

# AN-1324 LM3570 - Low Noise White LED Driver System

## 1 Introduction

The Texas Instruments LM3570 is a parallel white LED driver capable of running directly off of a lithium-ion battery. The LM3570 has three parallel white-led drivers and a regulated  $V_{OUT}$  pin (4.35V) capable of driving keypad or caller id display (CLI) diodes through the use of ballast resistors. The LM3570 evaluation board has a chip enable pin (active high logic) as well as a PWM (active high logic) pin which allows current sources to be turned on and off without completely disabling the part. The LM3570 is capable of supplying up to 80mA of current split between the regulated current sources and  $V_{OUT}$ . For more detail on the LM3570 features and specifications, see *LM3570 Low Noise White LED Driver System* ([SNVS263](#)).

## 2 Board Operation

### 2.1 LM3570 Functional Description

The LM3570 is a parallel white LED driver capable of running directly off of a lithium-ion battery. The LM3570 has three parallel white-led drivers and a regulated  $V_{OUT}$  pin (4.35V) capable of driving keypad or caller id display (CLI) diodes through the use of ballast resistors. The LM3570 evaluation board has a chip enable pin (active high logic) as well as a PWM (active high logic) pin which allows current sources to be turned on and off without completely disabling the part. The LM3570 is capable of supplying up to 80mA of current split between the regulated current sources and  $V_{OUT}$ .

The LM3570 comes in Texas Instruments LLP-14 package. For more information regarding the LM3570, please refer to the data sheet ([SNVS263](#)).

### 2.2 Basic Connections

To operate the LM3570 evaluation board, connect a supply voltage (2.7V to 5.5V) between board connectors VIN and GND.

Default Jumper Connections:

- EN: Connects the “+” post to the middle post of the EN header strip. This connects VIN to the EN pin of the LM3570, enabling the part.
- PWM: Connects the “+” post to the middle post of the ENA header strip. This connects VIN to the PWM pin of the LM3570, enabling D1-D4 outputs
- Cathode Connect: Jumper connects the two posts of the LEDS\_ON header strip. This connects the cathodes of all 3 LEDs to GND, establishing the LED current path.

When these connections are all made correctly, the bank of LEDs will be ON (D1-D4).

### 2.3 $R_{SET}$ Setting LED Currents

The resistance of the  $R_{SET}$  resistor sets the DC output currents of the LM3570 according to the following equation:

$$I_{DXX} = 100 \times (1.25V / R_{SET}) \text{ (typical)} \quad (1)$$

The default  $R_{SET}$  on the evaluation board is 8.3k $\Omega$ , resulting in a typical DC output current of 15mA.

Component  $R_{SET}'$  is an optional leaded (axial) resistor replacement for the surface mount  $R_{SET}$ .

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## 2.4 EN and PWM Headers: LED Activation and PWM Brightness Adjustment

The header strips EN and PWM can be used to enable/disable the LM3570 and/or the output currents. The connections to the ENx pins provided by these posts can also be used to connect pulse-width modulated (PWM) signals to the LM3570 in order to adjust the average brightness of the LEDs.

On each of these header strips, the post labeled “+” is connected to  $V_{IN}$ . The post labeled “-” is connected to GND. The middle post connects to EN and PWM, respectively.

Jumpers can be used to connect the EN pin to either  $V_{IN}$  or GND. Connecting EN to  $V_{IN}$  enables the charge pump and other internal circuitry of the LM3570. Connecting EN to GND places the part in Shutdown mode.

When the part is enabled ( $EN = V_{IN}$ ), connecting PWM to  $V_{IN}$  enables the D1-D4 LEDs. Connecting PWM to GND disables these LEDs.

Connecting a pulse signal to the PWM pin can be used to adjust the brightness of each bank of LEDs. The duty cycle of the pulse signal determines the net brightness, as perceived by the human eye. For example, with a duty cycle of 50%, the LEDs will only be ON for 50% of the time, and the perceived brightness will be approximately half of what the brightness is when the output current flows continuously through the LEDs. Care must be taken to make sure that the minimum on-time ( $T_{ON} = 100\mu s$ ) is not exceeded. The following equations will ensure that minimum on-time is not violated:

$$D \times (1/f) > T_{ON} \quad (2)$$

$$f_{MAX} = D_{MIN} \div T_{ON} \quad (3)$$

Recommended frequency range for PWM signals: 100Hz to 1kHz.

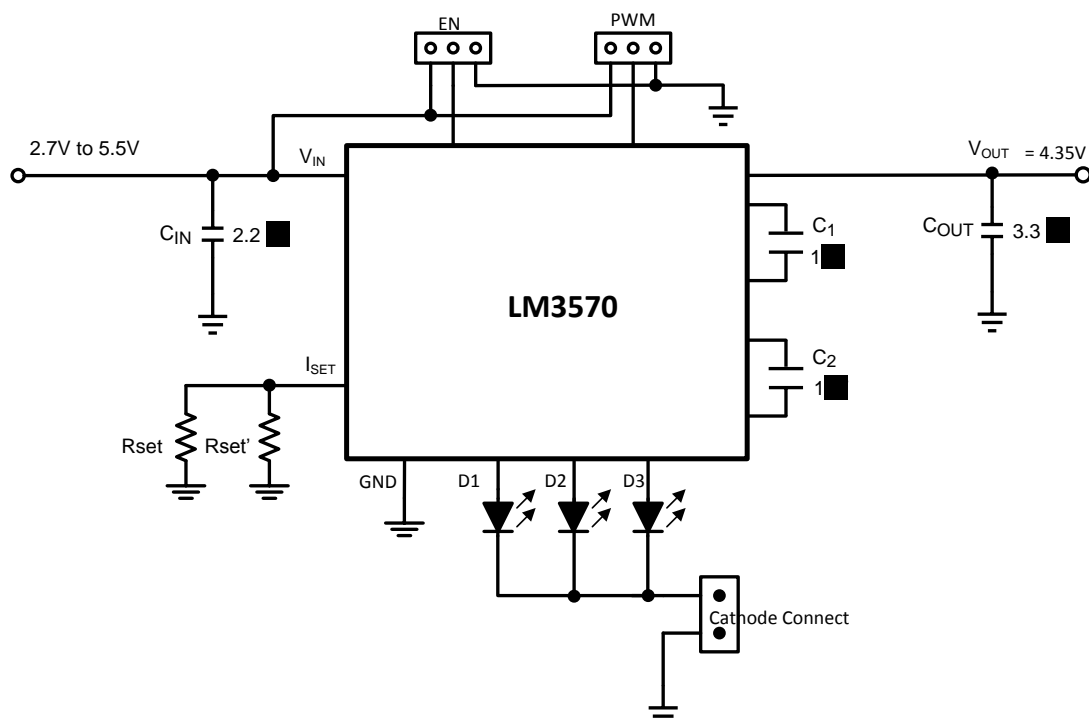
## 2.5 Using the LEDs on Headers to Measure Output Currents

By removing the Cathode Connect jumper, LM3570 output currents can easily be measured. Removing the jumper disconnects the cathodes of all LEDs from GND, breaking the LED current paths. By placing a current meter between the two header pins, the sum total of all LED currents can be measured.

With the Cathode Connect jumper removed, the current of an individual output can be measured by placing a current meter between a Dx header and GND.

With such a connection, the voltage on pin Dx will be almost 0V because the series resistance of the current meter is likely to be quite small. Since the regulated output currents of the LM3570 are almost completely independent of Dx pin voltage (provided  $V_{Dx}$  is not too high for regulation to be achieved), this measurement will still be quite accurate. For an even more precise measurement, however, a resistor or LED can be placed in series with the current meter so that the voltage at pin Dx more closely resembles the expected forward voltage of the LED in the normal application configuration.

### 3 Evaluation Board Schematic



**Figure 1. Evaluation Board Schematic**

**Table 1. Bill of Materials**

Designator	Description	Manufacturer	Model Number
U1	LM3570 Parallel White LED Driver	Texas Instruments	LM3570
D1-3	White LEDs	Osram	LWM67C-T1U1-3C5D
$C_{IN}$	Input Capacitor (2.2 $\mu\text{F}$ ceramic capacitor)	TDK	C1608X5R0J225K
$C_{OUT}$	Input Capacitor (3.3 $\mu\text{F}$ ceramic capacitor)	TDK	C2012X5R1A335K
C1, C2	Flying Capacitor (1.0 $\mu\text{F}$ ceramic capacitor)	TDK	C1608X5R1A105K
Rset	8.3k	Vishay-Dale	CRCW06048251F

#### 4 LM3570 Evaluation Board Layout

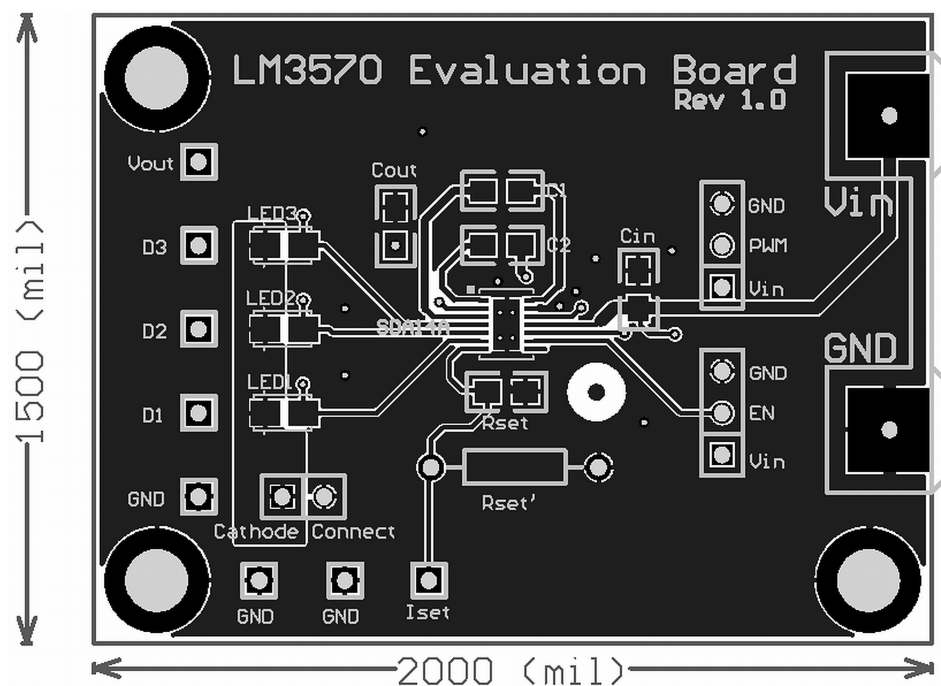


Figure 2. Top Layer

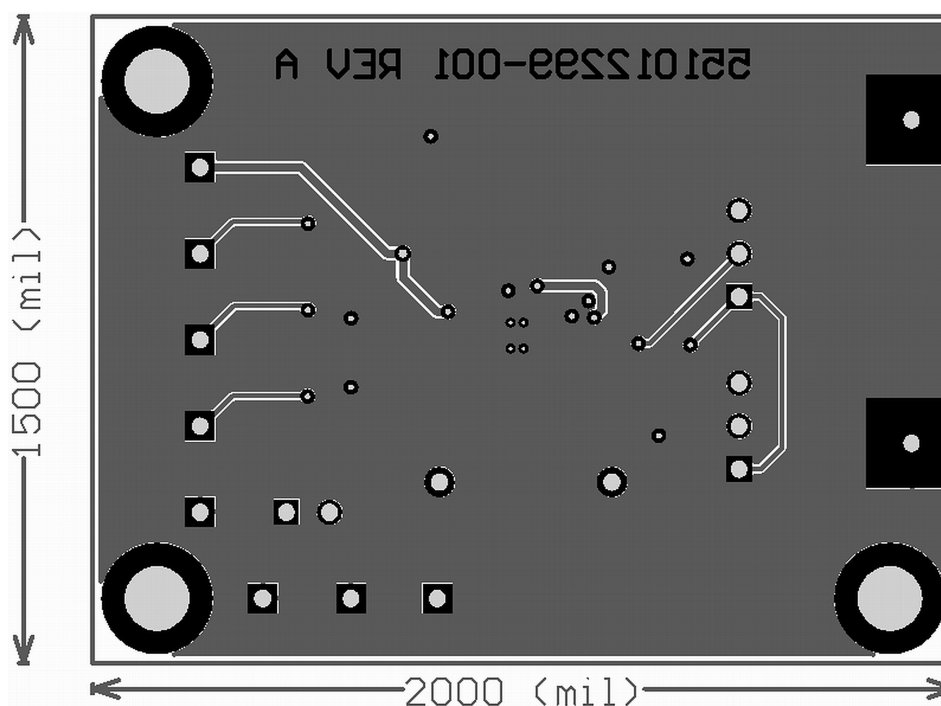


Figure 3. Bottom Layer (top view, unmirrored)

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