

## **AN-2196 LM3435 Evaluation Board**

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### **1 Introduction**

The Texas Instruments LM3435 Evaluation Board has been designed for evaluating the performance of the device in a typical pico projector application. The end user can interface his own system to the evaluation board to test out the performance of the system. With LM3435, the system requires only single DC-DC converter to drive three color LEDs instead of using three DC-DC converters with conventional design. The suggested approach not only saves components cost, but also releases invaluable PCB space to the system and enhances system reliability. Assuming the handy projector is powered by a single lithium battery cell or a 5Vdc wall mount adaptor, the key specifications of the evaluation board are:

Supply voltage range,  $V_{IN} = 2.7V$  to  $5.5V$

Preset LED current per channel,  $I_{LED} = 1.5A$

Minimum LED current per channel,  $I_{LED(MIN)} = 600mA$

Maximum LED forward voltage drop,  $V_{LED} = 3.5V @ 1.5A$

Flyback converter switching frequency,  $F_{SW} = \sim 500kHz$

### **2 Evaluation Board Schematic Diagram**

The complete schematic diagram of the evaluation board is shown in [Figure 1](#). For the details of the design, please see *LM3435 Compact Sequential Mode RGB LED Driver with I2C Control Interface* ([SNVS724](#)).

### **3 Connecting the Evaluation Board to the System**

The LM3435 Evaluation Board is optimized to run with input voltages ranging from 2.7V to 5.5V and requires a supply current not less than 4.1A for full range operation. A connection diagram to show the configuration between the system and the evaluation board is shown in [Figure 2](#). Proper connections to the I/Os must be confirmed before powering up the board. In order to avoid false triggering of the OPEN/SHORT fault detect of the device, the control pins GCTRL, BCTRL, and RCTRL must be kept in logic "LOW" during power-up.

### **4 Interfacing with the I<sup>2</sup>C Bus**

The current setting resistors only determine the nominal maximum LED current and the actual LED current can be further adjusted on-the-fly by the internal ten bits register for individual channel. The content of these registers are user programmable via standard I<sup>2</sup>C bus. The connection between the system MCU and the I<sup>2</sup>C bus is illustrated in [Figure 2](#). The resolution is 1 out of 1024 part of the LED current setting. The user can program the registers in the range from full output, that is, 1023 (3FFH) to minimum LED current that is restricted by the inductor ripple current amplitude. For Projected On-Time (POT) scheme used in LM3435, a minimum inductor ripple current of  $300mA_{PK-PK}$  is required to maintain proper operation. For the details of the registers addresses and definitions, please see *LM3435 Compact Sequential Mode RGB LED Driver with I2C Control Interface* ([SNVS724](#)).

## 5 Interfacing with the GPIO Bus

The PWM control pins GCTRL, BCTRL, and RCTRL are internally pulled low, push-pull I/O ports are recommended to interface properly with the system MCU. The device enable, EN pin is internally pulled high, so an open drain I/O port is recommended.

## 6 Changing the Preset LED Current

The factory preset LED current of the LM3435 evaluation board is 1.5A. In case the user need to make a change of the preset LED current, it can be done by simply replacing the LED current setting resistors R1, R2 and R3. The  $I_{LED(MIN)}$  condition should not be violated for proper regulation, that is, the  $I_{LED}$  current for all operation conditions must be no less than 600mA with this evaluation board. Some popular values for user's reference are listed in below. For details about the operation and calculations of the components, please see *LM3435 Compact Sequential Mode RGB LED Driver with I2C Control Interface* ([SNVS724](#)).

| Preset LED Current, $I_{LED}$ | R1, R2, R3 Value |
|-------------------------------|------------------|
| 1.5A                          | 16.5k $\Omega$   |
| 1.0A                          | 24.75k $\Omega$  |
| 0.75A                         | 33.0k $\Omega$   |



## 8 Connection Diagrams

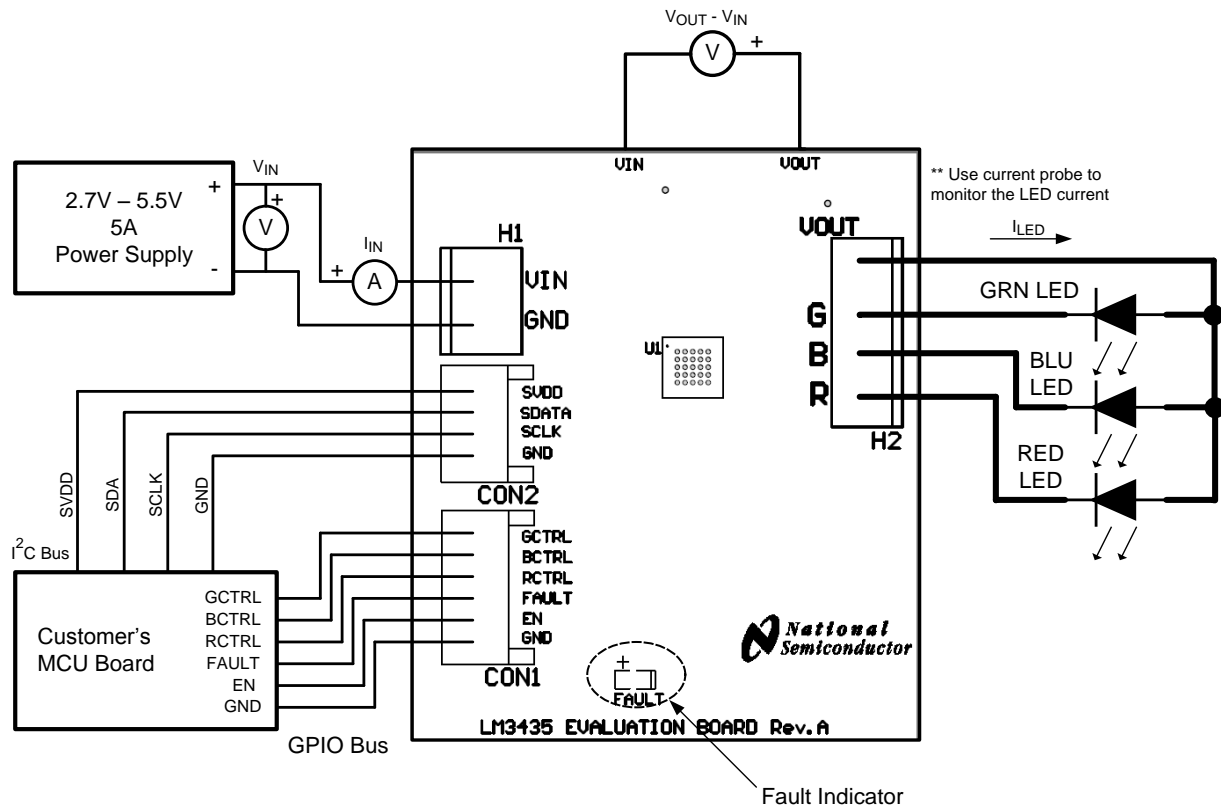


Figure 2. Evaluation Setup Connection Diagram

## 9 Typical Performance Waveforms

All curves taken at  $V_{IN} = 5V$  with configuration in typical application for driving one red (OSRAM LRW5AP-KZMX), one green (OSRAM LTW5AP-LZMY) and one blue (OSRAM LBW5AP-JYKX) LEDs with  $I_{LED} \text{ per channel} = 1.5A$  under  $T_A = 25^\circ C$ , unless otherwise specified.

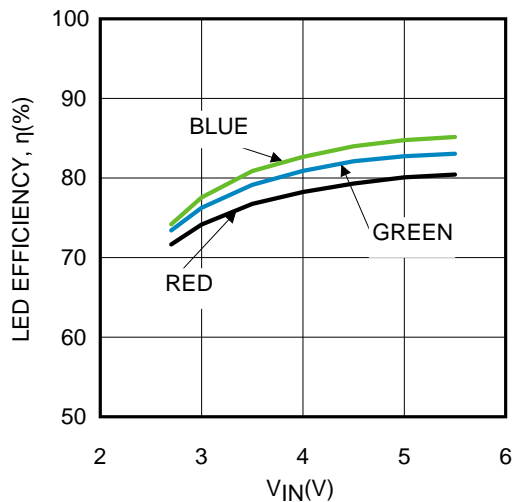


Figure 3. LED Efficiency vs  $V_{IN}$  @  $T_A=25^\circ C$

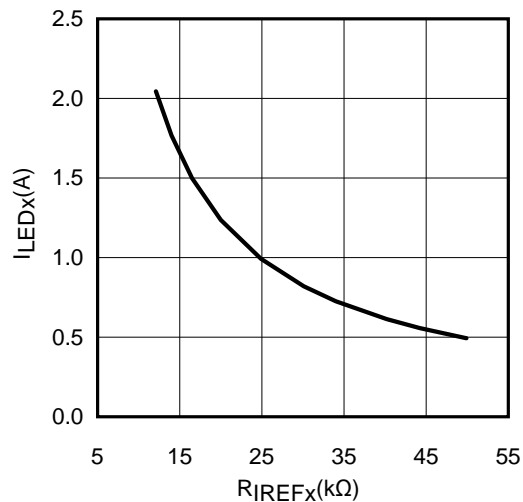


Figure 4.  $I_{LEDx}$  vs  $R_{REFx}$

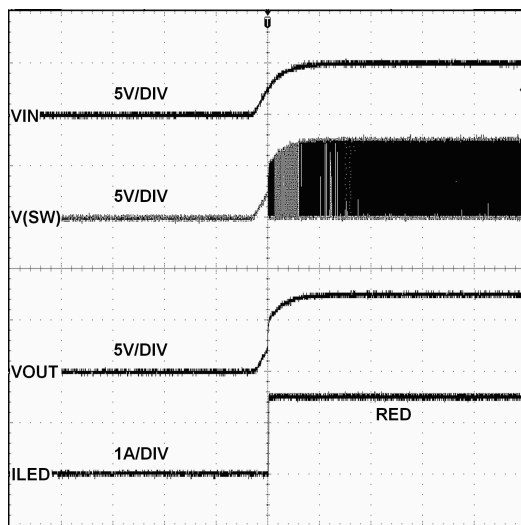


Figure 5. Power Up Transient (10ms/DIV)

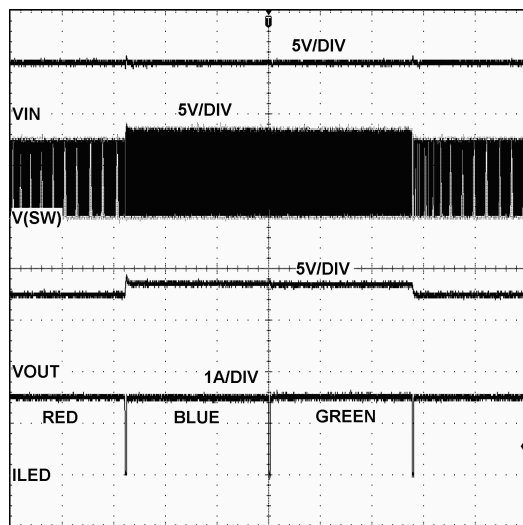
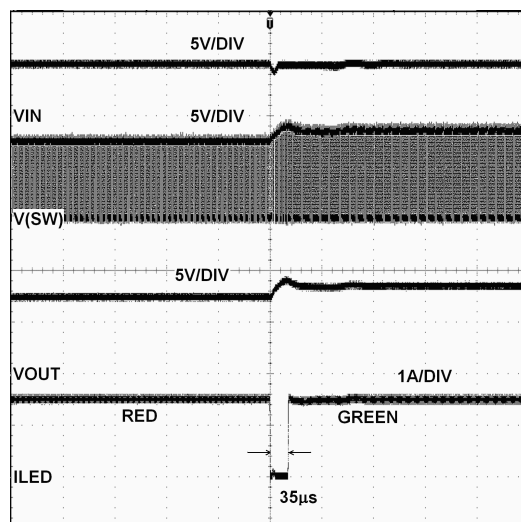


Figure 6. RGB Sequential Mode Operation (1ms/DIV)



**Figure 7. Color Transition Delay (100µs/DIV)**

## 10 Bill of Materials

In order to help customer shorten the design cycle of the target application system, a detailed list of all components used in this evaluation board is provided.

| ID            | Part Number      | Type              | Size      | Parameters               | Qty | Su                |
|---------------|------------------|-------------------|-----------|--------------------------|-----|-------------------|
| U1            | LM3435           | RGB LED Driver IC | WQFN-40   |                          | 1   | Texas Instruments |
| SD1           | RB160M-60        | Schottky Diode    | SOD-123   | 1A, 60V, Vf = 0.49V      | 1   | Rohm              |
| L1            | CDMC6D28NP-2R2MC | Power Inductor    | 7mm x 7mm | 2.2μH, 6A, 19mΩ          | 1   | Sumida            |
| C1, C9        | GRM31CR61A476M   | Ceramic Capacitor | 1206      | 47μF, 10V, X5R           | 2   | Murata            |
| C2            | GRM188R61E104K   | Ceramic Capacitor | 0603      | 0.1μH 25V, X5R           | 1   | Murata            |
| C3, C4A, C4B  | GJ831CR61E106K   | Ceramic Capacitor | 1206      | 10μF, 25V, X5R           | 3   | Murata            |
| C5, C6, C7    | GRM188R71H102K   | Ceramic Capacitor | 0603      | 1nF, 50V, X7R            | 3   | Murata            |
| C8            | GRM188R71A105K   | Ceramic Capacitor | 0603      | 1μF, 10V, X7R            | 1   | Murata            |
| C10, C11, C12 | GRM188R71E474K   | Ceramic Capacitor | 0603      | 0.47μF, 25V, X7R         | 3   | Murata            |
| R1, R2, R3    |                  | SMT Resistor      | 0603      | 16.5kΩ, ±1%              | 3   |                   |
| R4            |                  | SMT Resistor      | 0603      | 499kΩ, ±1%               | 1   |                   |
| R5, R6        |                  | SMT Resistor      | 0603      | 10kΩ, ±1%                | 2   |                   |
| R7            |                  | SMT Resistor      | 0603      | 1kΩ, ±1%                 | 1   |                   |
| FAULT         | LTST-C170EKT     | SMT LED           | 0805      | LED RED ORANGE           | 1   | Lite-On           |
| VIN, VOUT     | 1593-2           | Terminal Pin      | Φ2.35mm   | Turret DBL, 2.34mm       | 1   | Keystone          |
| H1            | B2PS-VH          | Connector Header  |           | 2 Position, Pitch 3.96mm | 1   | JST               |
| H2            | B4PS-VH          | Connector Header  |           | 4 Position, Pitch 3.96mm | 1   | JST               |
| CON1          | 35363-0660       | Connector Header  |           | 6 Position, Pitch 2mm    | 1   | Molex             |
| CON2          | 35363-0460       | Connector Header  |           | 4 Position, Pitch 2mm    | 1   | Molex             |

## 11 PCB Layout

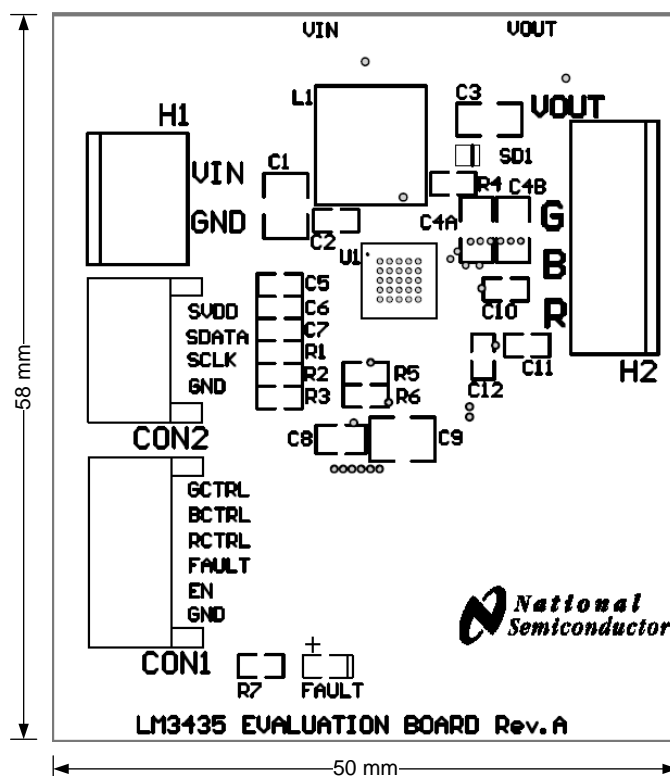
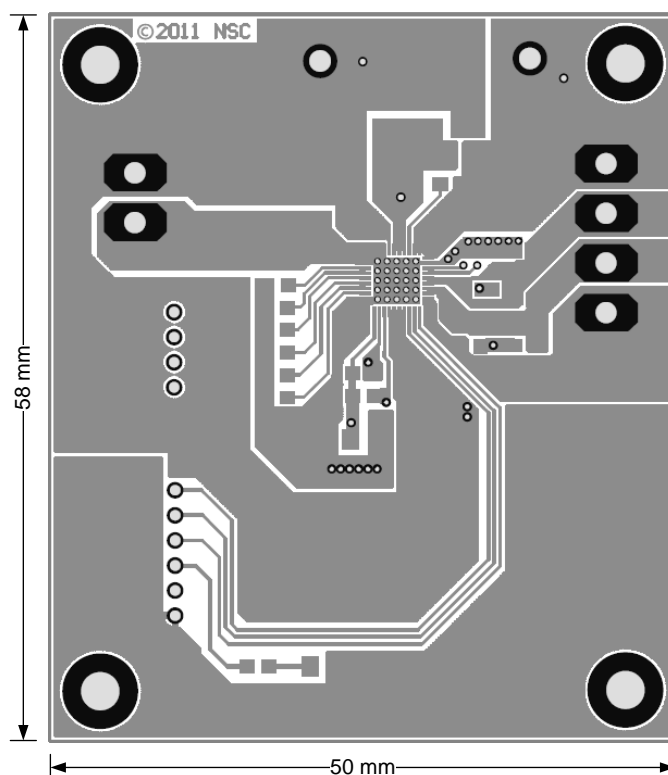
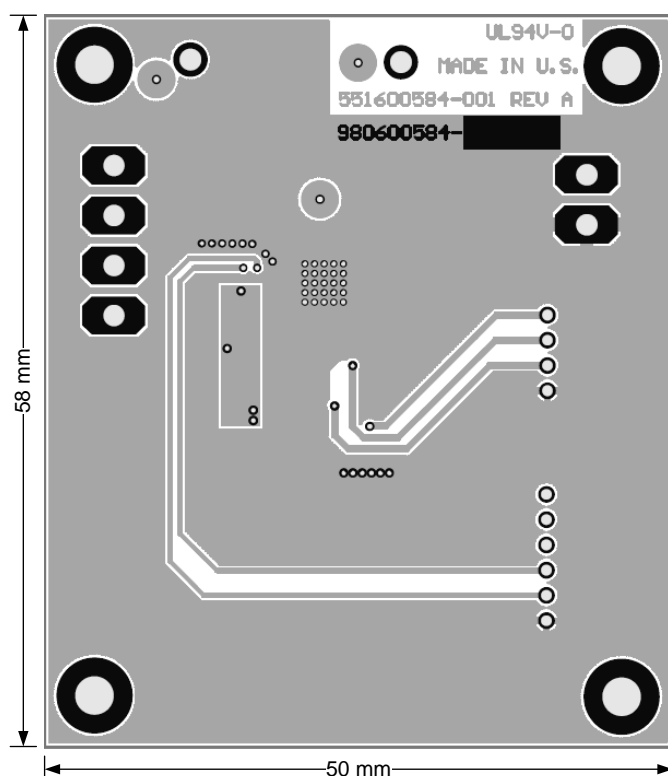


Figure 8. Top Overlay



**Figure 9. Top Layer**



**Figure 10. Bottom Layer**

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