

L6920 as LED driver for flashlight

By Nichola Siciliano
Jianwen Shao

Main components	
L6980DB	Synchronous rectifier step up converter
TS951ILT	Input/output rail-to-rail low-power operational amplifiers
STR2N2VH5	N-channel 20 V, 0.025 Ω typ., 5 A

Purpose and benefits

This design tip describes how to implement a solution for high current LED drivers that are suitable for those applications where the available power supply voltage is lower than the LED forward voltage. This kind of solution can be used, for instance, in a flashlight in which the regular bulb is to be replaced with a high current LED device (350mA typical). In this case, a boost topology implementation is mandatory.

In battery powered applications, the input voltage varies with the battery discharge profile. The following are the suitable battery types for these kinds of applications:

- 2 Alkaline cells AA or AAA
- 1 Li-Ion cell, with the voltage range comprised between 4.2V and 2.7V or less
- 2 Ni-MH cells, with the voltage range between 1.5V to 0.9V

We will focus our application examples on the L6920DB step-up switching regulator.

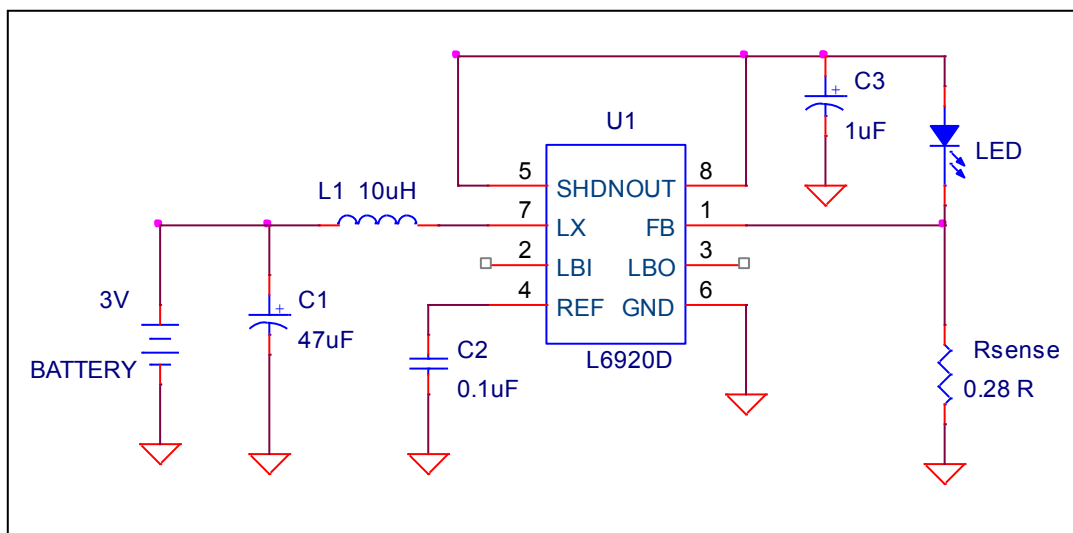
Description

The schematic in Figure 1 shows a basic circuit in which the L6920DB is configured as a constant current source to drive the high brightness LED. An output current of 350mA is set by the resistor, R_{sense} , according to the formula:

$$R_{sense} = V_{ref} / I_{LED}$$

where V_{ref} is 1.23V

Figure 1. LED driver: basic configuration



In this basic configuration, the power dissipated in R_{sense} negatively impacts the system efficiency. Since in battery powered equipment the efficiency is an important parameter, it would be desirable to improve the efficiency. The total power out is the sum of the power in the LED plus the power in R_{sense} .

$$\text{Power out} = I_{LED} * V_f + I_{LED}^2 * R_{sense}$$

So, lowering the value of R_{sense} will reduce the wasted power.

The example in Figure 2 shows a circuit to improve the efficiency.

Using an op-amp in a non-inverting configuration, we can decrease the drop across the resistor from 1.25 (reference value), to a significantly lower value. In this way, the LED brightness remains the same but system efficiency is improved. The resistor value depends on:

- The LED forward current (I_{LED})
- The gain stage amplification (A)

$$A = 1 + R_3 / R_4$$

Therefore, R_{sense} can be calculated from the equation:

$$R_{sense} = 1.23V / A * I_{LED}$$

In the schematic of Figure 2, we set the gain at 11.7 so the drop across R_{sense} is reduced from 1.23V to 105mV, thus the power dissipated in the resistor goes from:

$$P_{R_{sense}} = I_{LED} * 1.23, \text{ (Basic configuration-Fig. 1)}$$

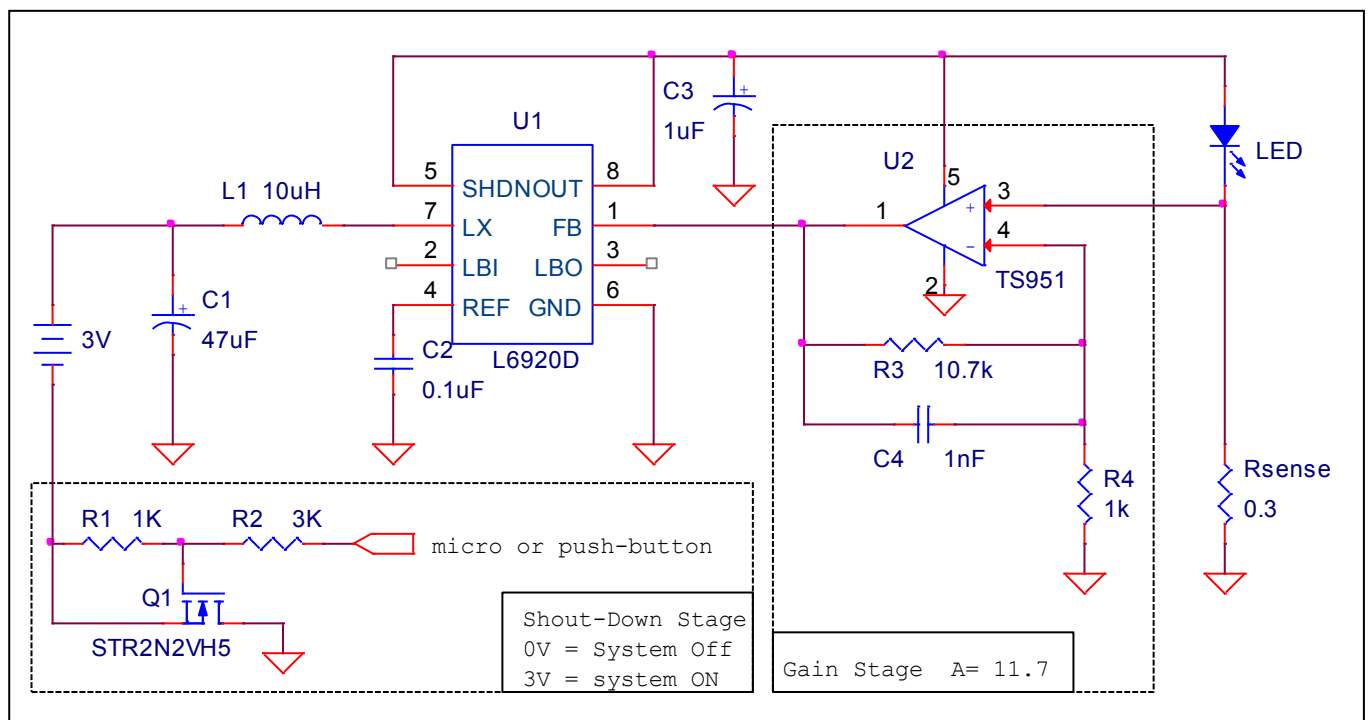
to

$$P_{R_{sense}} = I_{LED} * 0.105, \text{ (Higher efficiency configuration-Fig. 2)}$$

The LED considered is 1W (such as the Lumiled Luxeon Emitter, Osram LW-W5SG, or Seoul Semiconductor W11190), with a forward current in the range of 350mA, therefore R_{sense} value is:

$$R_{sense} = 0.105V / 0.35A = 0.3\Omega$$

Figure 2. LED driver: Higher efficiency configuration



This schematic can be easily adjusted to meet other application requirements such as lower or higher LED forward current, higher input voltage range etc...

Support material

Related design support material
Evaluation board – STEVAL-ISA077V21 High efficiency synchronous rectifier step-up converter based on L6920DB
Documentation
Datasheet: L6920DB , Synchronous rectifier step up converter
Datasheet: TS9511LT , Input/output rail-to-rail low-power operational amplifiers
Datasheet: STR2N2VH5 , N-channel 20 V, 0.025 Ω typ., 5 A
AN1941 - Low voltage LED drivers using L6920D, L4971 AND L6902D
AN1891 - Application ideas: driving LEDs using L497x, L597x, L692x DC-DC converters families

Revision history

Date	Version	Changes
17-Dec-2013	1	Initial release

Please Read Carefully

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at anytime, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

ST PRODUCTS ARE NOT DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com