

DN98

ZXLD1370 PCB Layout Guidelines

Introduction

ZXLD1370 is a multi-topology switching mode LED driver controller. With external switching components wired in different topologies. The LED driver is able to work in Buck, Boost or Buck-boost mode.

For a switching mode converter, it is important to have good PCB layout in order to obtain the best system performance from the design. An improperly laid out PCB may have the following consequences:

- Causing too much noise with the control circuitry which affects the system stability.
- Causing too many losses in PCB copper which affects the system efficiency.
- Causing excessive electromagnetic interference which affects the system compatibility.

In this design note, considerations and suggestions for a proper PCB design will be discussed.

PCB Layout Considerations

Copper Trace Width Consideration

For switching mode power circuitry, the main switch and the related power components carry high current. Copper trace used to connect these components, have resistance which is related to the thickness, width and length of copper trace. Heat generated with current passing through the copper trace causing not only efficiency drop, but temperature rise on copper trace. In order to limit the temperature rise, it is important to ensure the width of copper traces is sufficient for the rated switching current.

Below equation shows the relationship between temperature rise and copper trace cross-sectional area.

Internal traces: $I = 0.024 \times dT^{0.44} \times A^{0.725}$
 External traces: $I = 0.048 \times dT^{0.44} \times A^{0.725}$

where:

I = maximum current in Amps
 dT = temperature rise above ambient in °C
 A = cross-sectional area in mils²

Table 1 shows the minimum copper width against current capacity. These are based on 1oz/sq foot (35µm) copper with 20°C temperature rise on copper trace.

Width in inch	Width in millimetre	Current Capacity
0.01"	0.254mm	0.8A
0.015"	0.381mm	1.2A
0.02"	0.508mm	1.5A
0.05"	1.27mm	3.2A
0.1"	2.54mm	6A

Table 1 External Copper Trace Width vs Current Capacity (20°C temperature rise)

In order to illustrate the current flow during switch on and switch off phase, schematic is redrawn and shown in Figure 2 with switching circuitry placed on right hand side.

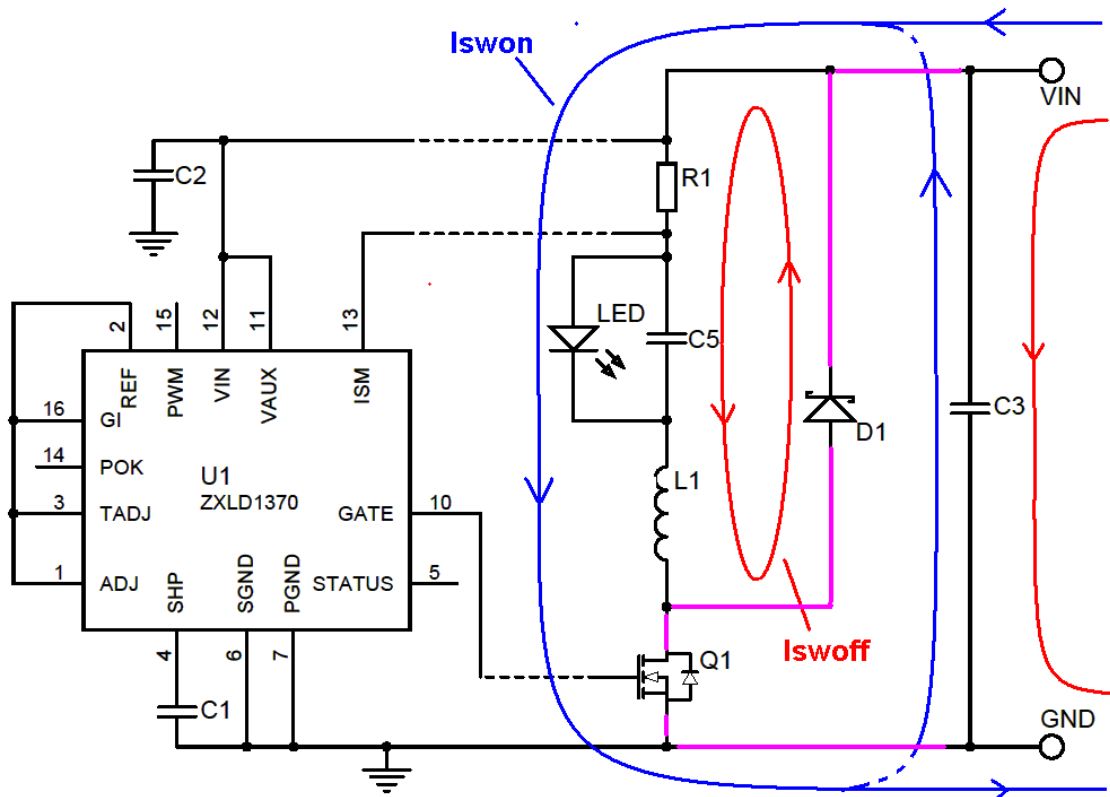


Figure 2 Switching Current Loops of ZXLD1370 Buck LED driver

During switching on phase (Q1 turn on), the inductor current remained during off phase will pass through the main switch Q1. The sudden change of switching current path results in high current change (di/dt) within conductors highlighted in purple.

- Conductors between Drain of Q1 and Cathode of D1.
- Conductors between Source of Q1 and C3.
- Conductors between D1 and C3.

During switching off phase (Q1 turn off), the inductor current stored during on phase will pass through the free wheeling rectifier D1. The sudden change of switching current path results in high current change (di/dt) within the same set of conductors highlighted in purple.

The amount of spike voltage generated due the switching, is related to resistance and parasitic inductance of highlighted copper traces. In order to minimize the spike voltage due to the switching, it is important to keep these copper traces short and wide.

Figure 3 shows an example Buck PCB layout with all the power components. The layout example has following features:

- The copper traces between Q1, D1 and C3 are kept as short as possible. This help to reduce noise generated due the resistance and parasitic inductance of these copper traces.
- All copper traces are placed on the same PCB side. This help to reduce the noise generated through any vias.

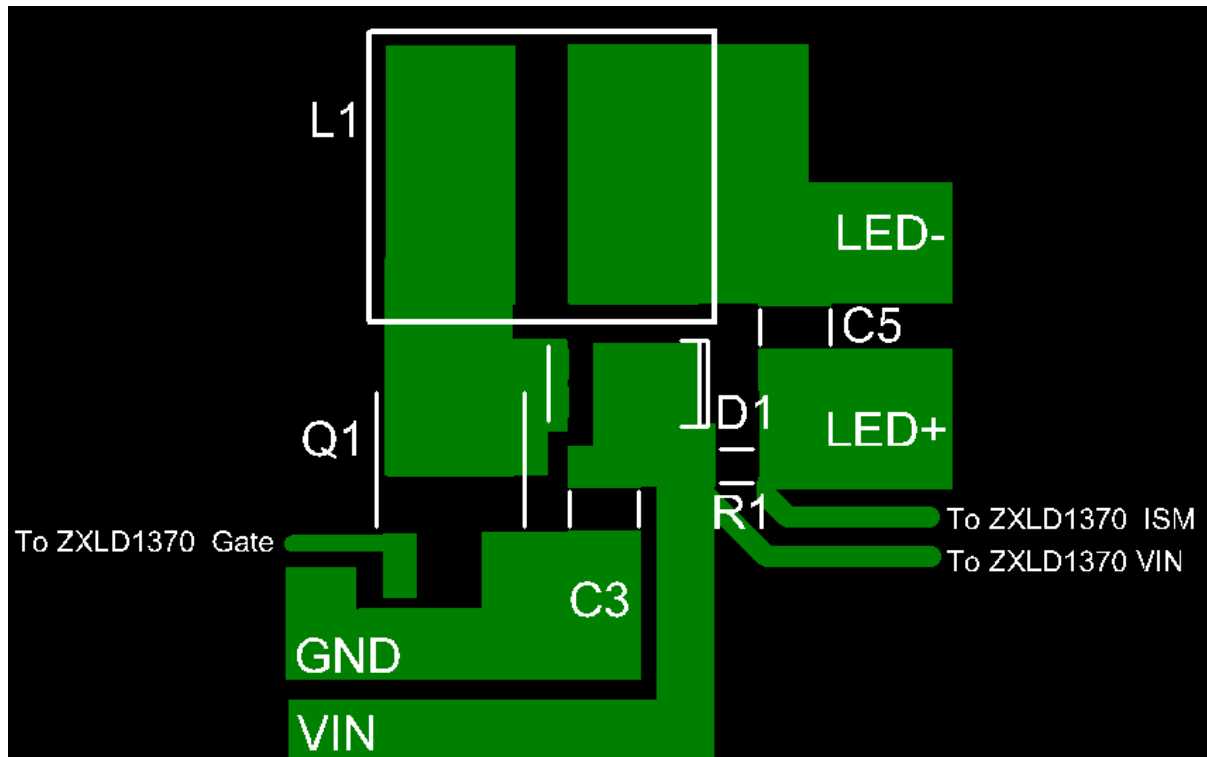


Figure 3 PCB layout example of ZXLD1370 Buck LED driver

Boost Mode

Figure 4 shows the typical schematic of ZXLD1370 works under Boost mode. The major switching loop consist of Q1, D1, sense resistor R1 and L1 with input decoupling capacitor C3 and load formed by LED, output filter capacitor C5.

C2 is the power rail decoupling capacitor for ZXLD1370. In order to ensure stable operation of ZXLD1370, C3 should be connected directly to VIN and GND pin of ZXLD1370 with the shortest PCB copper length.

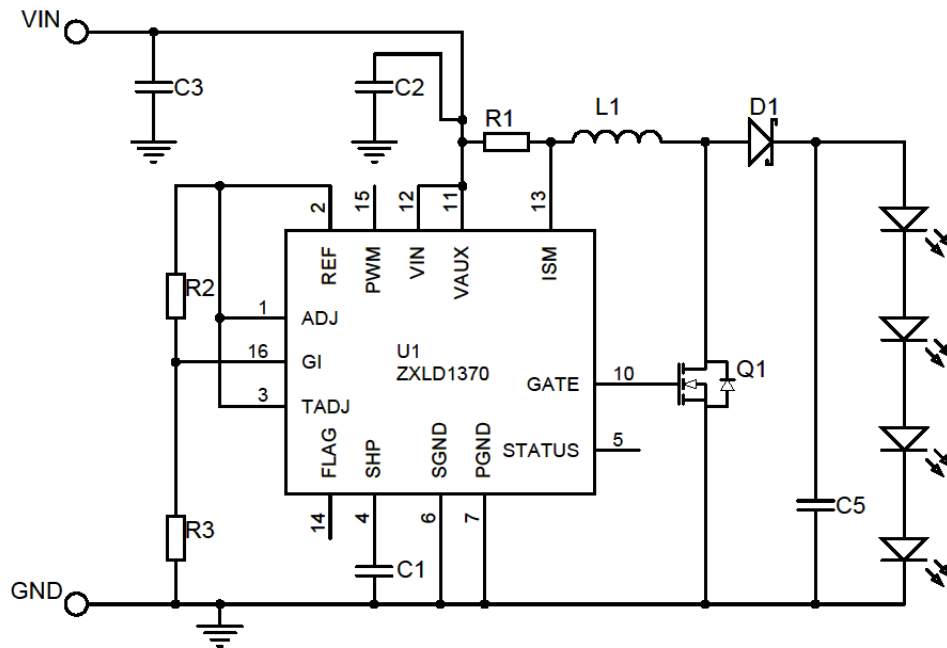


Figure 4 Schematic of ZXLD1370 Boost LED driver

In order to illustrate the current flow during switch on and switch off phase, schematic is redrawn and shown in Figure 5 with switching circuitry placed on right hand side.

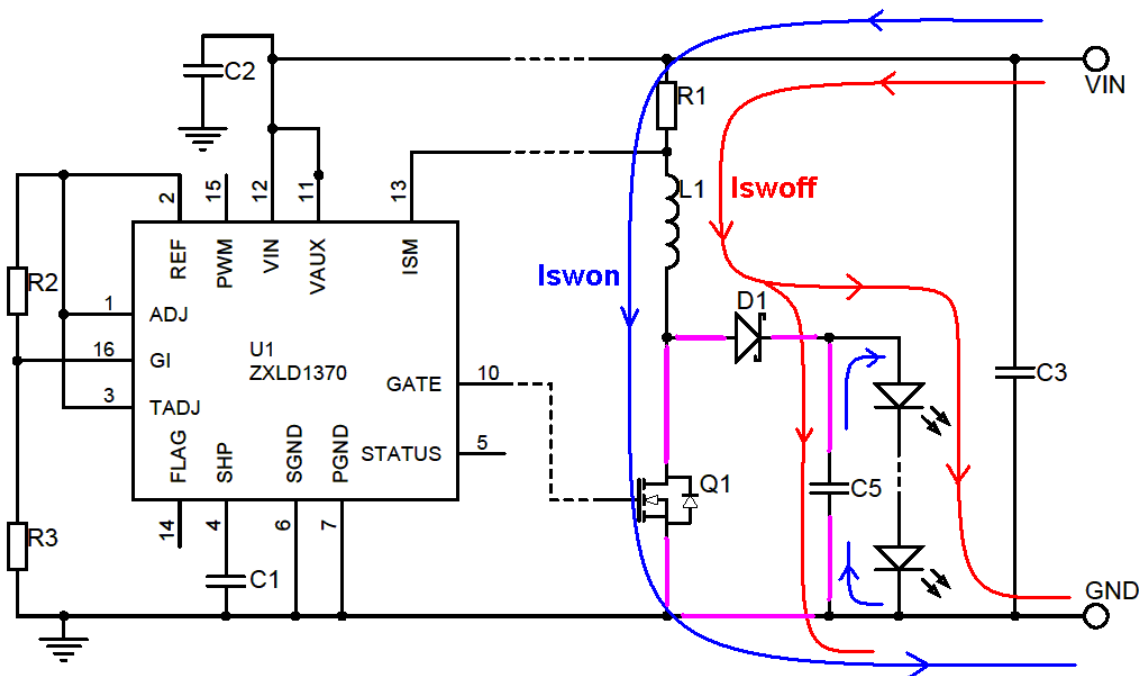


Figure 5 Switching Current Path of ZXLD1370 Boost LED driver

During switching on phase (Q1 turn on), the inductor current stored during off phase will pass through the main switch Q1. The sudden change of switching current path results in high current change (di/dt) within conductors highlighted in purple.

- Conductors between Drain of Q1 and Cathode of D1.
- Conductors between Source of Q1 and C5.
- Conductors between D1 and C5.

During switching off phase (Q1 turn off), the inductor current stored during on phase will pass through the free wheeling rectifier D1. The sudden change of switching current path results in high current change (di/dt) within the same set of conductors highlighted in purple.

The amount spike voltage generated due the switching, is related to resistance and parasitic inductance of highlighted copper traces. In order to minimize the spike voltage due to the switching, it is important to keep these copper traces short and wide.

Figure 6 shows an example Buck PCB layout with all the power components. The layout example has following features:

- The copper traces between Q1, D1 and C5 are kept as short as possible. This help to reduce noise generated due the resistance and parasitic inductance of these copper traces.
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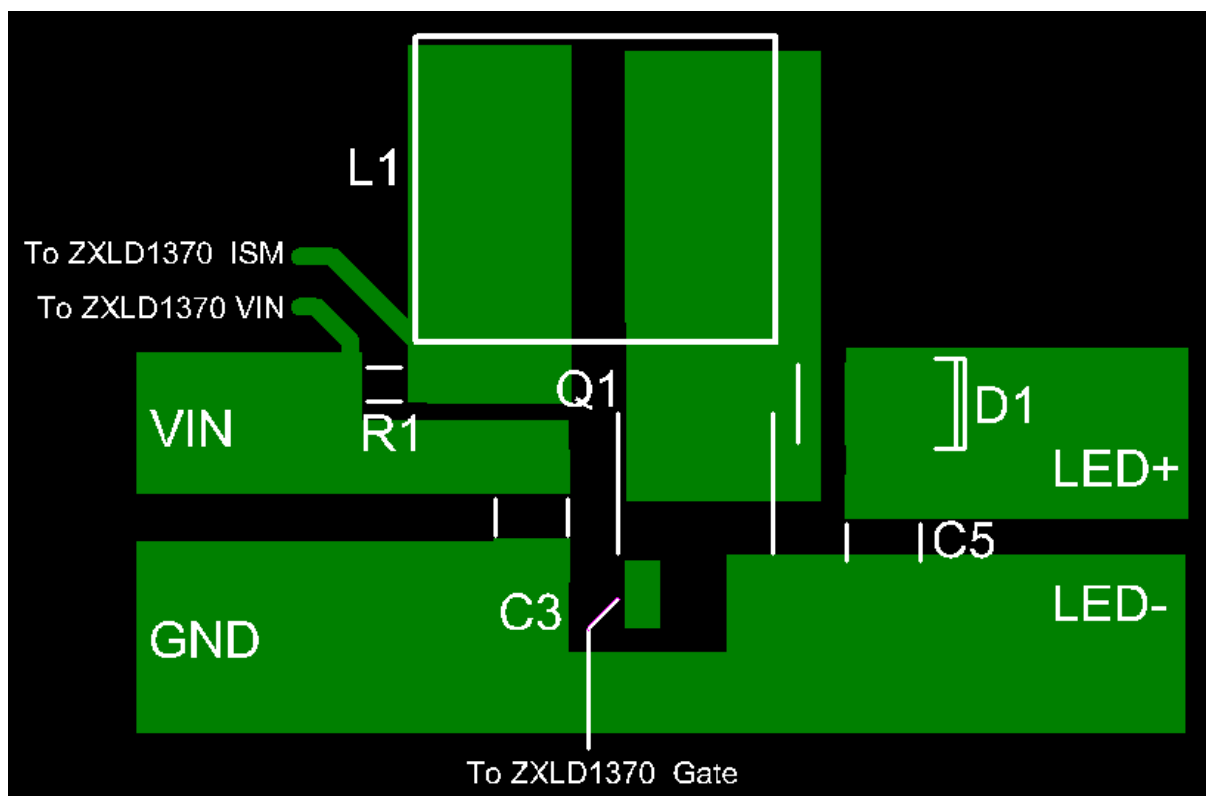


Figure 6 PCB layout example of ZXLD1370 Boost LED driver

Conclusion

For all switching regulators careful layout is important to ensure good operation and low radiated and conducted noise. This is true for the ZXLD1370 in any of its operating modes. By minimizing track lengths large di/dt are avoided. The key to getting a good layout is understanding the current paths and designing the PCB accordingly.

Further good use of copper to around the power components can be calculated and not simply guessed to ensure good thermal layout is also achieved

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