AN48
Getting more out of the ZXLD1350 - high output current
Ray Liu, Systems Engineer, Zetex Semiconductors

Introduction
The ZXLD1350 is a continuous mode inductive step-down converter, designed for driving single or multiple series connected LEDs efficiently from a voltage source higher than the LED voltage. The device operates from an input supply between 7V and 30V and provides an externally adjustable output current of up to 350mA. In order to obtain higher output current to drive LEDs with higher power, a high current externally connected output stage is required.

700mA driver for multiple 3W LEDs in series
This driver is designed to drive up to six 3W LEDs in series which could deliver total output power of 15W with an overall efficiency of around 90%.

![Figure 1 Schematic of 700mA driver](image-url)
Part list

Table 1

<table>
<thead>
<tr>
<th>Part ref.</th>
<th>Part no.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>ZXLD1350</td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>FCX619</td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>FMMT619</td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>FMMT619</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>ZLLS1000</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>25.6V Zener diode</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>68μH 1A</td>
<td></td>
</tr>
<tr>
<td>RS1</td>
<td>150mΩ</td>
<td></td>
</tr>
<tr>
<td>RS2</td>
<td>2.2Ω</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>2.2KΩ</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>470Ω</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>15KΩ</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>3.3μF 50V</td>
<td>X5/7R or other low ESR cap</td>
</tr>
<tr>
<td>C2</td>
<td>0.1μF</td>
<td>Optional</td>
</tr>
</tbody>
</table>

Circuit description

The output driver consists of two NPN transistors (Q1 and Q2). Transistor Q2 acts as a small signal inverter which inverts the original LX switch signal. The collector of Q2 is connected to the base of transistor Q1 which acts as the power output switch.

Transistor Q3 and Zener diode D2 form a simple regulator to supply a constant voltage to the driver stage. The voltage at emitter of Q3 is around 5V. This helps to provide a stable driving current to both Q1 and Q2. The driving currents are around 2mA and 9mA respectively.

Total propagation delay is less than 200ns against the LX pin. Both the rise time and the fall time of the output switch are less than 70ns when input supply voltage is 30V.
Typical performance graphs

5 LEDs in series with total $V_F = 17.9V$

4 LEDs in series with total $V_F = 14.9V$

3 LEDs in series with total $V_F = 11.1V$
Typical performance graphs (cont.)

2 LEDs in series with total $V_F = 7.7V$

1 LED in series with $V_F = 3.8V$
A driver for supply voltage up to 16V

This driver is a simplified version to the 700mA driver described above. The driver is designed to drive up to 3 Luxeon® K2 LEDs in series which could deliver a total output power of 10W with a maximum input supply voltage of 16V.

![Schematic of 1A driver](image)

**Figure 2  Schematic of 1A driver**

**Part List**

<table>
<thead>
<tr>
<th>Part ref.</th>
<th>Part no.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>ZXLD1350</td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>ZXTN25020DFH</td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>ZXTN25020DFH</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>ZLLS2000</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>47μH 1.5A</td>
<td></td>
</tr>
<tr>
<td>RS</td>
<td>100mΩ</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>4.7KΩ</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>1.5KΩ</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>4.7μF 25V</td>
<td>X5/7R or other low ESR cap</td>
</tr>
<tr>
<td>C2</td>
<td>0.1μF</td>
<td>Optional</td>
</tr>
</tbody>
</table>
Circuit description

This circuit is similar to the 700mA driver described above. The output driver consists of two NPN transistors (Q1 and Q2). Transistor Q2 acts as a small signal inverter which inverts the original LX switch signal. The collector of Q2 is connected to the base of transistor Q1 which act as the power output switch.

Unlike the 700mA driver, the driving current to both Q1 and Q2 varies with the input supply voltage. Hence, the maximum input supply voltage is limited to 16V. The driving current to Q1 is between 5mA and 10mA with input supply voltage between 8V and 16V. Lowering the maximum supply voltage to 16V enables us to use a lower voltage BJT with better switching performance.

Total propagation delay is less than 200ns against the LX pin. Both the rise time and the fall time of the output switch are less than 60ns when input supply voltage is 16V.
Typical performance graphs

2 LEDs in series with total $V_F = 7.1\text{V}$

1 LED in series with total $V_F = 3.5\text{V}$
Definitions

Product change
Zetex Semiconductors reserves the right to alter, without notice, specifications, design, price or conditions of supply of any product or service. Customers are solely responsible for obtaining the latest relevant information before placing orders.

Applications disclaimer
The circuits in this design/application note are offered as design ideas. It is the responsibility of the user to ensure that the circuit is fit for the user's application and meets with the user's requirements. No representation or warranty is given and no liability whatsoever is assumed by Zetex with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Zetex does not assume any legal responsibility or will not be held legally liable (whether in contract, tort (including negligence), breach of statutory duty, restriction or otherwise) for any damages, loss of profit, business, contract, opportunity or consequential loss in the use of these circuit applications, under any circumstances.

Life support
Zetex products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Zetex Semiconductors plc. As used herein:
A. Life support devices or systems are devices or systems which:
1. are intended to implant into the body
   or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labelling can be reasonably expected to result in significant injury to the user.
B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Reproduction
The product specifications contained in this publication are issued to provide outline information only which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned.

Terms and Conditions
All products are sold subjects to Zetex' terms and conditions of sale, and this disclaimer (save in the event of a conflict between the two when the terms of the contract shall prevail) according to region, supplied at the time of order acknowledgement. For the latest information on technology, delivery terms and conditions and prices, please contact your nearest Zetex sales office.

Quality of product
Zetex is an ISO 9001 and TS16949 certified semiconductor manufacturer.
To ensure quality of service and products we strongly advise the purchase of parts directly from Zetex Semiconductors or one of our regionally authorized distributors. For a complete listing of authorized distributors please visit: www.zetex.com/salesnetwork
Zetex Semiconductors does not warrant or accept any liability whatsoever in respect of any parts purchased through unauthorized sales channels.

ESD (Electrostatic discharge)
Semiconductor devices are susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

Green compliance
Zetex Semiconductors is committed to environmental excellence in all aspects of its operations which includes meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.
All Zetex components are compliant with the RoHS directive, and through this it is supporting its customers in their compliance with WEEE and ELV directives.

Product status key:
- “Preview” Future device intended for production at some point. Samples may be available
- “Active” Product status recommended for new designs
- “Last time buy (LTB)” Device will be discontinued and last time buy period and delivery is in effect
- “Not recommended for new designs” Device is still in production to support existing designs and production
- “Obsolete” Production has been discontinued

Datasheet status key:
- “Draft version” This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.
- “Provisional version” This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice.
- “Issue” This term denotes an issued datasheet containing finalized specifications. However, changes to specifications may occur, at any time and without notice.

Zetex sales offices

Europe
Zetex GmbH
Kustermann-park
Balanstraße 59
D-81541 München
Germany
Telephone: (49) 89 45 49 49 0
Fax: (49) 89 45 49 49 49
Europe.sales@zetex.com

Americas
Zetex Inc
700 Veterans Memorial Highway
Hauppauge, NY 11788
USA
Telephone: (1) 631 360 2222
Fax: (1) 631 360 8222
usa.sales@zetex.com

Asia Pacific
Zetex (Asia Ltd)
3701-04 Metroplaza Tower 1
Hing Fong Road, Kwai Fong
Hong Kong
Telephone: (852) 26100 611
Fax: (852) 24250 494
asia.sales@zetex.com

Corporate Headquarters
Zetex Semiconductors plc
Zetex Technology Park, Chadderton
Oldham, OL9 9LL
United Kingdom
Telephone: (44) 161 622 4444
Fax: (44) 161 622 4446
hq@zetex.com

© Zetex Semiconductors plc 2007