

No Boost Inductor Design with LM364x for Long-Time Focusing in Camera Module



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ABSTRACT

In smartphone application, LED flash driving unit plays very important role in different working pattern, such as Vlog mode, video mode, camera mode. Higher performance of LED flash driving unit will make end-user's experience feel better. Texas Instruments released LM364x (LM3642, LM3643, LM3648, LM3644, and LM36010) family, this series LED flash driver with less than 1.69×1.31 BGA package which can support up to 2-channel LED. In this application report, it provides a novel idea to make total PCB size more compact and cost saving without boost inductor. LM364x family can help designers to implement LED flash driving unit design easily with better performance.

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2 No Boost Inductor Flash Driving Design with LM3644

2.1 Why Try to Not Use Boost Inductor Solution?

In most smart-phone applications, the UVP threshold of system is more than 3.6 V, and most of LED forward voltage-drops at 1 A or 1.5 A flash current condition is 3 V around, at this condition, flash driver will work in linear mode or bypass mode, it means boost inductor will not participate, at this point, boost inductor prefers a normal copper wire. For designers, they can remove boost inductor to save more PCB area and solution cost.

2.2 No Boost Inductor Schematic of LM3644 for Two LED

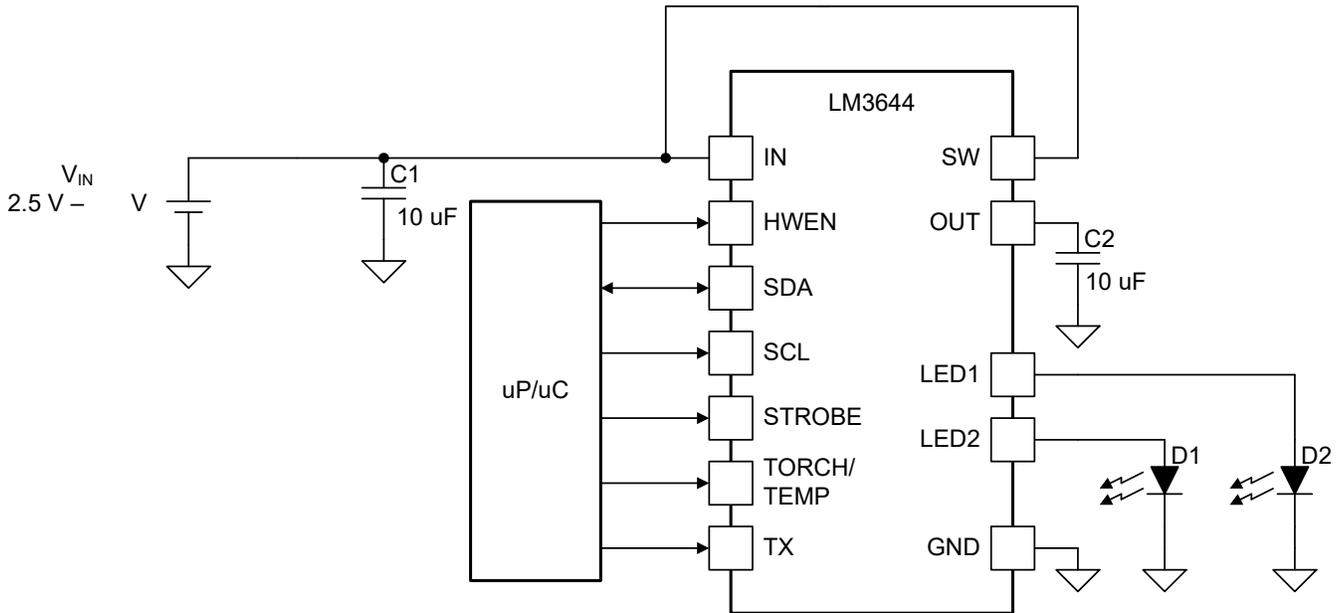


Figure 2-1. LM3644 Dual Channel Without Boost Inductor Simplified Schematic for Two LEDs

2.3 No Boost Inductor Schematic of LM3644 for Single LED

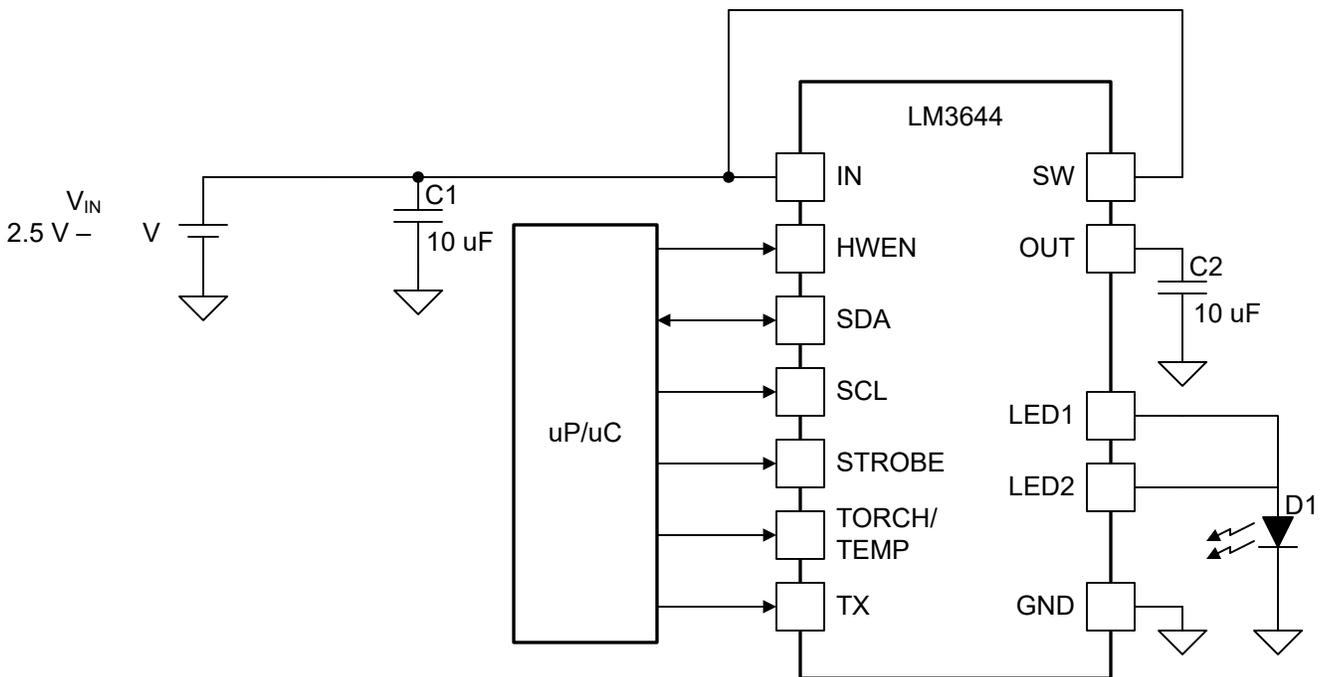


Figure 2-2. LM3644 Dual Channel without Boost Inductor Simplified Schematic for Single LED

2.4 Real Design Sample for No Boost Inductor Design, Torch Mode, Single LED

For a special application, such as for high brightness and long-time focusing in camera module, the total current is 500 mA and focusing adjust time would be 10s or more, so at this condition, torch mode will meet this target.

Condition

- $V_{IN} = 3.7\text{ V}$
- $I_{LED_total} = 500\text{ mA}$, 2 channel are connected together, per channel provides 250 mA
- Torch mode
- Torch time = 2s
- $V_{LED_Forward} = 3.3\text{ V}$

Register Configuration

- Set Pass Mode: bit 2 of register 0x07 should be 1 to enter Pass Mode
- Set Torch Mode: bit 3 and 2 of register 0 × 01 should be 10 to enter Torch Mode
- Set LED current: for each channel bit 6~0 of register 0 × 06 should be 0010 1100 to set 125 mA for each channel
- Enable LED1 + LED2: bit 1 and 0 of register 0 × 01 should be 11 to turn on LED1 and LED2
- Wait for 2s or other expected delay time
- Disable LED1 + LED2: bit 1 and 0 of register 0 × 01 should be 00 to turn off LED and LED2

LED2 Torch Brightness Register (0x06)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RFU	LED2 Torch Brightness Levels $I_{TORCH1/2}\text{ (mA)} \approx (\text{Brightness Code} \times 1.4\text{ mA}) + 0.977\text{ mA}$ or $I_{TORCH1/2}\text{ (mA)} \approx (\text{Brightness Code} \times 2.8\text{ mA}) + 1.954\text{ mA}$ (LM3644TT) 0000000 = 0.977 mA or 1.954 mA (LM3644TT) 0111111 = 89.3 mA (Default) or 178.6 mA (LM3644TT) 1111111 = 179 mA or 360mA (LM3644TT)						

Boost Configuration Register (0x07)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Software Reset Bit 0 = Not Reset (Default) 1 = Reset	RFU	RFU	RFU	LED Pin Short Fault Detect 0 = Disabled (Default) 1 = Enabled	Boost Mode 0 = Normal (Default) 1 = Pass Mode Only	Boost Frequency Select 0 = 2 MHz (Default) 1 = 4 MHz	Boost Current Limit Setting 0 = 1.9 A (Default) 1 = 2.8 A (Default)

Enable Register (0x01)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX Pin Enable 0 = Disabled (Default) 1 = Enabled	Strobe Type 0 = Level Triggered (Default) 1 = Edge Triggered	Strobe Enable 0 = Disabled (Default) 1 = Enabled	TORCH/TEMP Pin Enable 0 = Disabled (Default) 1 = Enabled	Mode Bits: M1, M0 00 = Standby (Default) 01 = IR Drive 10 = Torch 11 = Flash		LED2 Enable 0 = OFF (Default) 1 = ON	LED1 Enable 0 = OFF (Default) 1 = ON

Figure 2-3. LM3644 Register Map

Figure 2-4 and Figure 2-5 shows the test results.

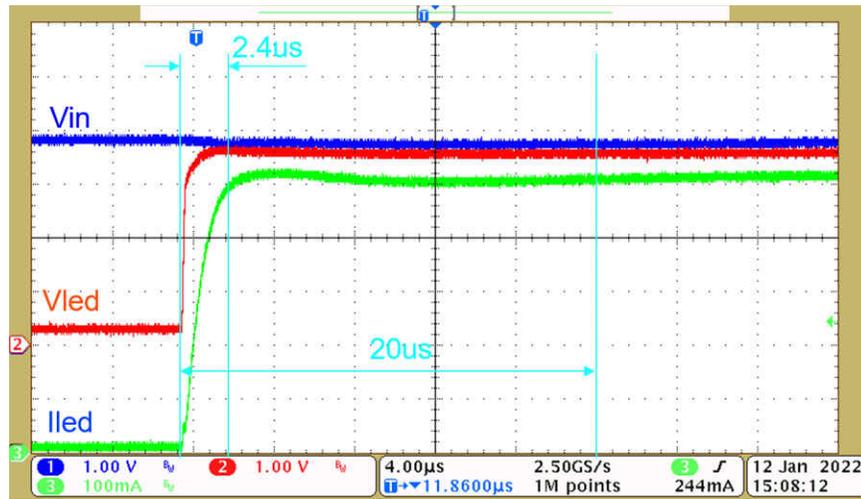


Figure 2-4. LM3644 Input and Output

Summary

- Rising time is 2.4 µs from 0 to 500 mA
- After 20 µs, the output current becomes stable

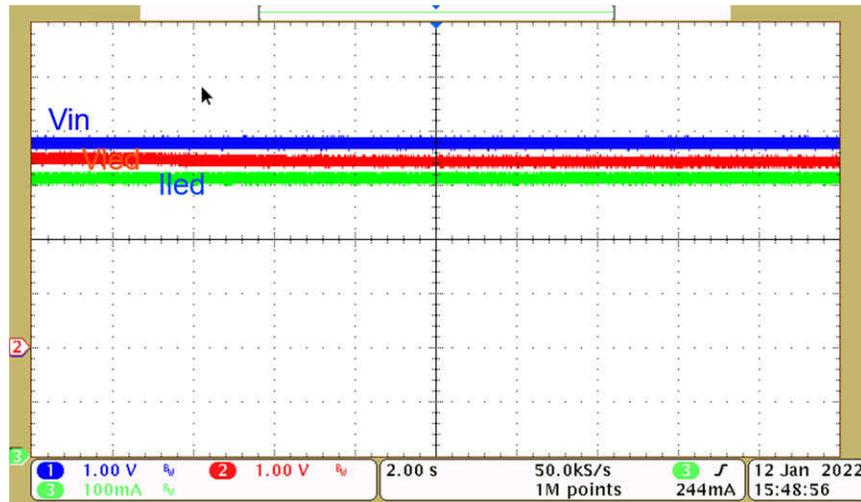


Figure 2-5. V_{dropout} of LED

Summary

- Keep torch time for 20s
- V_{dropout} ($V_{\text{in}} - V_{\text{led}}$) is about 350 mV, and this value is reasonable since the V_{hr} is 270 mV@typ and PFET conduction drop is $0.5 \text{ A} * 86 \text{ mOhm} = 43 \text{ mV}$

3 PCB Layout Tips for LM3644 Without Boost Inductor

A good PCB layout will guarantee good performance, so designer has to pay more attention on PCB layout. A good example with LM3644 without boost inductor is shown in [Figure 3-1](#).

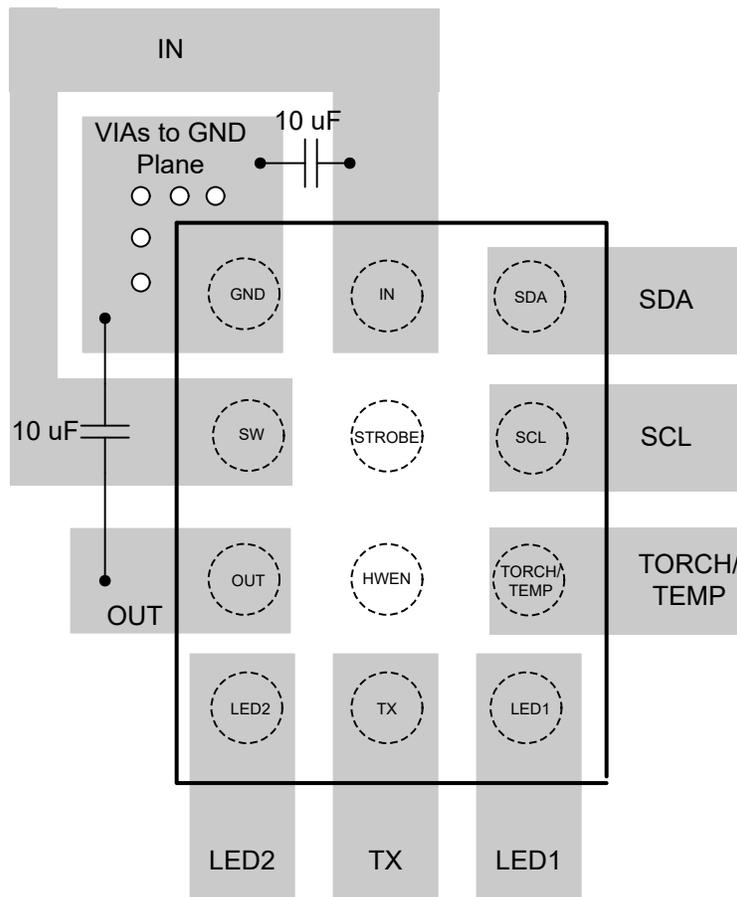


Figure 3-1. LM3644 Dual Channel PCB Layout

- Placed C_{IN} , C_{OUT} capacitors close to LM3697, the power trace should be short and wide to decrease power loss on PCB trace
- GND pin should be connected to main ground plane directly to get better thermal sink and better EMI performance

4 References

- Texas Instruments, [LM3644 Dual 1.5-A Current Source Camera Flash LED Driver](#) data sheet.

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