THE DATASHEET OF

LM3401-MR16DEMO/NOPB

AN-1996 LM3410X 190mA, LED Driver 6-Pin LLP Evaluation Board

1 Introduction

This evaluation board showcases the LM3410X as a boost LED driver. It is designed to drive four, on-board LEDs (V_{OUT} = 11.4 V) in series at an average LED current (I_{LED}) of 190mA. The circuit can accept an input voltage of 3.3 V-5.5 V. The switching frequency of the LM3410X converter is 1.6MHz allowing the use of small surface mount inductors and chip capacitors. This evaluation board also features the PWM capability of the LM3410 by enabling the user to apply a periodic pulse signal to the DIM terminal of varying duty cycle.

This is a 2-layer board using the bottom layer as a ground plane. A schematic and layout are shown below along with measured performance characteristics. A bill of materials is also provided that describes the parts used on this evaluation board. The above restrictions for the input voltage are valid only for the evaluation board as shipped with the evaluation board schematic shown in Figure 1.

Operating Conditions:

- V_{IN} = 3.3 V to 5.5 V
- $V_{OUT} \cong V_F \times 4 + V_{FB} \cong 2.8\ V \times 4 + 0.190\ V \cong 11.4\ V$
- $I_{LED} \cong 190$ mA

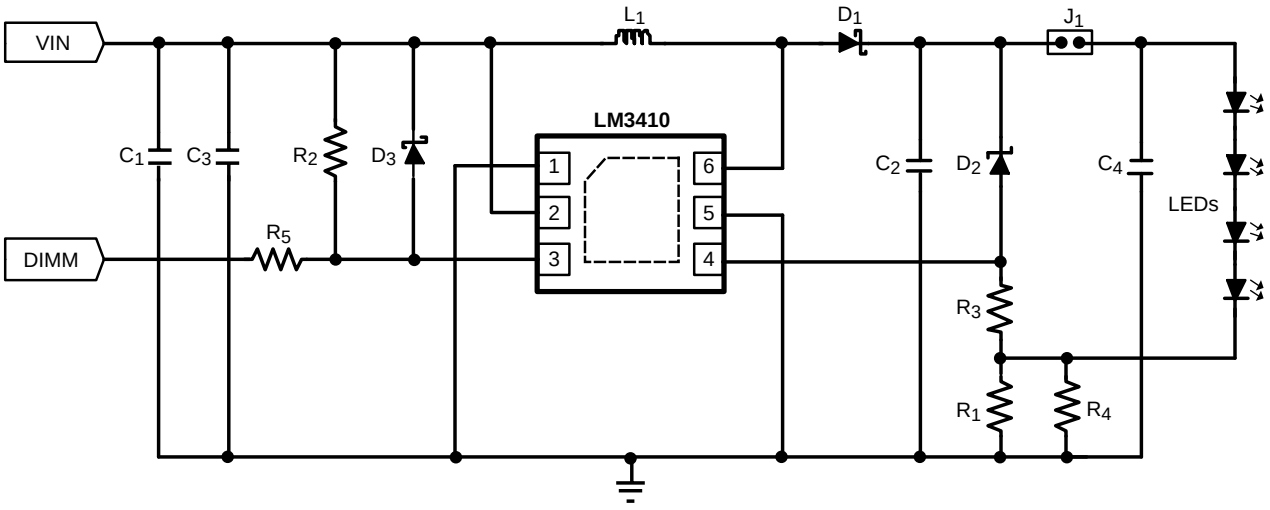

Figure 1. Schematic

Table 1. Pin Descriptions

Pin	Name	Function
1	PGND	Power ground pin. Place PGND and output capacitor GND close together.
2	V_{IN}	Supply voltage for power stage, and input supply voltage.
3	DIM	Dimming & shutdown control input. Logic high enables operation. Duty Cycle from 0 to 100%. Do not allow this pin to float or be greater than V_{IN} + 0.3 V.
4	FB	Feedback pin. Connect FB to external resistor divider to set output voltage.
5	AGND	Signal ground pin. Place the bottom resistor of the feedback network as close as possible to this pin & pin 4.
6	SW	Output switch. Connect to the inductor, output diode.
DAP	GND	Signal & Power ground. Connect to pin 1 and pin 5 on top layer. Place 4-6 vias from DAP to bottom layer GND plane.

Table 2. Bill of Materials

Part ID	Part Value	Manufacturer	Part Number
U1	2.8A I_{SW} LED Driver	TI	LM3410X
C1, Input Cap	10µF, 6.3 V, X5R	TDK	C2012X5R0J106M
C2, Output Cap	2.2µF, 25 V, X7R	TDK	C3225X7R1E225K
C3, Input Cap	Placeholder (not stuffed)	-	-
C4, Output Cap	4.7µF, 25 V, X7R	TDK	C3225X7R1E475K
D1, Catch Diode	0.4 V_f Schottky, 500mA	ON Semiconductor	MBR0530T1G
D2	15 V Zener Diode	Central Semiconductor	CMHZ4702
D3	0.4 V_f Schottky, 500mA	ON Semiconductor	MBR0530T1G
L1	3.3µH, 5.4A	Coilcraft	DO3316P-332
R1	1Ω, 1%	Vishay	CRCW12061R00FNEA
R2	Placeholder (not stuffed)	-	-
R3	100Ω, 1%	Vishay	CRCW0603100RFKEA
R4	Placeholder (not stuffed)	-	-
R5	6.8kΩ, 1%	Vishay	CRCW08056K80FKEA
J1	Jumper	Samtec	TSW-102-07-T-S
SH-J1	Jumper shunt	Tyco Electronics	2-382811-1
LEDs	700mA, $V_f \cong$ 3.4 V	Cree	XPEWHT-L1-0000-008E5

2 Setting the LED Current

The default forward current I_{LED} delivered to the LED array is 190mA. To adjust this value, the current setting resistors R1 and R4 can be changed according to the following equation:

$I_{LED} = (V_{FB})/(R1 \parallel R4)$

The feedback voltage V_{FB} is regulated at 0.190 V typically. The resistors R1 and R4 should be rated to handle the power dissipation of the LED current.

3 PWM Dimming

The default set-up of the DIM terminal is to enable PWM dimming. If PWM dimming is not required, then the DIM pin can be tied to V_{IN} through a resistor, R2, using the existing 0805 sized resistor footprint. This enables the LM3410 whenever V_{IN} is applied and allows the set I_{LED} current to flow through the LEDs continuously. A recommended value for R2 is 100kΩ.

A periodic pulse signal at different frequencies and/or duty cycle can be applied to the evaluation board's DIM terminal for PWM dimming. The voltage measured at the DIM package lead must not be higher than 0.3 V above V_{IN} for proper operation. Diode D3 and resistor R5 have been placed in the circuit to clamp the signal at the DIM lead to no greater than 0.3 V above V_{IN}. Although not recommended, a PWM signal can therefore be applied to the evaluation board DIM terminal with a peak voltage greater than V_{IN}.

4 Over-Voltage Protection

The evaluation board includes over-voltage protection (OVP) circuitry, in the combination of zener diode D4 and resistor R3, to protect the LM3410 device in a situation where the output load is suddenly removed from the rest of the converter (i.e. an LED goes open). A header (J1) on the board allows the user to activate the OVP function by removing the associated jumper. The switching voltage at the SW pin will then be clamped to approximately the zener diode voltage of 18 V. Current will then flow through D4, R3 and sense resistor R1. This generates a voltage greater than 0.190 V at the FB pin that forces the LM3410's internal switching power FET to turn off, thereby, preventing an over-voltage condition at the SW pin and damaging the LM3410.

5 Typical Performance Characteristics

T_A = +25°C, V_{OUT} = 11.4 V, unless otherwise specified.

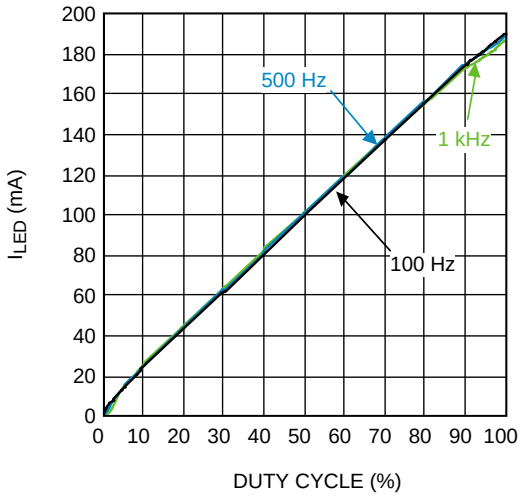

Figure 2. PWM Dimming, V_{IN} = 3.3 V

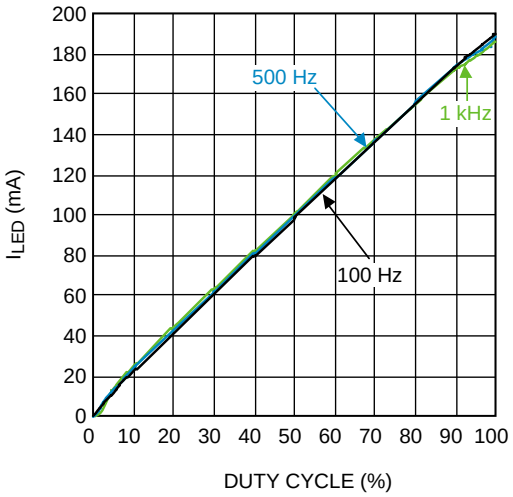

Figure 3. PWM Dimming, V_{IN} = 5.5 V

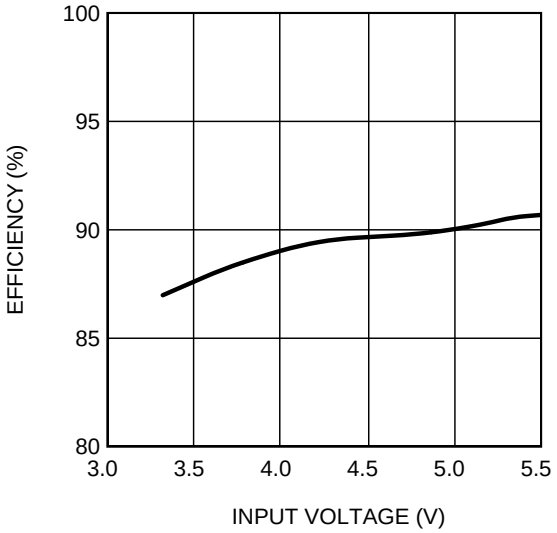

Figure 4. Efficiency vs. Input Voltage, I_{LED} = 190 mA

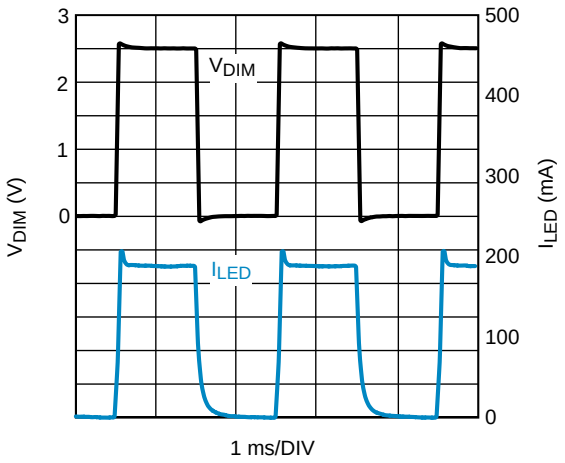

Figure 5. 500Hz PWM Dimming, 50% Duty Cycle, V_{IN} = 3.3 V

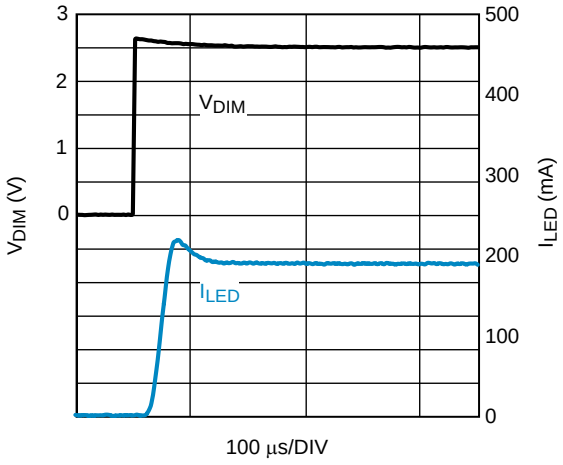

Figure 6. 500Hz PWM Dimming (Rising Edge), 50% Duty Cycle, V_{IN} = 3.3 V

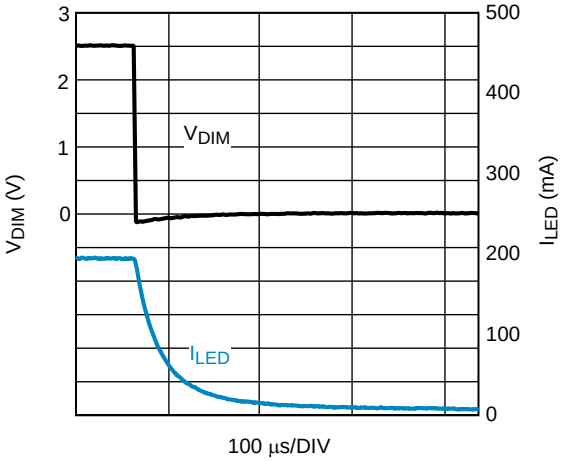

Figure 7. 500Hz PWM Dimming (Falling Edge) 50% Duty Cycle, V_{IN} = 3.3 V

6 Two Power Supply Design with 12 V > V_{PWR} > 5.5 V

The evaluation board can be modified to allow the user to derive the power from an input supply that is larger than 5.5 V. In Figure 8, two separate supplies are needed. V_{IN} must be between 3.3 V minimum to 5.5 V maximum, but V_{VPWR} can be as great as 12 V. The recommended power-up sequence is V_{IN} then V_{PWR}. Power-down should be in the reverse order.

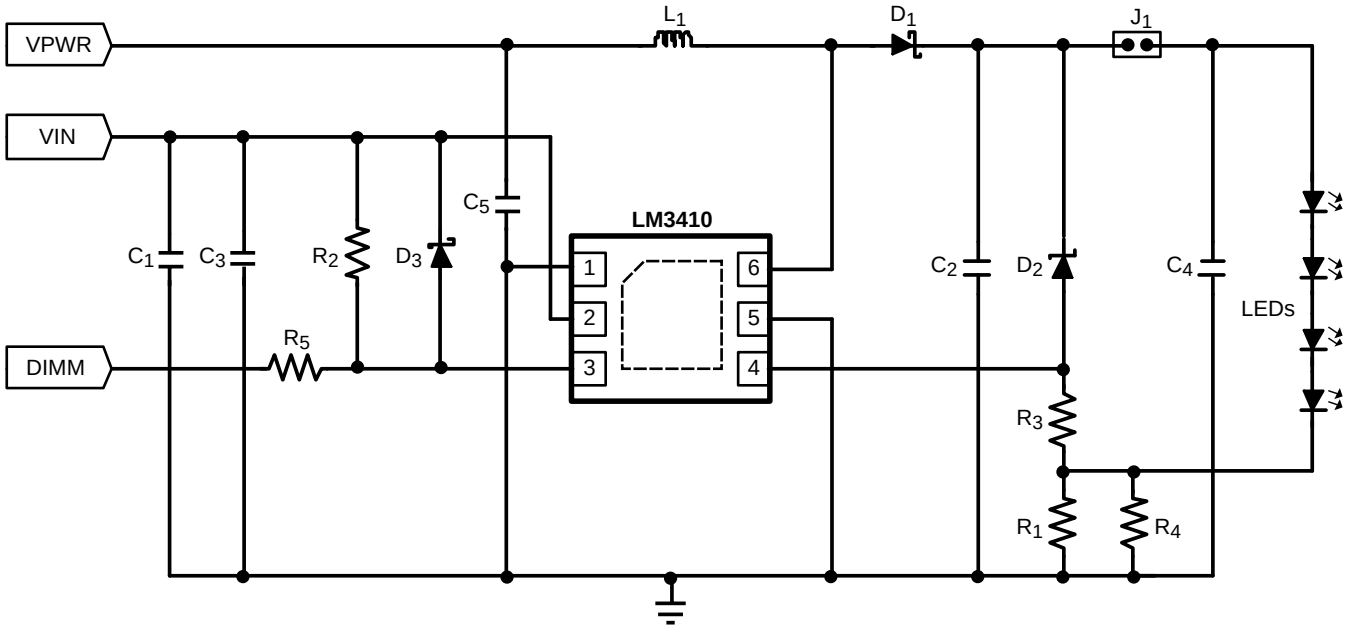

Figure 8. Two Power Supply Schematic

Table 3. Bill of Materials (BOM) - Two Power Supply Design

Part ID	Part Value	Manufacturer	Part Number
U1	2.8A I_{SW} LED Driver	TI	LM3410X
C1, V_{IN}, Input Cap	10µF, 6.3 V, X5R	TDK	C2012X5R0J106M
C2, Output Cap	2.2µF, 25 V, X7R	TDK	C3225X7R1E225K
C3, Input Cap	Placeholder (not stuffed)	-	-
C4, Output Cap	4.7µF, 25 V, X7R	TDK	C3225X7R1E475K
C5, V_{PWR}, Input Cap	10µF, 25 V, X5R	TDK	C3225X5R1E106M
D1, Catch Diode	0.4 V_f Schottky, 500mA	ON Semiconductor	MBR0530T1G
D2	15 V Zener Diode	Central Semiconductor	CMHZ4702
D3	0.4 V_f Schottky, 500mA	ON Semiconductor	MBR0530T1G
L1	3.3µH, 5.4A	Coilcraft	DO3316P-332
R1	1Ω, 1%	Vishay	CRCW12061R00FNEA
R2	Placeholder (not stuffed)	-	-
R3	100Ω, 1%	Vishay	CRCW0603100RFKEA
R4	Placeholder (not stuffed)	-	-
R5	6.8kΩ, 1%	Vishay	CRCW08056K80FKEA
J1	Jumper	Samtec	TSW-102-07-T-S
SH-J1	Jumper shunt	Tyco Electronics	2-382811-1
LEDs	700mA, V_f ≅ 3 .4 V	Cree	XPEWHT-L1-0000-008E5

7 PCB Layout

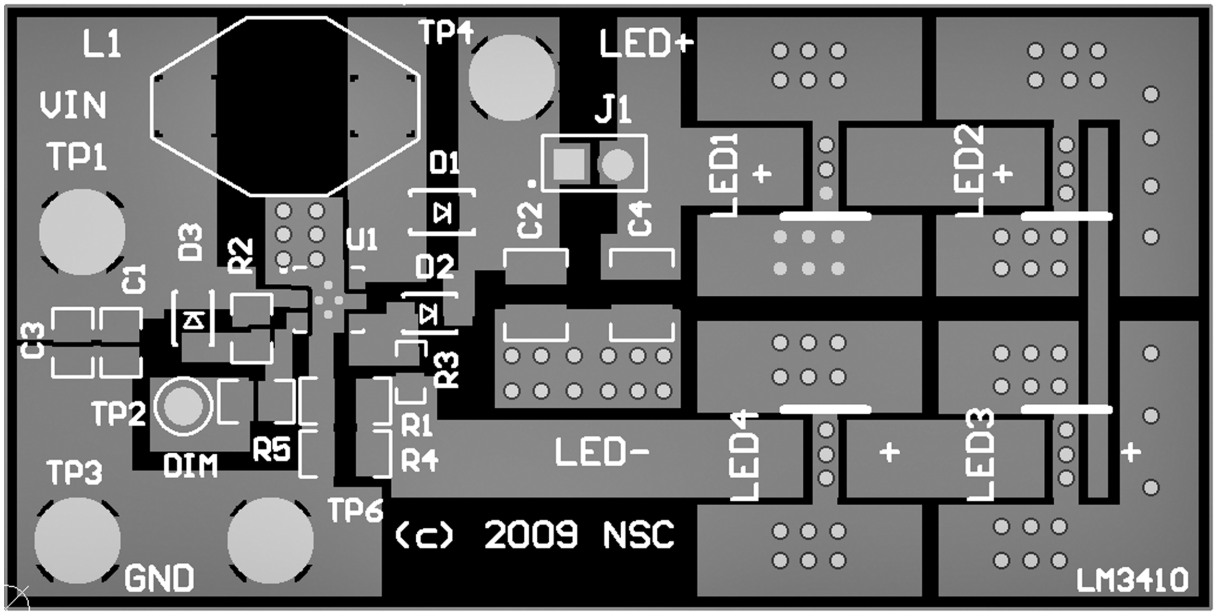

Figure 9. Top Layer

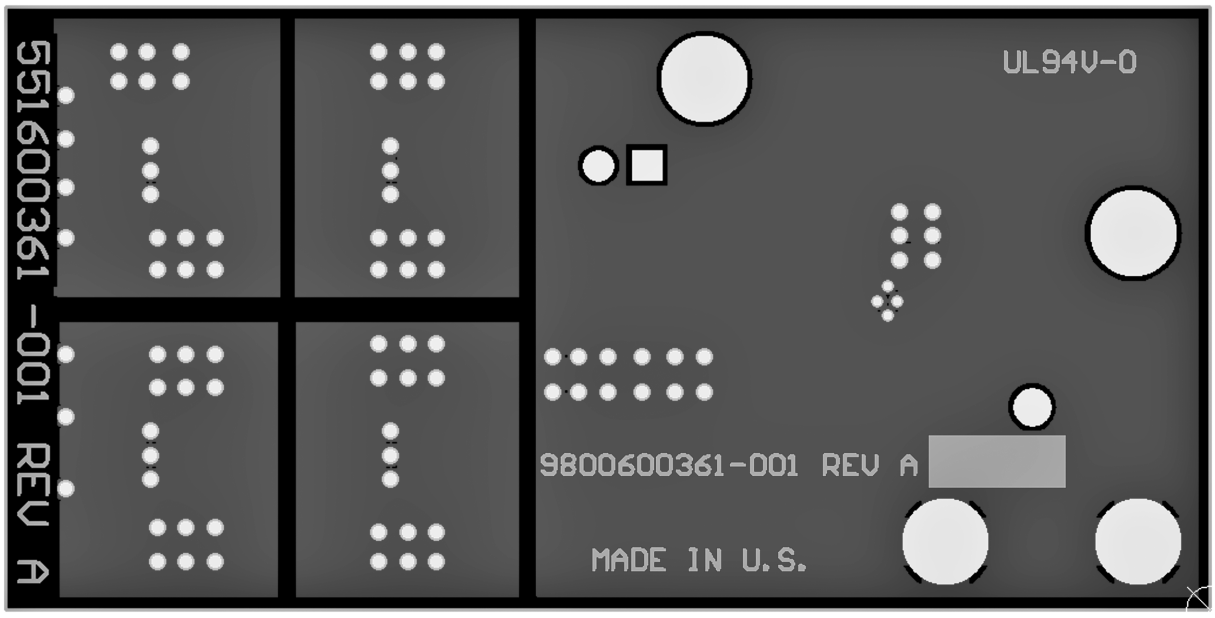

Figure 10. Bottom Layer

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