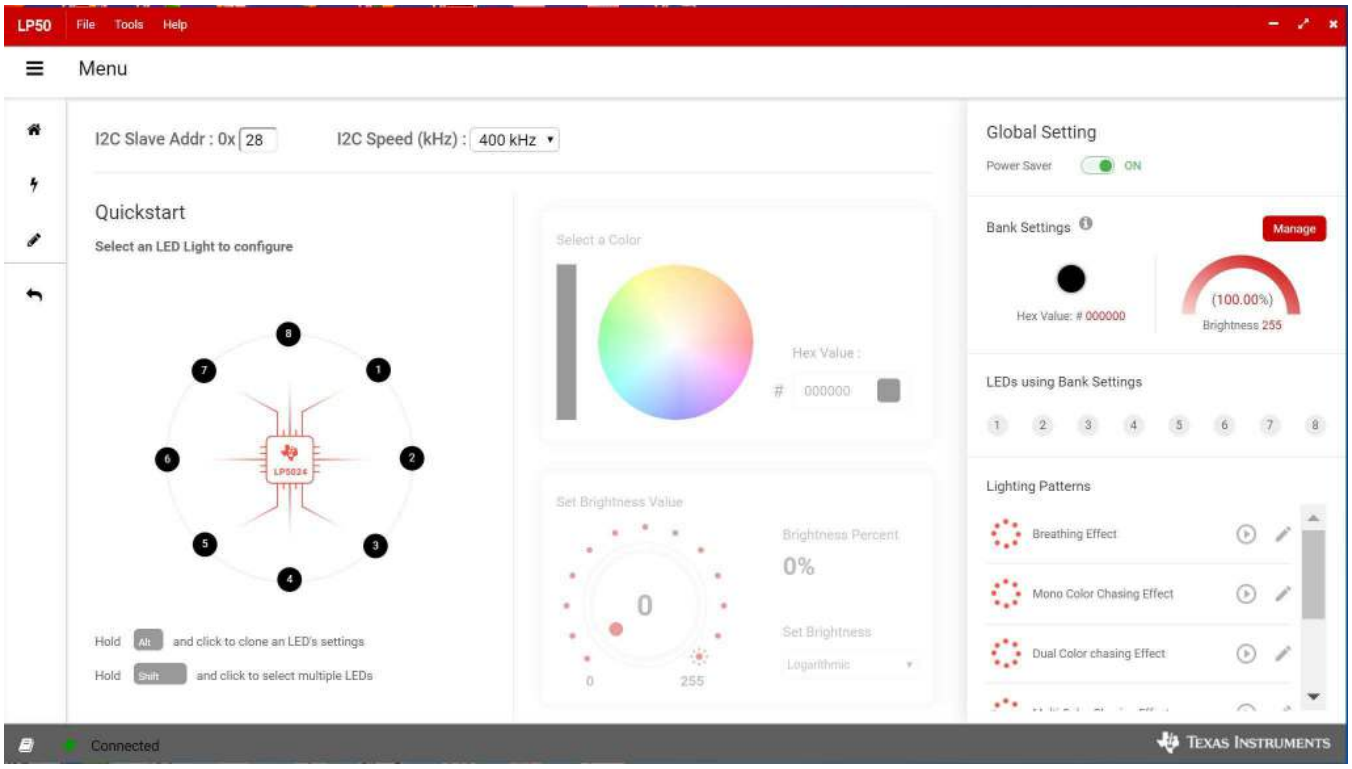


**Figure 6. LED Control Panel**



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### 3.3.1 Connection Status

Before using the GUI, make sure the connection status indicator at the bottom left corner is*green*, which means the USB2ANY is connected to the computer successfully. If the status indicator is *red*, try to reconnect the USB2ANY cable and restart the LP50 EVM GUI.

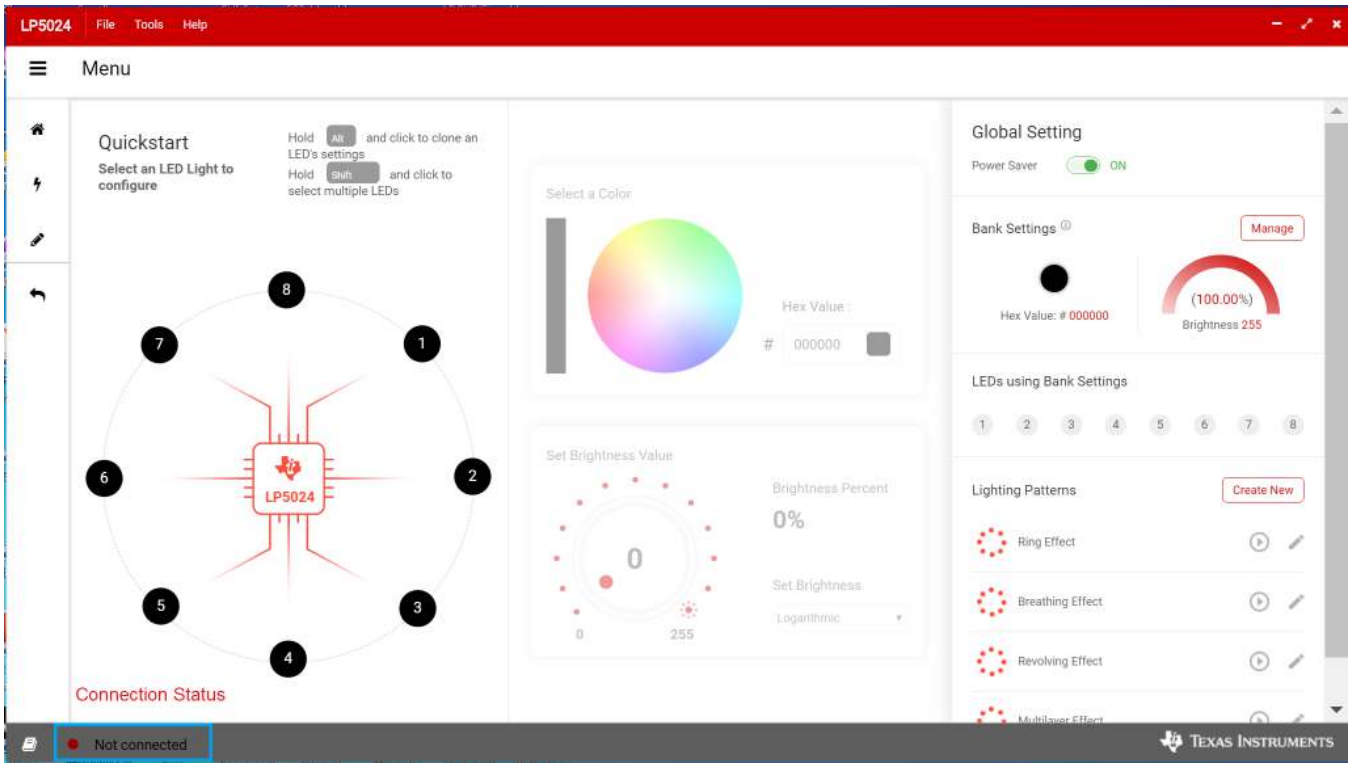


**Figure 7. LP50 EVM GUI Connection Status**


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### 3.3.2 GUI Functions

#### *3.3.2.1 Global Setting*

When all the LED outputs are inactive, the LP50xx device is able to enter power-save mode automatically, thus lowering idle-current consumption down to 10 μA (typical). Automatic power-save mode is enabled when register bit Power_Save_EN = 1 (default) and all the LEDs are off for a duration of >30 ms. Almost all analog blocks are powered down in power-save mode. If any $I^2C$ command to the device occurs, the LP50xx device returns to the NORMAL mode. Set the Power Saver switch to activate the function (see Figure 7).

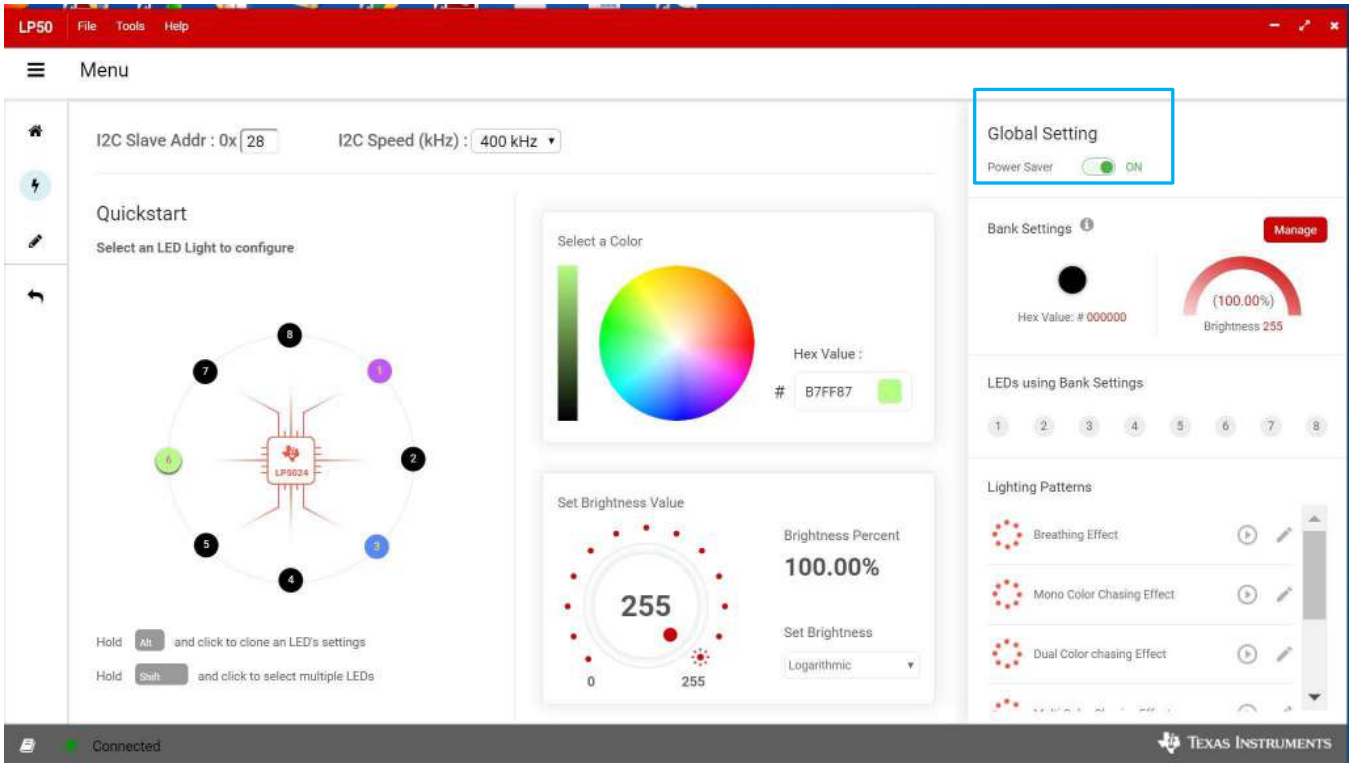


**Figure 8. LP50xx Global Setting**



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### 3.3.2.2 RGB LED Color and Brightness Control

Each output channel has its own individual 8-bit color-setting register (OUTx_COLOR). The device allows every RGB LED module to achieve >16 million (256 × 256 × 256) color-mixing. When color is fixed, the independent brightness-control is used to achieve accurate and flexible dimming control for every RGB LED module. Every three consecutive output channels are assigned to their respective brightness-control register (LEDx_BRIGHTNESS). The LP50xx device allows 256-step brightness control for each RGB LED module, which helps achieve a smooth dimming effect. For human-eye-friendly visual performance, a logarithmic-scale dimming curve is usually implemented in LED drivers. The LP50xx device, with independent color-mixing and brightness-control registers, implements the logarithmic scale dimming control inside the brightness control function, which solves the color distortion issue effectively. Also, the LP50xx device allows users to configure the dimming scale either logarithmically or linearly through the global Log_Scale_EN register. Click the Manage button, shown in Figure 9. to set the color and brightness.

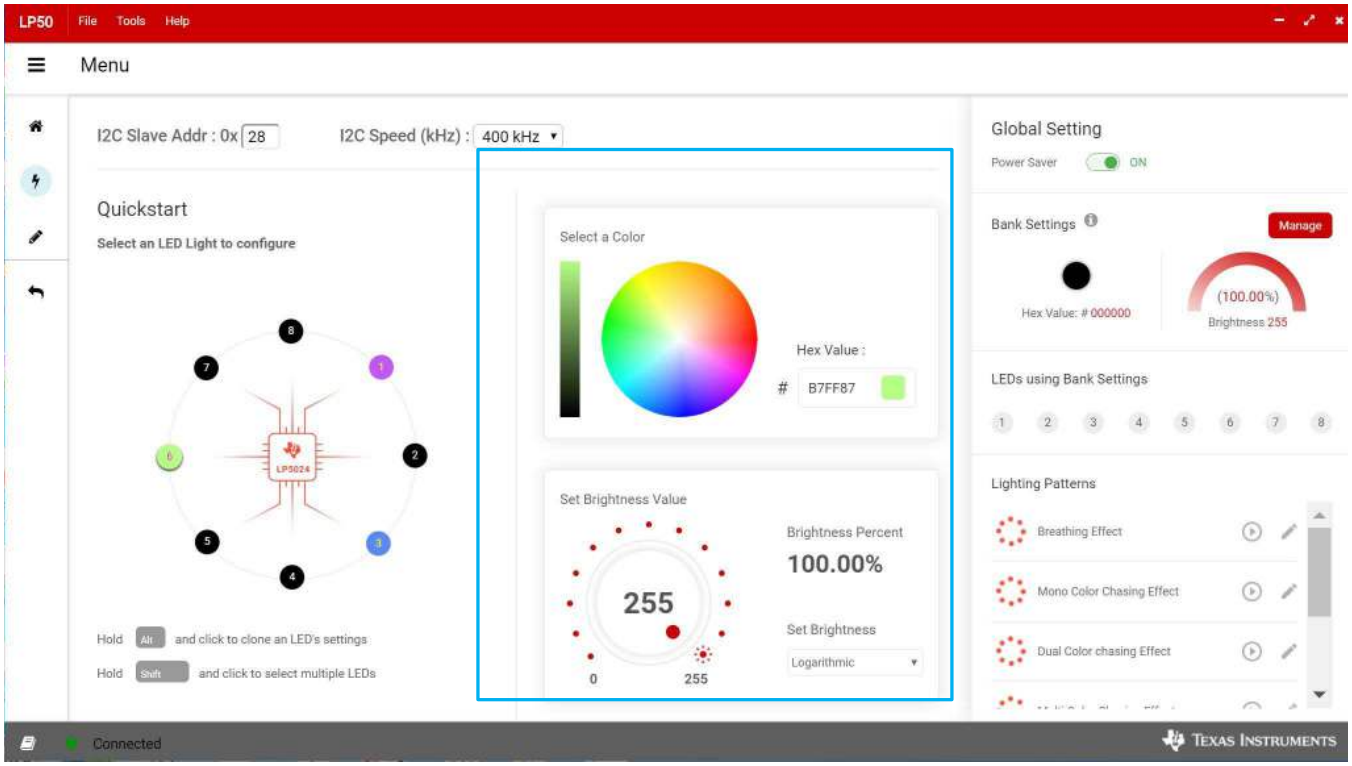


**Figure 9. LED Color and Brightness Setting**

### 3.3.2.3 Bank Management

For most LED-animation effects, like blinking and breathing, all the RGB LEDs have the same lighting pattern. Instead of controlling the individual LED separately, which occupies the microcontroller resources heavily, the LP50xx device provides an easy coding approach, the LED bank control. Each channel can be configured as either independent control or bank control through the LEDx_Bank_EN register. When LEDx_Bank_EN = 0 (default), the LED is controlled independently by the related color-mixing and brightness-control registers. When LEDx_Bank_EN = 1, the LP50xx device drives the LED in LED bank-control mode. The LED bank has its own independent PWM control scheme, which is the same structure as the PWM scheme of each channel. See Out_x Color in the register map, Figure 13 for more details. When a channel is configured in LED bank-control mode, the related color mixing and brightness control is governed by the bank control registers (BANK_A_COLOR, BANK_B_COLOR, BANK_C_COLOR, and BANK_BRIGHTNESS) regardless of the inputs on its own color-mixing and brightness-control registers.


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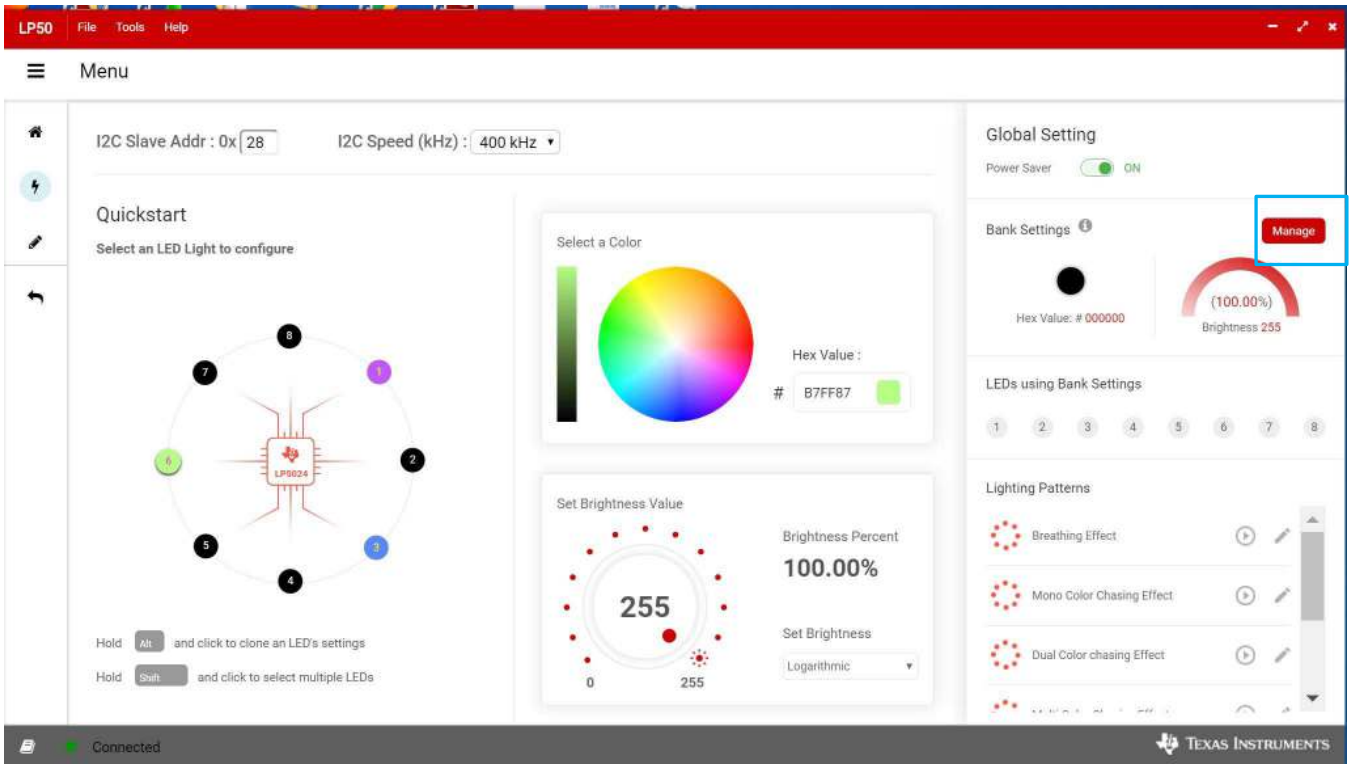


**Figure 10. Bank Management Entry**

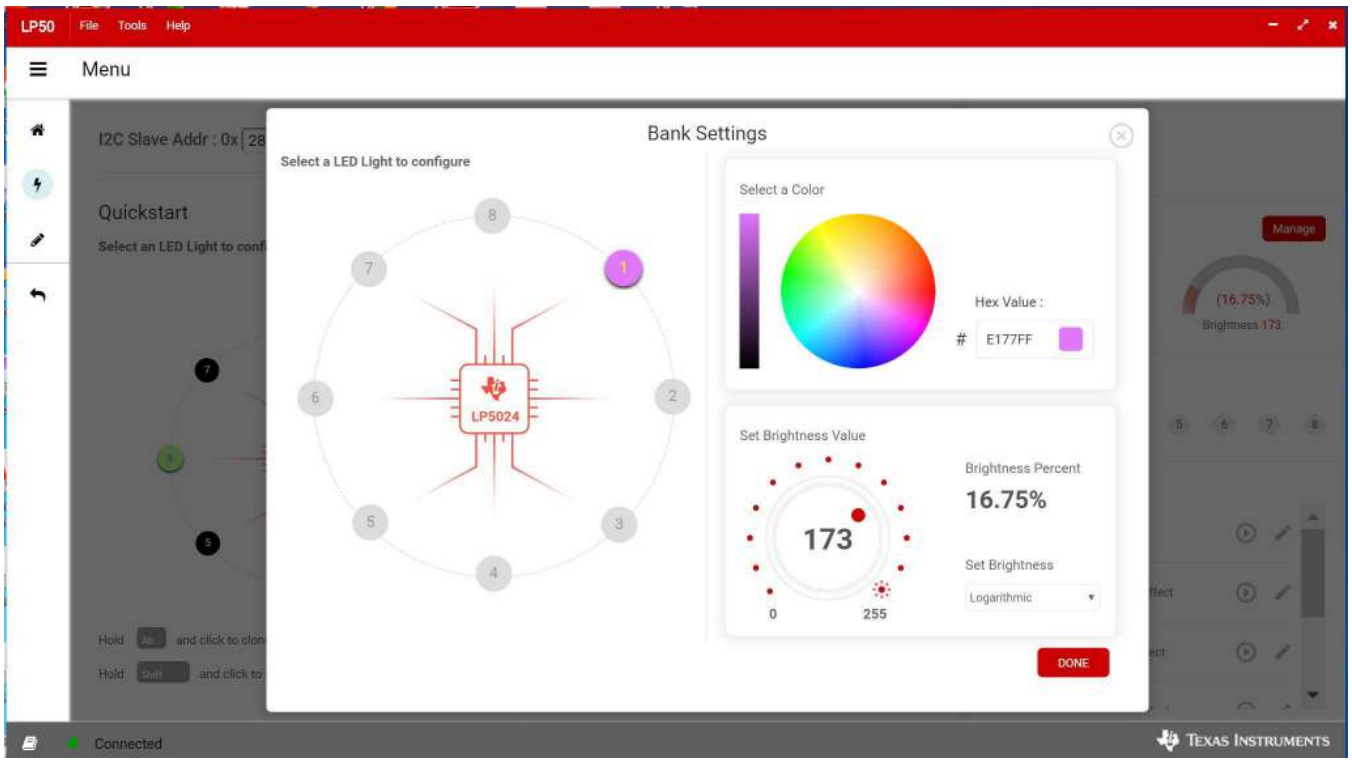


**Figure 11. Bank Setting**



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### 3.3.3 Lighting Patterns

The GUI also can run the preset lighting patterns and customize the lighting pattens by modifying some parameters.

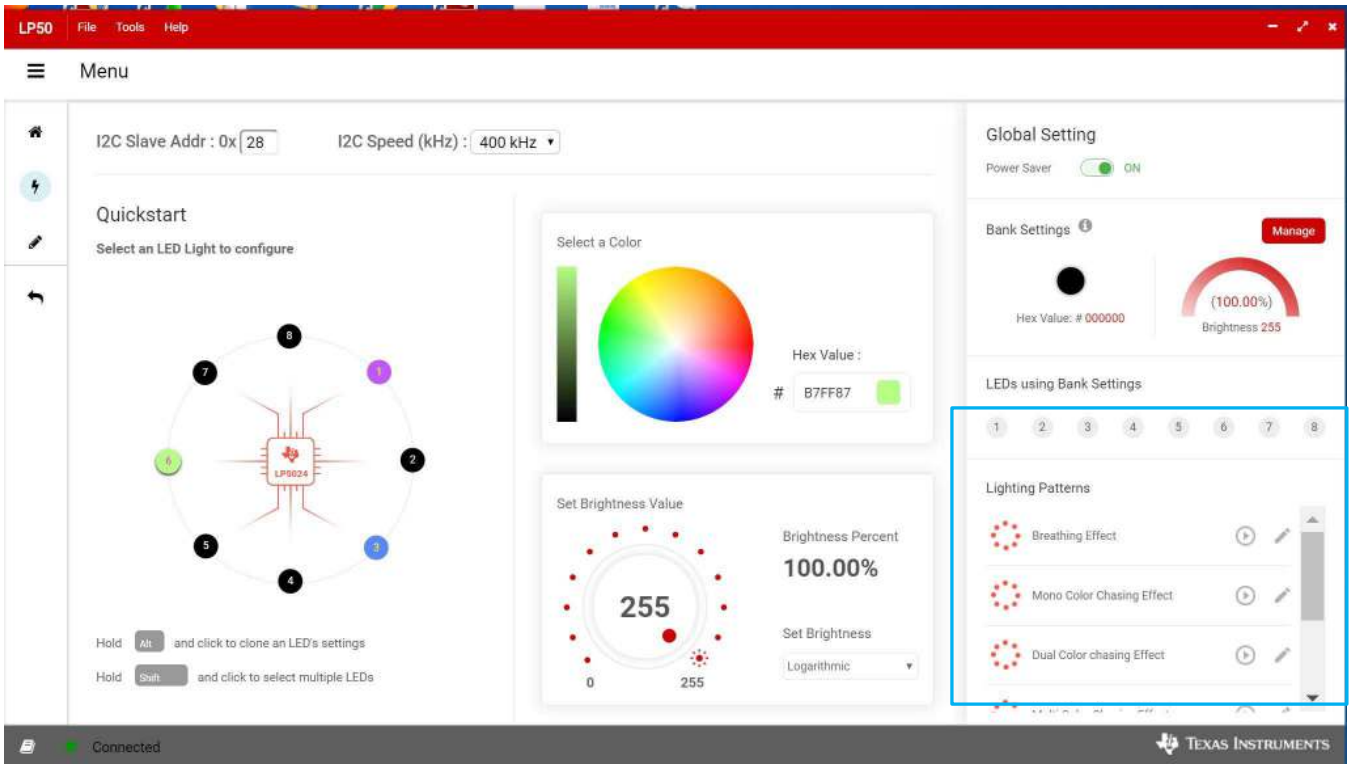


**Figure 12. LED Lighting Pattern**


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### 3.3.4 Register Map

The register view appears when the Register icon is clicked. The register view provides the register values, field values, and descriptions. The registers can be operated directly through the input check box.

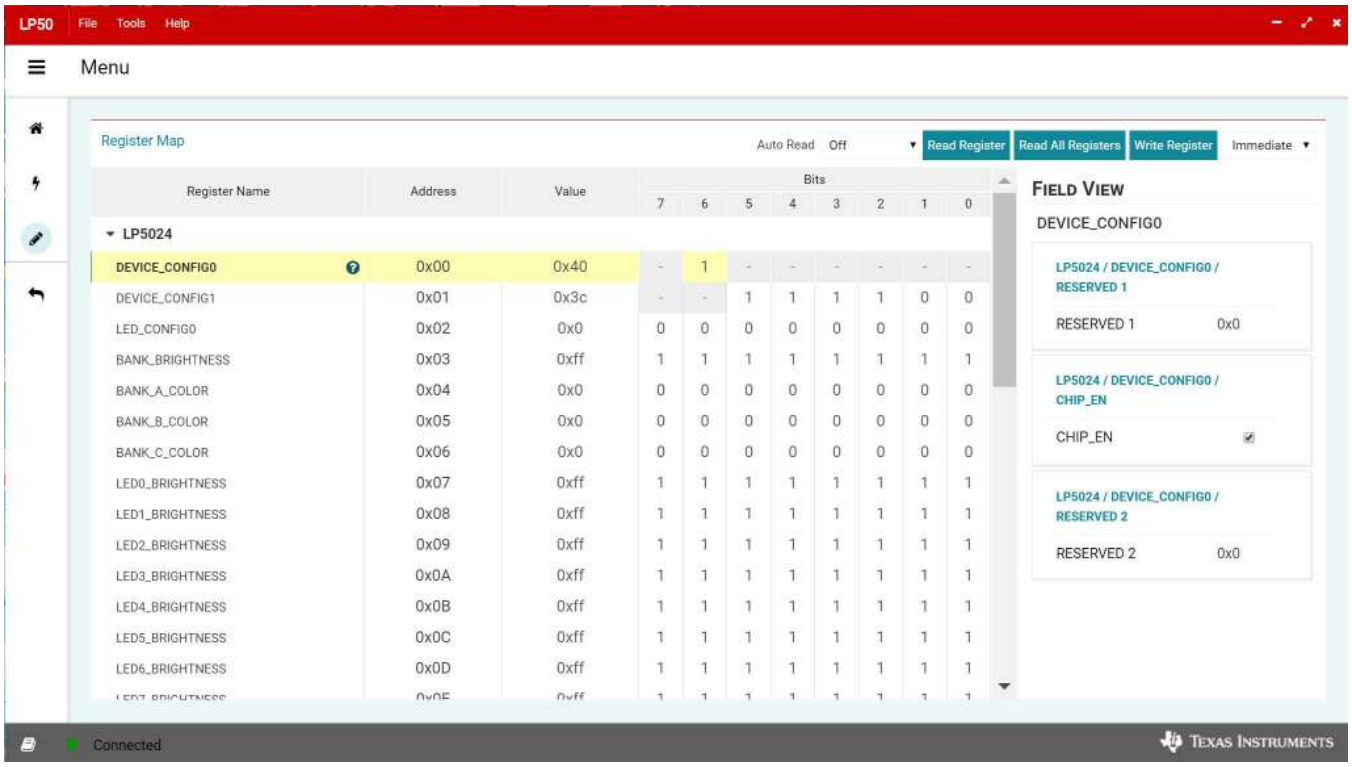


**Figure 13. Register Map**

Enter the desired hex value in the registers (Current Value column), perform a bit-wise configuration of any register fields by double-clicking on the corresponding register bit, or configure a register field by entering the desired value as hex in the Value column, binary in the Bits columns, or by using the input boxes for each field under FIELD VIEW to set values for the corresponding variables. Field View displays the description of all fields of the selected register. Each register can be read independently or all registers can be read at once by using the Read Register or Read All Registers button, respectively. The data is written to the registers in one of two ways, depending on the update mode (Immediate↓ or Deferred↓) button. Clicking the button toggles between the two modes. In Immediate mode, the register data is written immediately following a Current Value , an individual bit, or a Value change. In Deferred mode, the displayed data is written to all registers on depression of the Write Register button. Press the Read All Registers button to read back all the registers and update the values in this table. If any register value must be changed, simply double-click on the individual bit values to change the value in this table in immediate updated mode or press the Write Register button to write all the registers at a time if Deferred is selected instead of Immediate from the drop-down box. Register settings can be saved in text-file format by selecting Save Registers from the file menu. A register settings file in text-file format can be loaded and programmed automatically by selecting Load Register from the file menu.


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### 3.3.5 Tool Bar

Registers can be loaded and saved through the tool bar under the File menu.

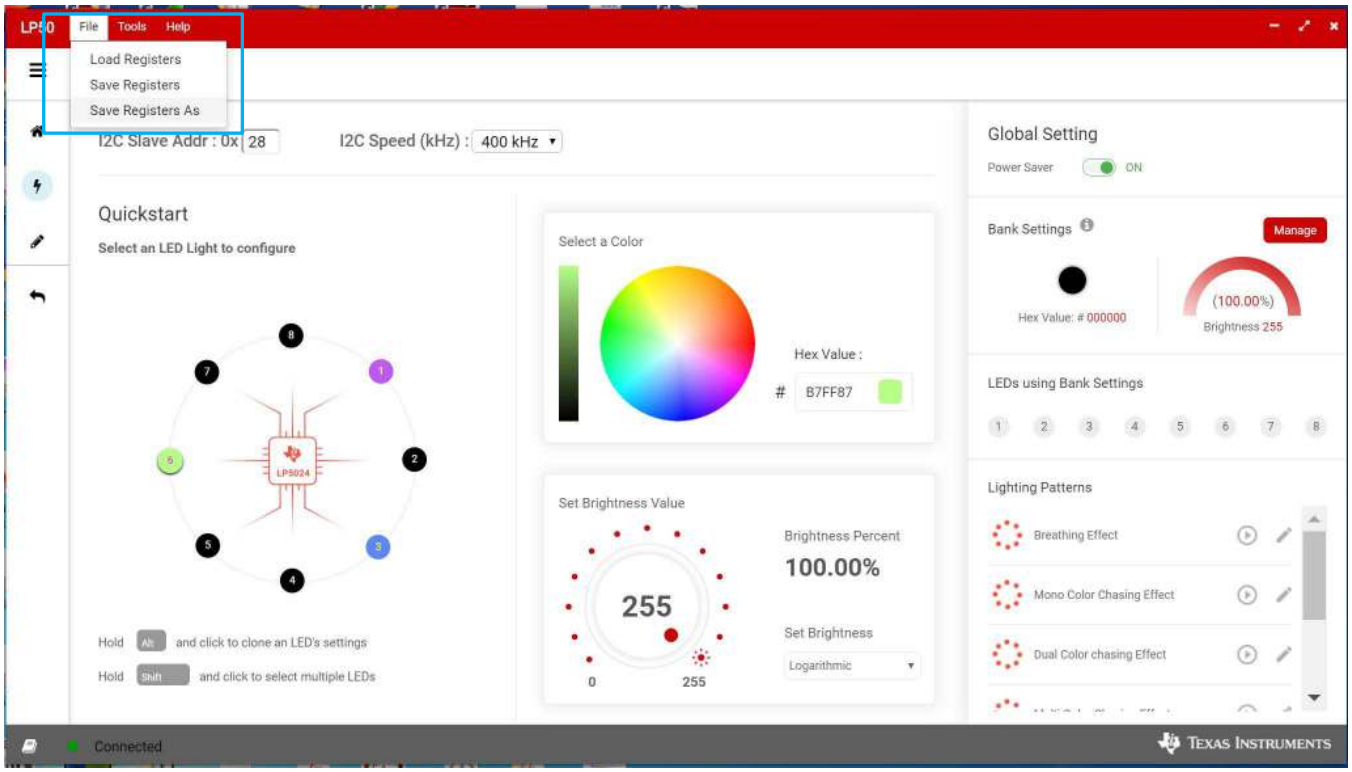


**Figure 14. Tool Bar**


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# 4 Board Layout

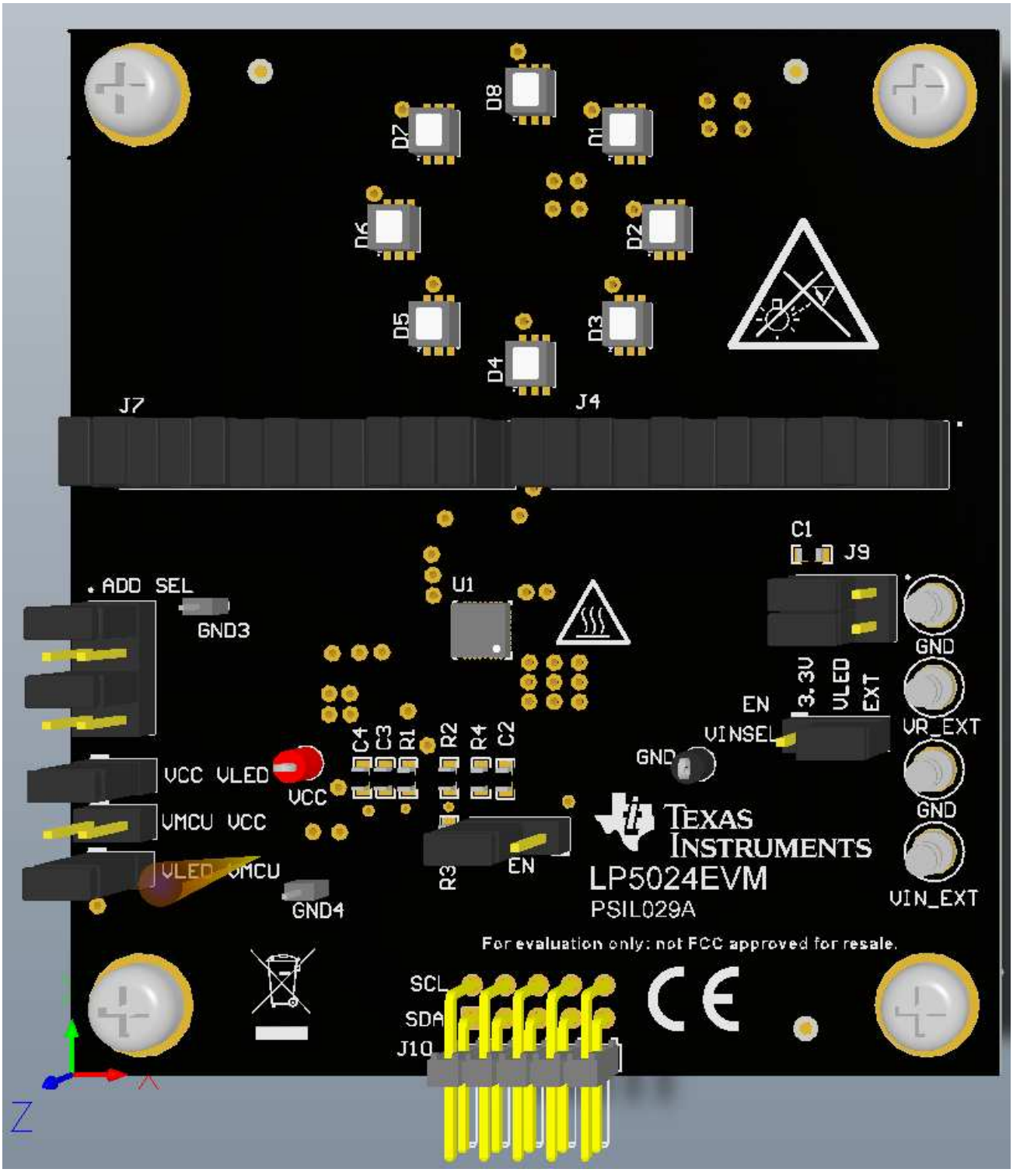


**Figure 15. Top Assembly Layer**



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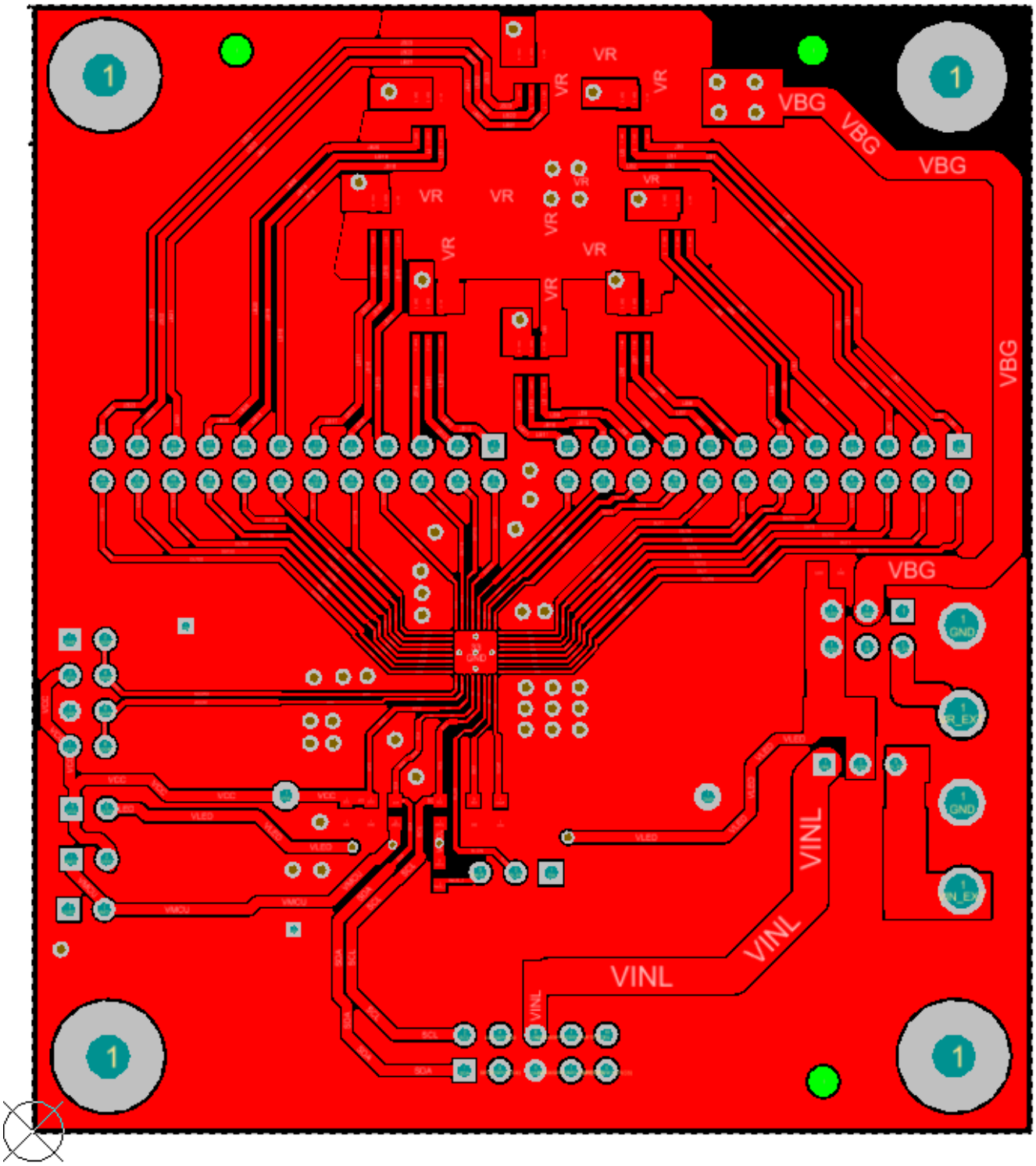


**Figure 16. Top Layer Routing**


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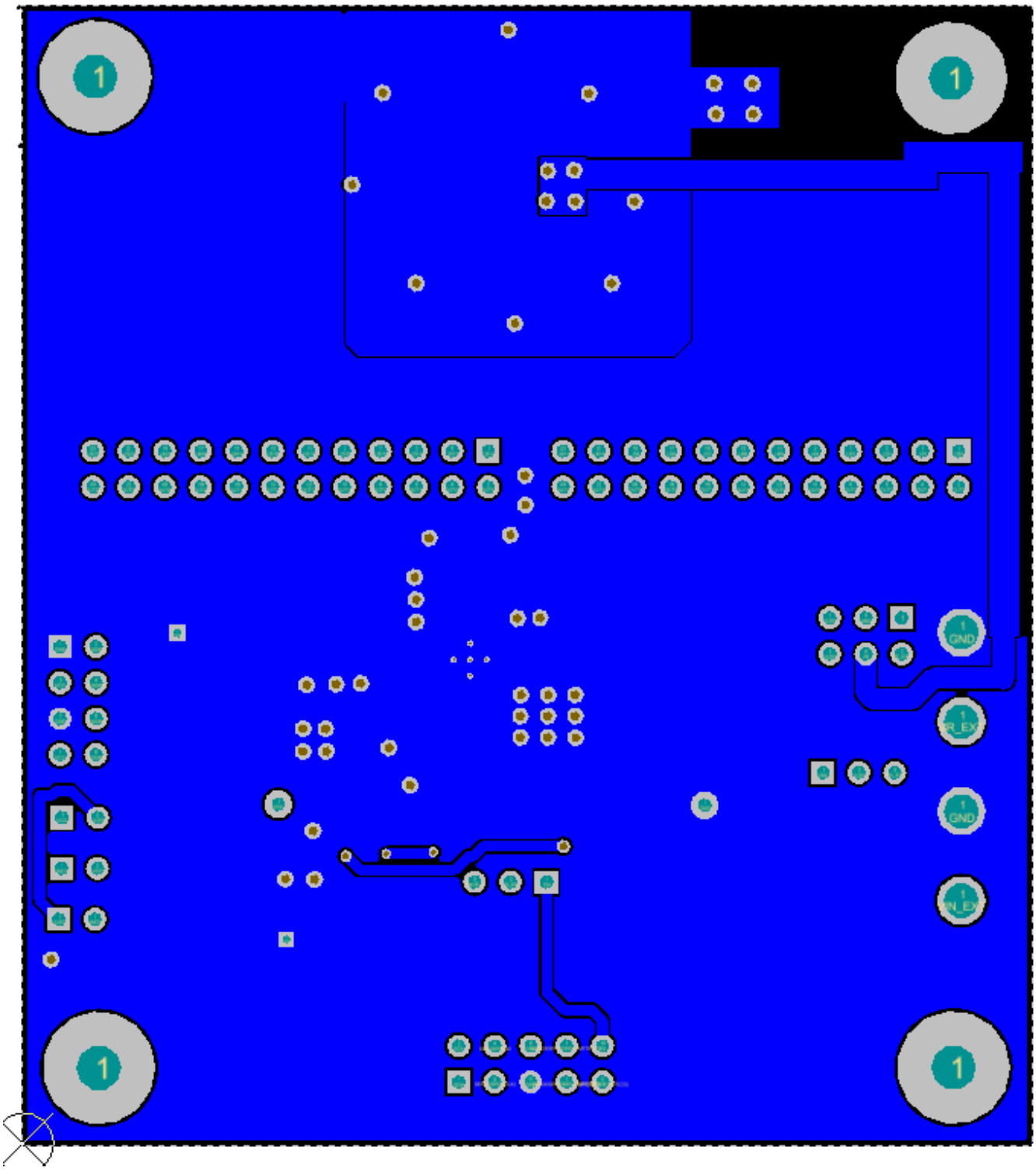


**Figure 17. Bottom Layer Routing (Mirrored)**



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## 4.1 Schematic

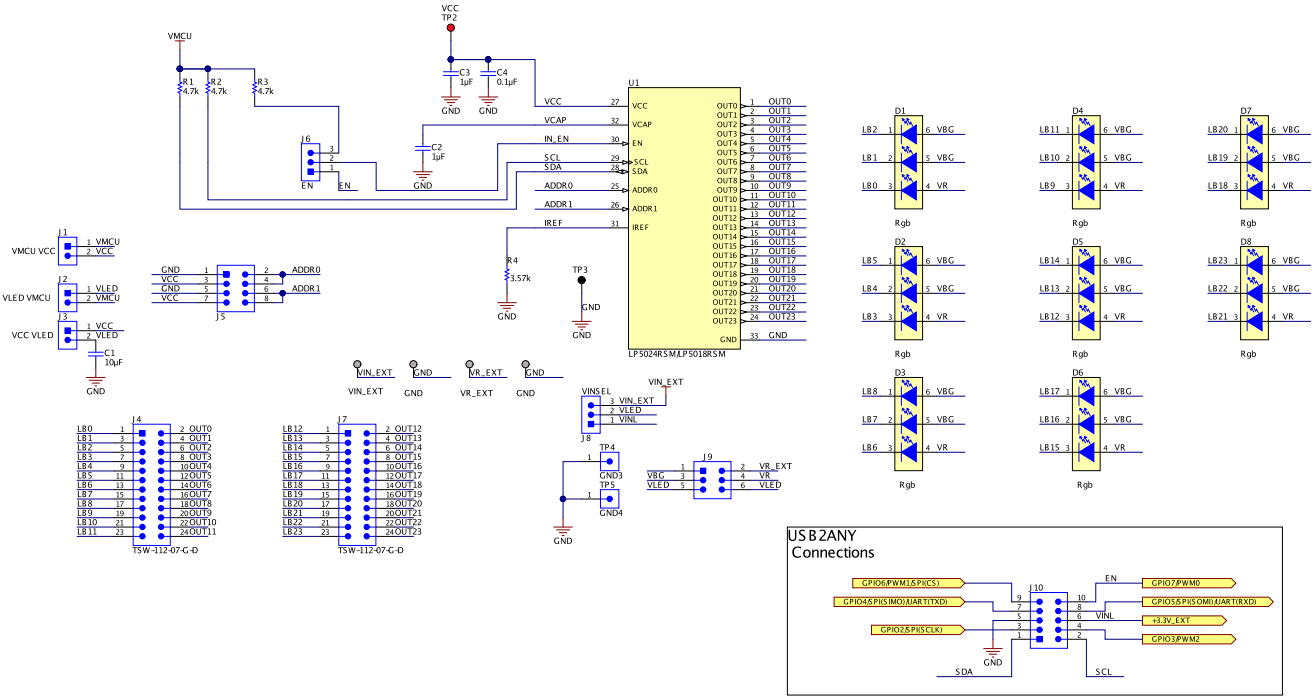


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**Figure 18. LP5024EVM Schematic Diagram**


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## 4.2 BOM

**Table 2. Bill of Materials (BOM)**

| DESIGNATOR | DESCRIPTION | MANUFACTURER | PART NUMBER | QUANTITY |
|---|---|---|---|---|
| C1 | Capacitor, ceramic, 10-µF, 6.3-V, ±10%, JB, 0603 | AVX | C1608JB0J106K080AB | 1 |
| C2, C3 | Capacitor, ceramic, 1-µF, 25-V,±10%, X7R, 0603 | AVX | 06033C105KAT2A | 2 |
| C4 | Capacitor, ceramic, 0.1-µF, 16-V, ±5%, X7R, 0603 | AVX | 0603YC104JAT2A | 1 |
| D1, D2, D3, D4, D5, D6, D7, D8 | LED, RGB, SMD | Avago | ASMT-YTC2-0AA02 | 8 |
| H1, H3, H5, H7 | Standoff, hex, 0.5"L #4-40 nylon | Keystone | 1902C | 4 |
| H2, H4, H6, H8 | Machine screw, round, #4-40 1/4, nylon, Philips pan head | B&F Fastener Supply | NY PMS 440 0025 PH | 4 |
| J1, J2, J3 | Header, 100-mil, 2×1, gold, TH | Samtec | TSW-102-07-G-S | 3 |
| J4, J7 | Header, 100-mil, 12×2, gold, TH | Samtec | TSW-112-07-G-D | 2 |
| J5 | Header, 100-mil, 4×2, gold, TH | Samtec | TSW-104-07-G-D | 1 |
| J6, J8 | Header, 100-mil, 3×1, gold, TH | Samtec | TSW-103-07-G-S | 2 |
| J9 | Header, 100-mil, 3×2, gold, TH | Samtec | TSW-103-07-G-D | 1 |
| J10 | Header, 100-mil, 5×2, gold, R/A, TH | Samtec | TSW-105-08-G-D-RA | 1 |
| R1, R2, R3 | Resistor, 4.7-kΩ, 5%, 0.1-W, 0603 | Vishay-Dale | CRCW06034K70JNEA | 3 |
| R4 | Resistor, 3.57-kΩ, 1%, 0.1-W, 0603 | Yageo America | RC0603FR-073K57L | 1 |
| SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9, SH10, SH11, SH12, SH13, SH14, SH15, SH16, SH17, SH18, SH19, SH20, SH21, SH22, SH23, SH24, SH25, SH26, SH27, SH28, SH29, SH30, SH31, SH32 | Shunt, 100-mil, flash gold, black | Sullins Connector Solutions | SPC02SYAN | 32 |
| TP1, TP6, TP7, TP8 | Terminal, turret, TH, double | Keystone | 1502-2 | 4 |
| TP2 | Test point, miniature, red, TH | Keystone | 5000 | 1 |
| TP3 | Test point, miniature, black, TH | Keystone | 5001 | 1 |
| TP4, TP5 | Header, 1×1, Tin, TH | Samtec | TMS-101-02-T-S | 2 |
| U1 | 24-channel $I^2C$ constant-current RGB LED driver, RSM0032B (VQFN-32) | Texas Instruments | LP5024RSM | 1 |



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