Using the LM3643/4/8 in an Inductorless and/or Simplified PCB Routing Configuration

1 Introduction

The LM3643, LM3644 and LM3648 are a family of high-power LED flash drivers designed to be a lighting source in many applications ranging from a mobile-phone, front-facing "selfie" flash to a flashlight/torch on a handheld point-of-sale (POS) terminal. While each device is highly configurable, there are designs where the full feature set may not be needed or where the fine pitch of the device (0.4 mm) could be prohibitive. To help highlight these auxiliary use cases, this application note discusses how to use the LM3643/4/8 family of devices, without an inductor, for applications that do not require the DC-DC boost converter, as well as a use case where the LM3643/4/8 family can be placed on a PCB without the use of micro vias for the center bumps.

2 No Inductor Use Case

For lighting applications that always have an input voltage higher than the LED forward voltage, the inductor for the DC-DC converter on the LM3643/4/8 parts can removed from the bill of materials (BOM) with little, or no, impact on the light quality. In many cases, the inductor is the largest passive component in the flash-driver solution, and its removal can shrink the overall printed circuit board footprint dramatically while lowering the overall BOM cost. There are a few key system-related items that must be evaluated before removing the inductor from the BOM.

2.1 Maximum Allowed LED Forward Voltage

To determine whether or not the inductor can be used for a given application, confirm that the maximum LED forward voltage at the target current is less than minimum supply voltage minus the voltage drops across the LM3643/4/8. Find the maximum LED voltage for a given current and input voltage using a simple equation:

$$V_{IN\ MIN} = (I_{LEDTOTAL} \times R_{PMOS}) + V_{LED} + V_{HR} \quad (1)$$

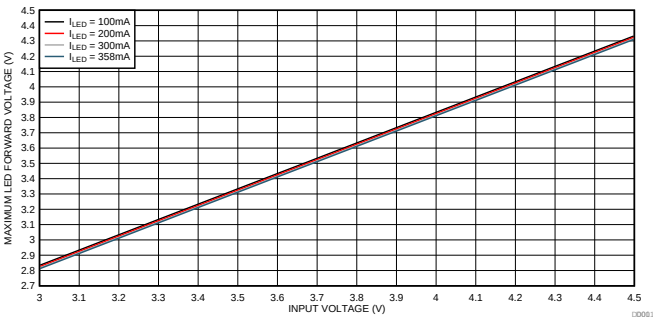


Figure 1. Maximum LED Voltage in Torch Mode

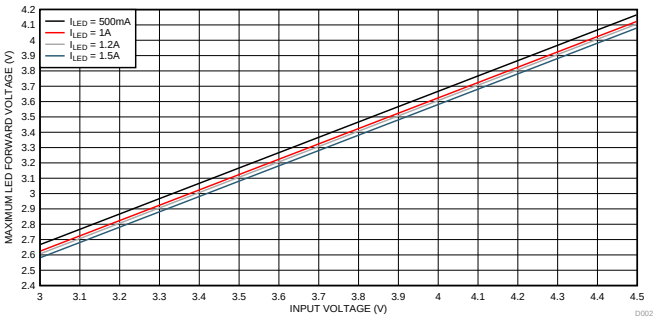


Figure 2. Maximum LED Voltage in Flash Mode

NOTE: When operating the devices at high current, careful PCB layout must be observed to manage the thermal dissipation across the device. At higher input voltages, the power dissipated across the device can be high causing the maximum on-chip temperature to reach or exceed the maximum operating junction temperature highlighted in the data sheet. To mitigate this self heating, shorted current pulses might be required to avoid exceeding the maximum junction temperature as well as to prevent the on-chip thermal shutdown.

In the LM3643/4/8 devices, the R_{PMOS} value is equal to 86 mΩ and V_{HR} is 158 mV in torch and 290 mV in flash mode. As V_{IN} drops, V_{HR} drops as well. If V_{IN} drops enough to violate the V_{HR} requirement for regulation, the LED current decreases. In Figure 3, V_{IN} starts at 4.5 V and drops to below 3 V when trying to deliver 500 mA. As V_{IN} drops below V_{LED} + V_{HR}, the LED current starts to decay linearly as the current source is no longer able to regulate. As V_{IN} increases, the LED current returns to regulation.

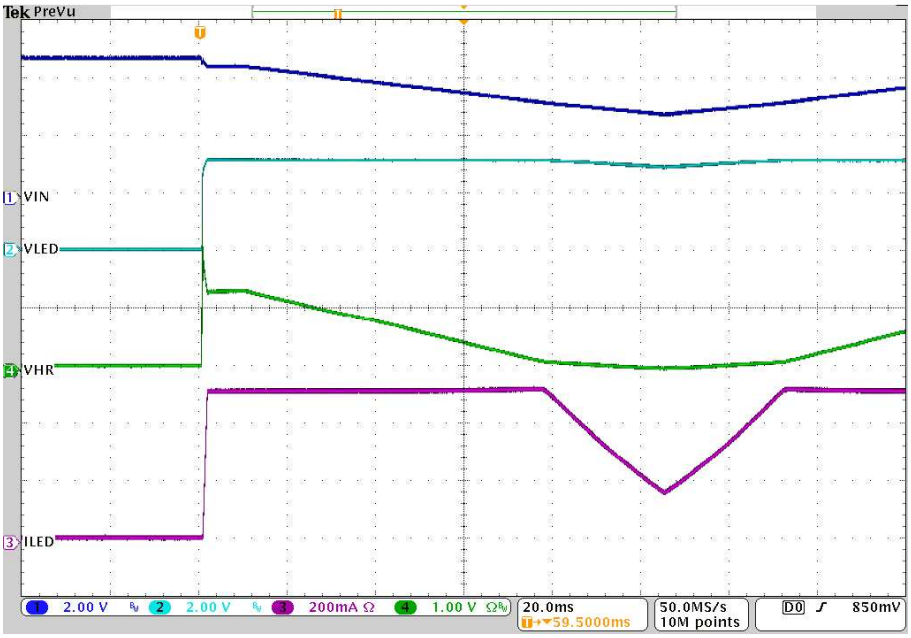


Figure 3. Effect of Low Headroom on Flash Current

2.2 Schematic

To operate the LM3643/4/8 devices without an inductor, the IN and SW pin must be shorted on the PCB. This provides the power path to the current source/s.

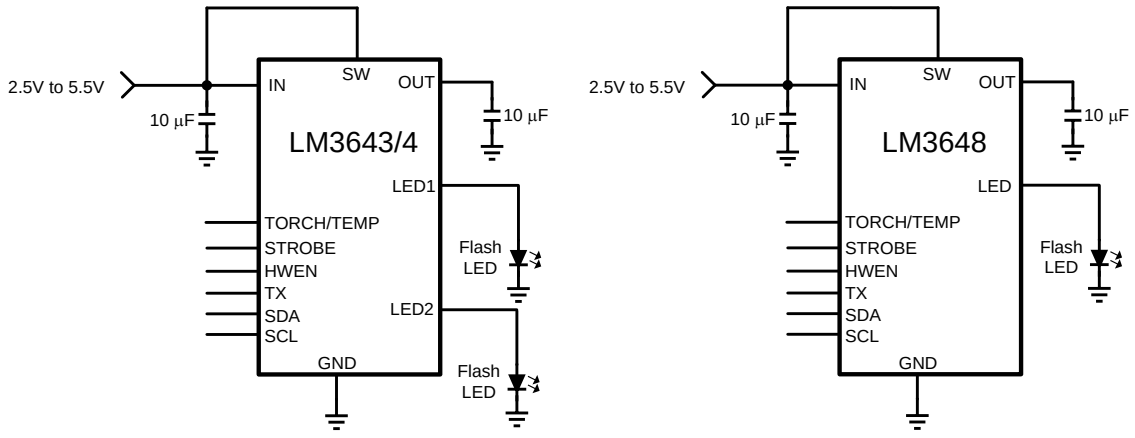
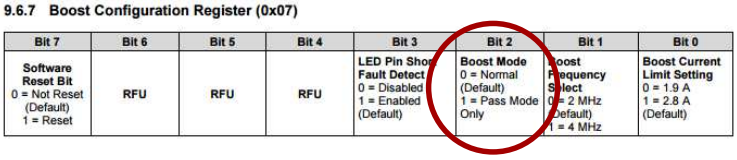


Figure 4. Typical Application Drawing With No Inductor

2.2.1 I2C Configuration

To prevent the NMOS of the boost DC-DC from turning on, it is imperative to set the boost mode bit in the Boost Configuration Register (Bit2 in Register 0x07) to a 1. This forces the device to be in pass mode, while allowing the current source/s to still turn on.



9.6.7 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 1 = Enabled (Default)	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 1 = 2.8 A (Default)

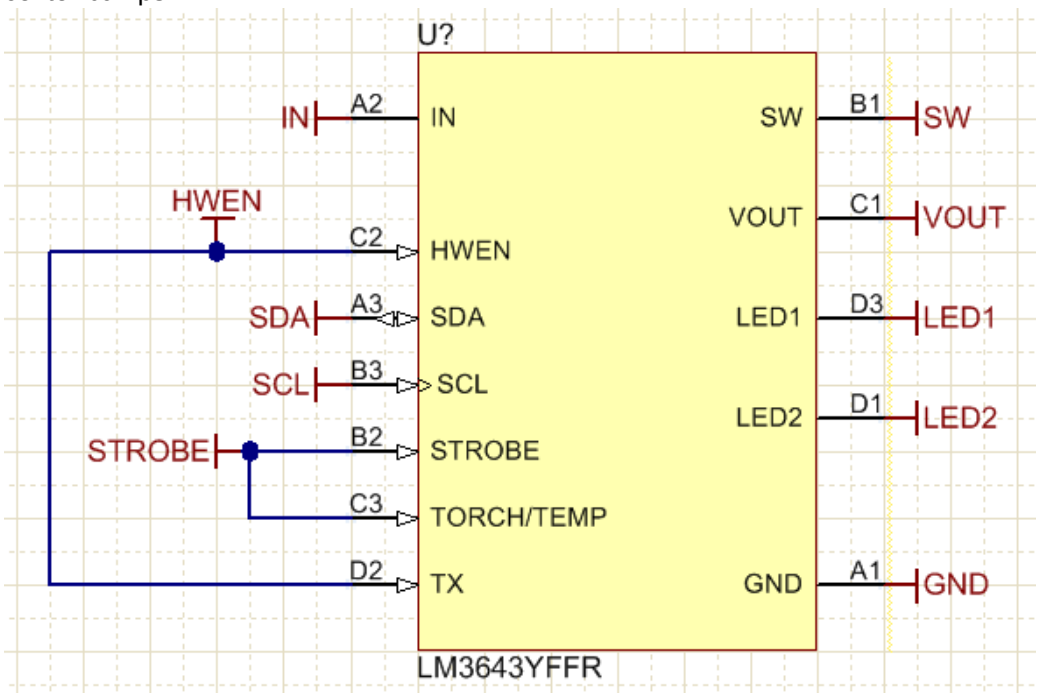
Figure 5. Boost Mode Bit Setting

3 Layout Without Micro Vias

Because the LM3643/4/8 has 12 bumps in a 4 × 3 bump array, two of the center bumps require the use of fine-pitch micro vias to route the traces to the outer perimeter of the device on a different PCB layer. In some designs, the use of micro vias is not an option due to cost or lack of a manufacturing flow that allows for micro vias. In these instances, the LM3643/4/8 family of devices can still be used with the omission of certain functions. By omitting the TX function, the HWEN center pin can easily be routed to the outer edge of the device by using a simple PCB trace. The STROBE functionality can be preserved as well by omitting the use of the TORCH/TEMP functionality.

3.1 Schematic

By connecting the HWEN and TX pins together, as well as connecting the STROBE and TORCH/TEMP pins together, the LM3643/4/8 devices can be routed and controlled without the need of micro vias in the center bumps.



3.2 Layout

The PCB trace to bring the HWEN pin out to the perimeter is very straightforward. It requires only a trace to route from the C2 bump through the outer D2 bump as shown in Figure 6. To connect route the B2 STROBE pin to the outside bump, a diagonal trace to the C3 bump is required. This connection requires a PCB manufacturing process that can tolerate narrow trace to bump clearances due to the diagonal routing. If the clearance constraint required to route the STROBE trace is too narrow, the STROBE functionality can still be enabled via I2C commands.

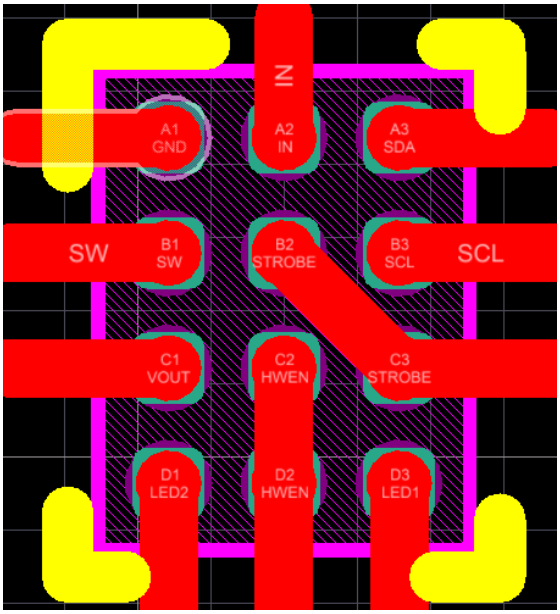


Figure 6. PCB Layout

3.3 I2C Register Settings

To ensure that the LM3643/4/8 does not create a false TX or TORCH/TEMP event, the pin-enable bits for these functions must be disabled via I2C. Bit 7 and Bit 4 in register 0x01 must be set to logic 0 to disable the pin functionality.

9.6.1 Enable Register (0x01)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX Pin Enable 0 = Disabled 1 = Enabled (Default)	**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 7. Enable Register Information

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