

1 Introduction

The progress made in the field of LEDs has led to rapid and impressive results in output current capabilities. A short time ago the most advanced LEDs had current at 0.350 A, soon followed by 0.7 A and then 1 A devices. Nowadays even LEDs with several amps of output are present on the market. These high currents are increasing the requirements on the driving circuitry for both efficiency and features. This document presents the demonstration board designed for 2.8 A LEDs (1-3 in a series string) focusing on easy dimming and high efficiency.

Figure 1. STEVAL-ILL023V1 - 2.8 A LED driver (LED is not included in the kit)



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2 Description of reference design

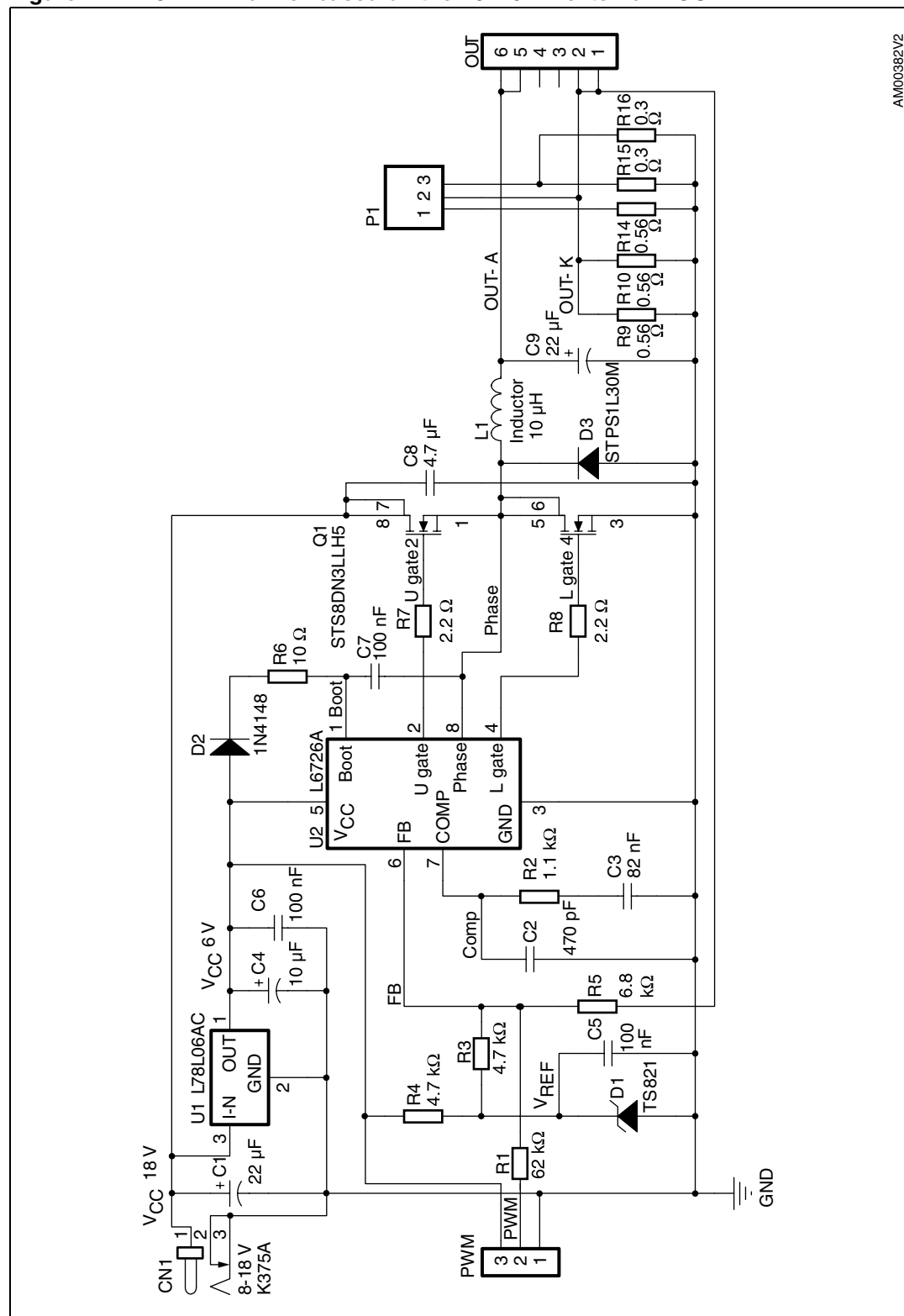
This solution uses the L6726A controller with two external MOSFETs for synchronous rectification. The main advantage is very good efficiency. Future scalability for even higher currents could be seen as another advantage. This solution is much safer concerning the border conditions as the current limit is defined only by the selection of the MOSFET.

Table 1. Board parameters

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input voltage		8		18	V
V_{OUT}	Output voltage	$V_{IN} = 18\text{ V}$	2.5		14	V
I_{LED}	Output current			1 / 1.5 / 2.8		A
Dimm	Analog dimming	$I_{LED} - 0\text{ A}$	0		2.5	V
	PWM signal	Low level		0		V
		High level	2.8	3.3	3.8	V
	Duty cycle ⁽¹⁾	$f_{DIM} = 200\text{ Hz}$	0		99	%
η	Efficiency	$V_{IN} = 18\text{ V}; V_{OUT} = 12.6\text{ V}$		94.8		%

1. PWM signal has inverted characteristics (0% = full power).

AM00382V2



2.1 Current sensing

Adapting the voltage step-down regulator as a constant current source requires few external components (as indicated in [Figure 3](#)). Basically only a sense resistor would be necessary, but that results in high losses on the sense resistors (feedback reference is 0.8 V). When voltage reference TS821 is used, the losses are almost three times lower.

The application depicted allows setting three different values of the output current. The options are 1 A, 1.5 A and 2.8 A. The output currents are chosen by the jumper on the header P1 as indicated in [Table 2](#).

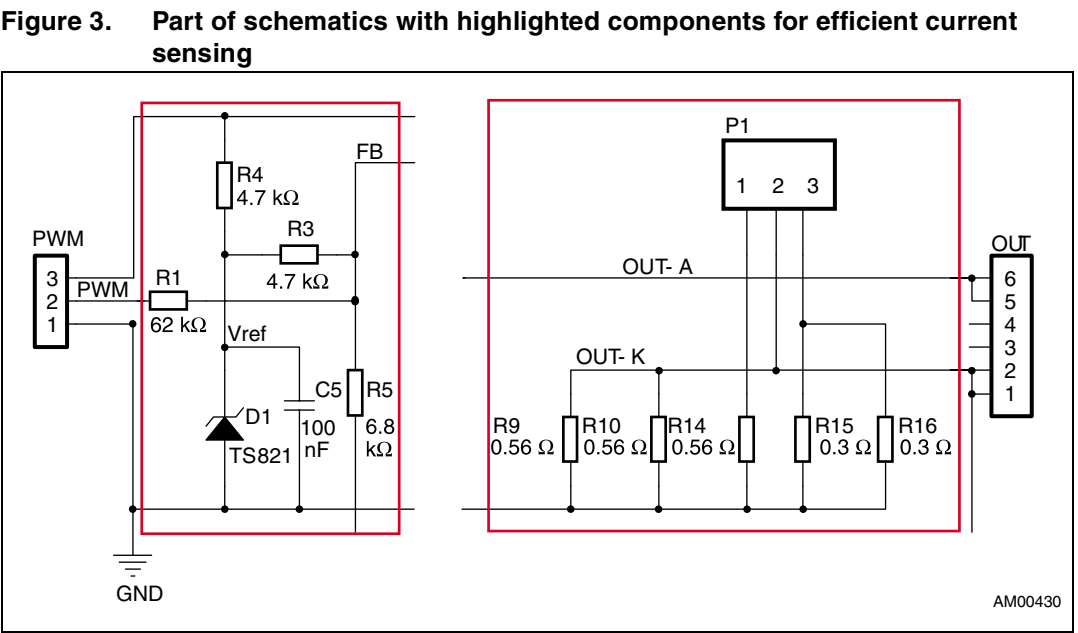


Table 2. Nominal output current settings

Header P1 1 2 3	Output current
■ ● ● AM00386	1 A
■ ● ● AM00387	1.5 A
■ ● ● AM00388	2.8 A

2.2 Dimming interface

For more advanced applications, the reference design also includes an interface for dimming. The board itself does not include any signal generator, but to keep universality with different control schemes (analog or digital dimming) a three-pin connector was built in as depicted in [Figure 3](#). A supply voltage of 6 V V_{CC} can serve as an external PWM generator (implemented by either the microcontroller or by comparators). The PWM pin is an universal dimming input, working with both analog and digital dimming. Any voltage above 2.5 V is considered as 0% power, i.e. the analog dimming works in the range from 0 V to 2.5 V, where 0 V (grounding the pin) results in full power. The standard 3.3 V logic levels can be used as a PWM control signal for digital dimming. In this case the brightness changes from 0% (full power) to 99% (minimum power) duty cycle. If the driver is used without the PWM generator, pins 1 (GND) and 2 (PWM) on the PWM connector must be connected together.

3 Application

The PCB layout (top and bottom side) of the application displayed in the schematic of [Figure 2](#) is shown in the two figures below. The two layers of the PCB (35 μm thickness of Cu) are used, when the size of the circuit itself (including several sense resistors for different versions of output current) is 40 mm x 23 mm.

Figure 4. PCB layout - top side

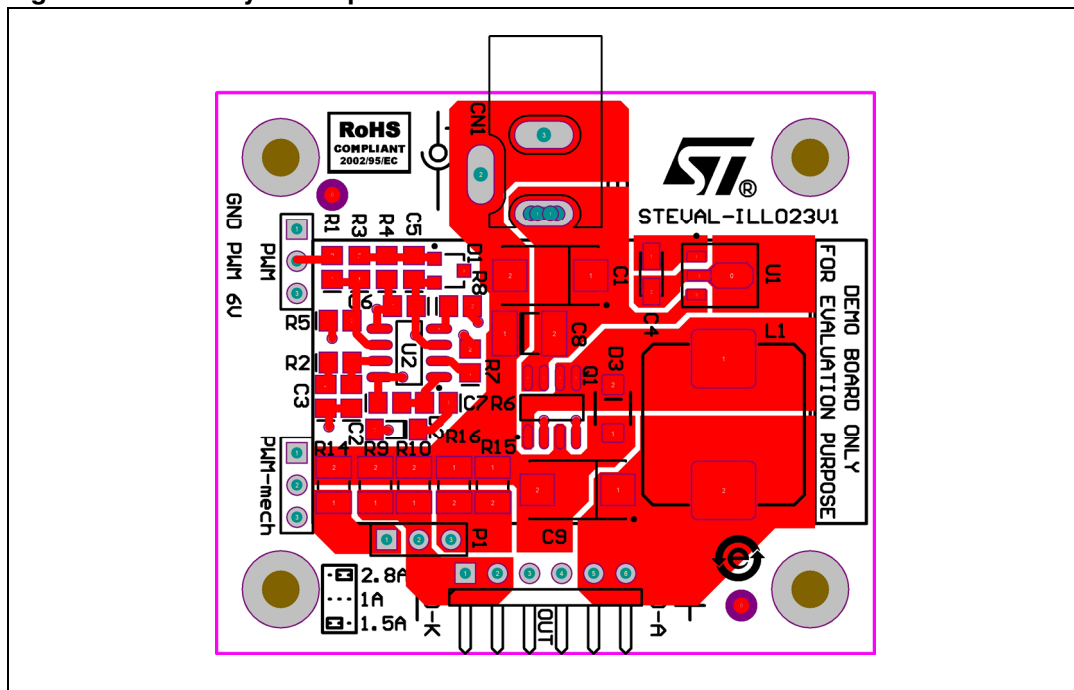


Figure 5. PCB layout - bottom side

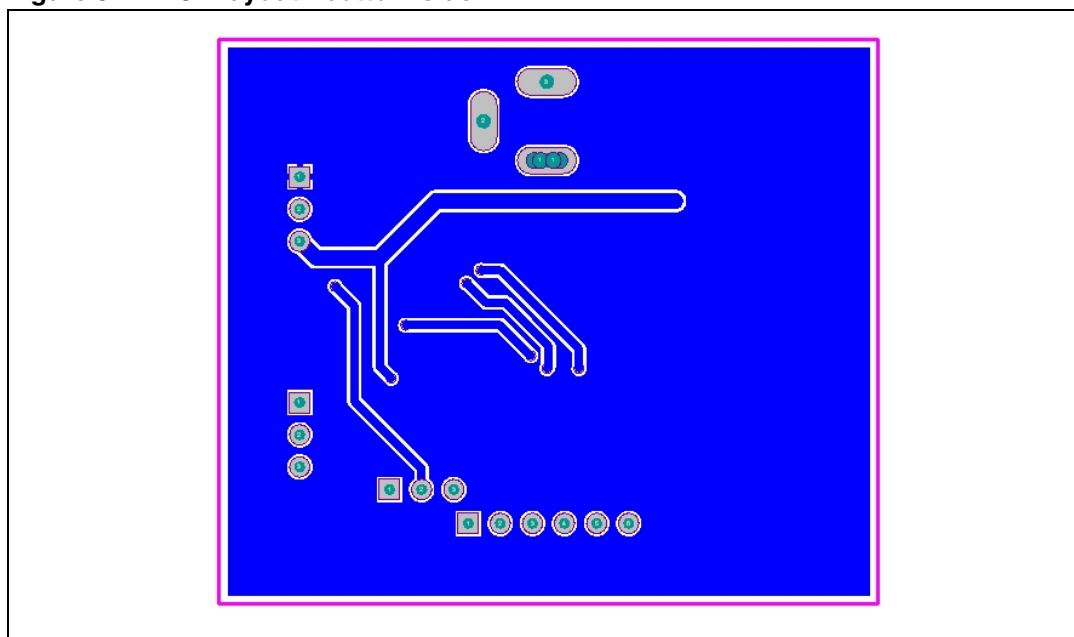


Figure 6. Reference design detail

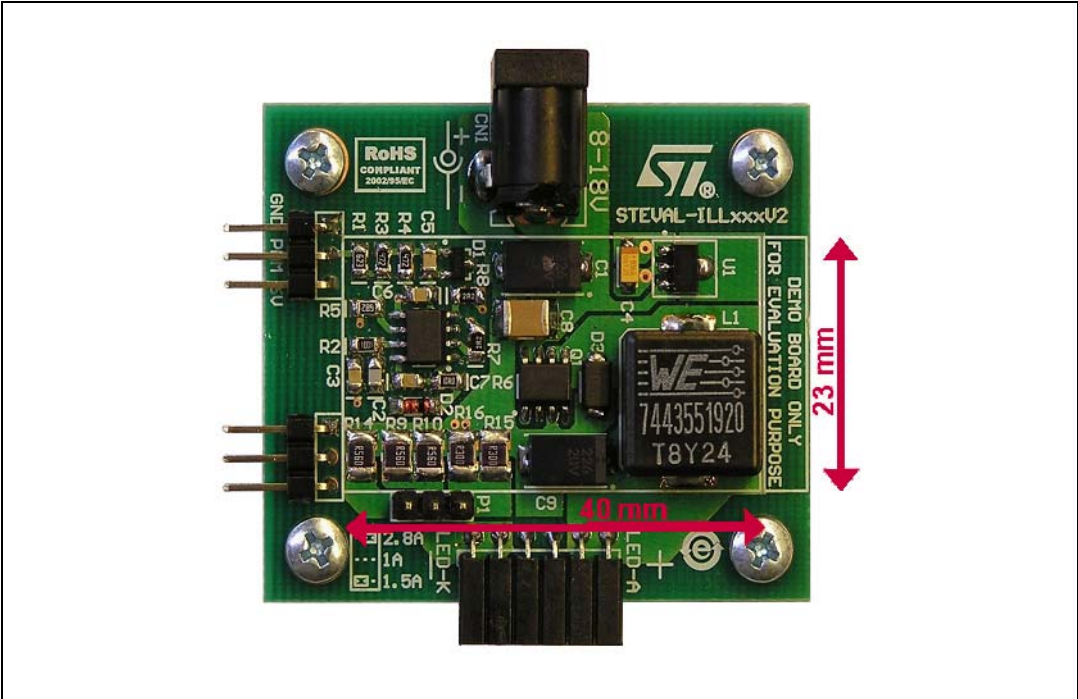
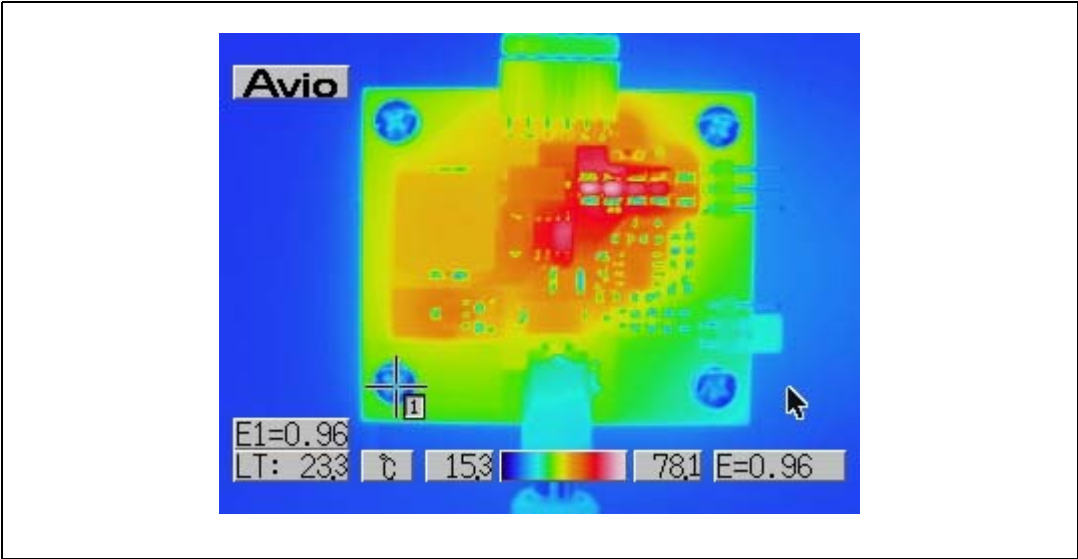


Figure 7. Thermal snapshot at full load



3.1 Measurement results

Several tests made on the reference design can be observed in [Figure 8](#) through [11](#).

Figure 8. Output current with 1 LED (Seoul Semiconductor P7)

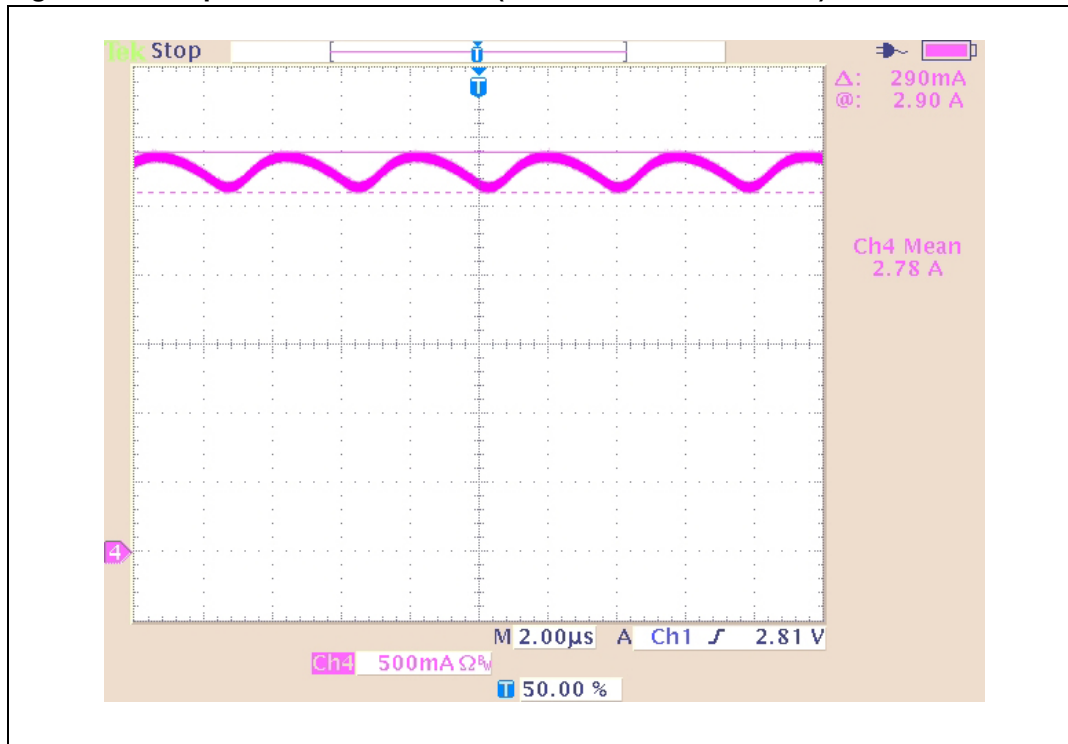


Figure 9. Dimming control curve (12 V input, 1 LED output)

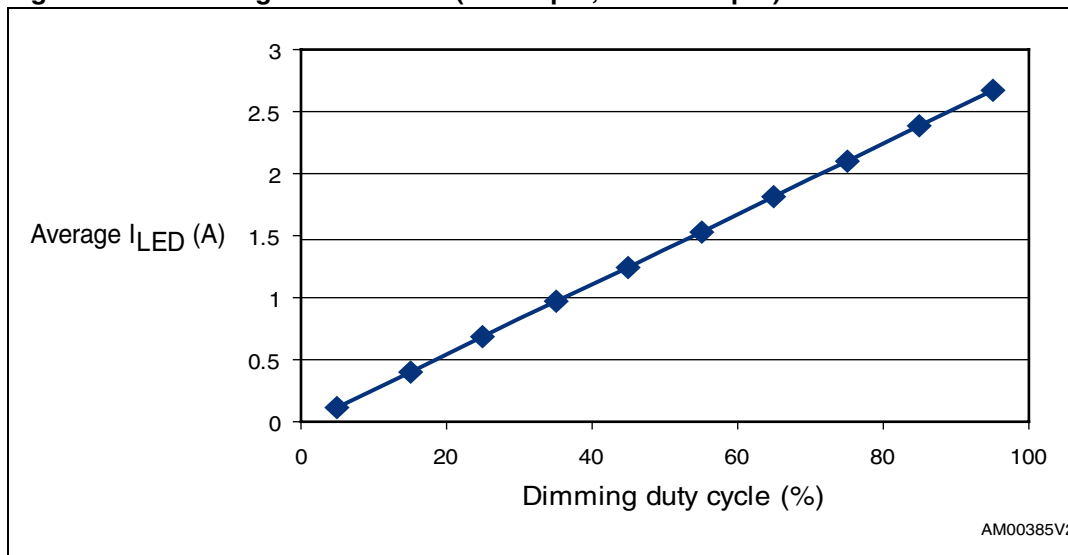


Figure 10. Variation in output currents with load change (number of LEDs in a string)

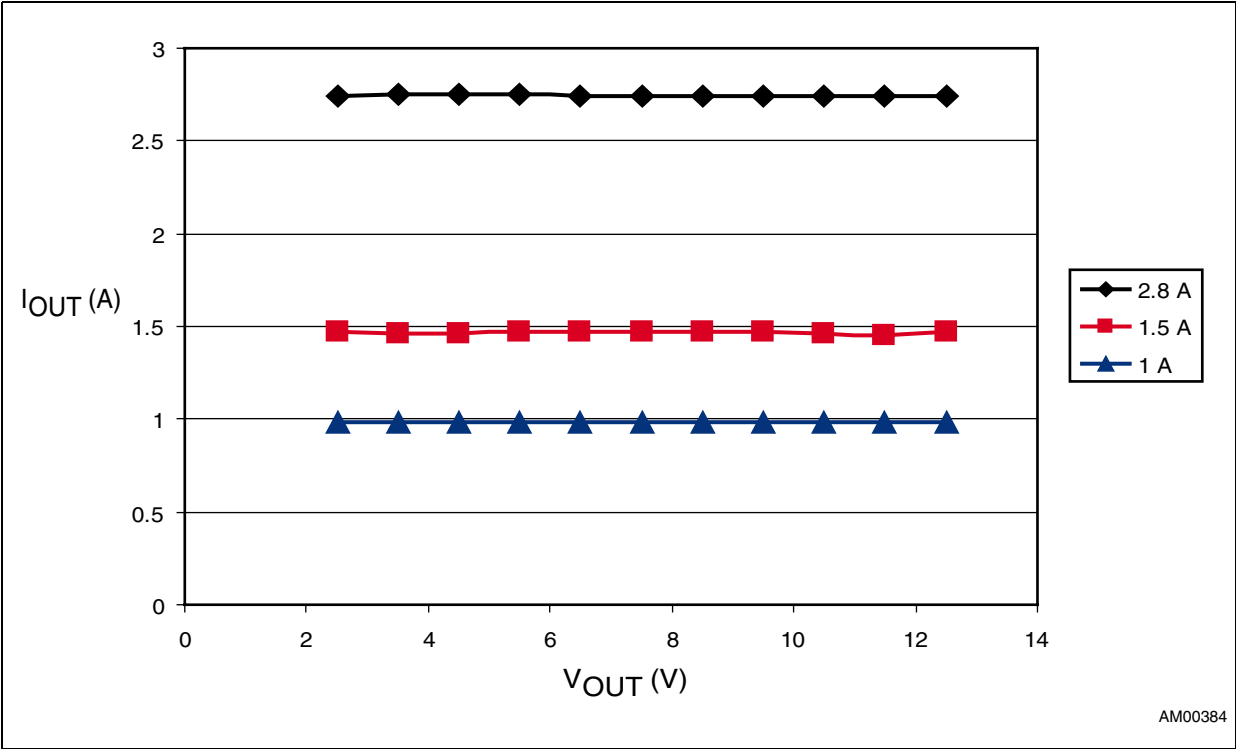
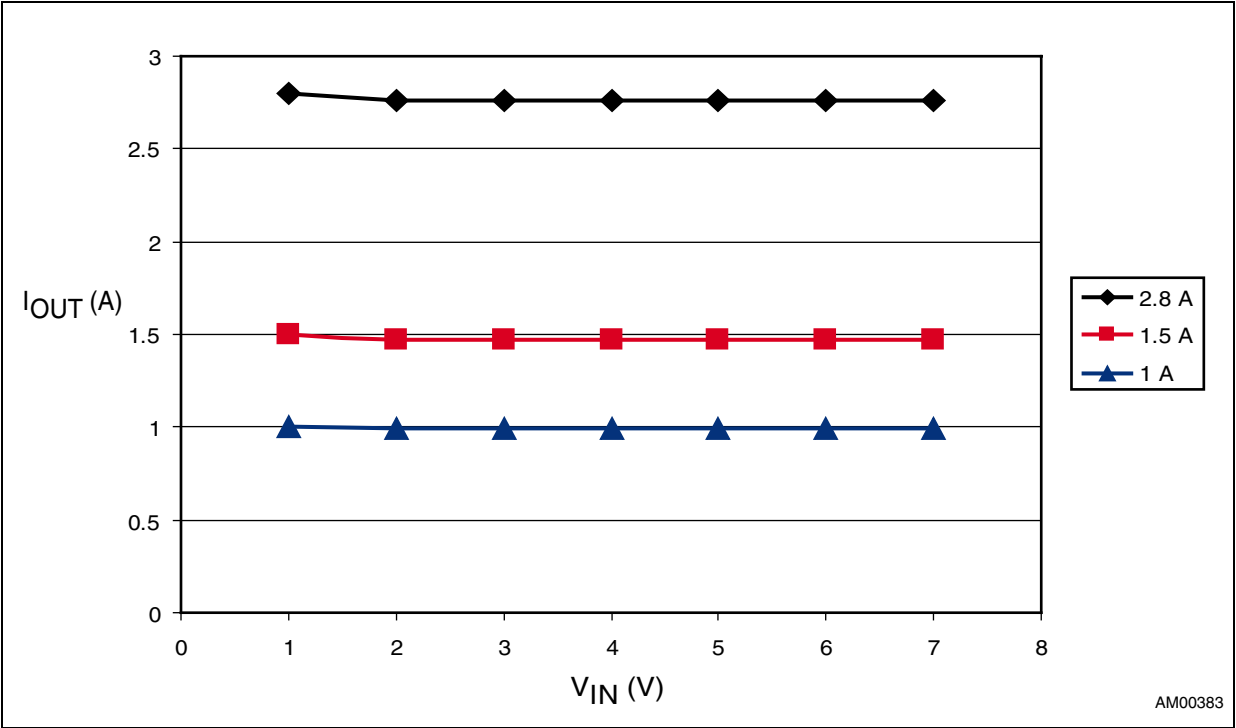


Figure 11. Variation in output current vs. input voltage (1 LED load)



4 Bill of material

Table 3. Bill of material

Designator	Comment	Description	Footprint	Value
C1	Cap. pol.	Polarized capacitor (tantalum)	SMD D	22 μ F / 25 V
C2	Cap.	Ceramic capacitor	0805	470 pF
C3	Cap.	Ceramic capacitor	0805	100 nF
C4	Cap. pol.	Polarized capacitor (tantalum)	SMD A	10 μ F / 10 V
C5	Cap.	Ceramic capacitor	0805	100 nF
C6	Cap.	Ceramic capacitor	0805	100 nF
C7	Cap.	Ceramic capacitor	0805	100 nF
C8	Cap.	Ceramic capacitor	1812	4.7 μ F / 25 V
C9	Cap. pol.	Polarized capacitor (tantalum)	SMD D	22 μ F / 20 V
CN1	Connector	Low voltage DC power connector		Dia. 2.1 mm
D1	V _{REF}	Voltage reference 1.225 0.5%	SOT23-3	TS821B
D2	Diode	Diode SMD	MINI-MELF	1N4148
D3	Sch. diode	Schottky diode 1 A, 30 V	SMA_A	STPS1L30A
L1	Inductor	High current inductor	13.2 x 12.8 mm	9.2 μ H
OUT	Header 6	Header, 6-pin, 90° female	1 x 6 2.54 mm	1 x 6 pin
P1	Header 3	Header, 3-pin, male	1 x 3 2.54 mm	1 x 3 pin
PWM	Header 3	Header, 3-pin, 90° male	1 x 3 2.54 mm	1 x 3 pin
Q1	MOSFET	Dual N-channel MOSFET 30 V, 10 A	SO-8	STS8DN3LLH5
R1	Res.	Resistor SMD 1%	0805	62 k Ω
R2	Res.	Resistor SMD	0805	1 k Ω
R3	Res.	Resistor SMD 1%	0805	4.7 k Ω
R4	Res.	Resistor SMD	0805	4.7 k Ω
R5	Res.	Resistor SMD 1%	0805	6.8 k Ω
R6	Res.	Resistor SMD	0805	10 Ω
R7	Res.	Resistor SMD	0805	2.2 Ω
R8	Res.	Resistor SMD	0805	2.2 Ω
R9	Res.	Resistor SMD 1%	1210	0.56 Ω
R10	Res.	Resistor SMD 1%	1210	0.56 Ω
R14	Res.	Resistor SMD 1%	1210	0.56 Ω
R15	Res.	Resistor SMD 1%	1210	0.3 Ω
R16	Res.	Resistor SMD 1%	1210	0.3 Ω
U1	Vreg.	Positive voltage regulator 6 V 5%	SOT-89	L78L06AC
U2	PWM cont.	Single-phase PWM controller	SO-8	L6726A

5 References and related materials

1. AN2129 - DIMMING OF SUPER HIGH BRIGHTNESS LEDS WITH L6902D - see www.st.com/stonline/products/literature/an/11247.pdf
2. AN1891 - APPLICATION IDEAS: DRIVING LEDS USING L497X, L597X, L692X DC-DC CONVERTERS FAMILIES - see www.st.com/stonline/products/literature/an/10232.pdf
3. ST1S10 - 3 A, 900 kHz, monolithic synchronous step-down regulator - see www.st.com/stonline/products/literature/ds/13844.pdf
4. L6726A - Single phase PWM controller - see www.st.com/stonline/products/literature/ds/12754.pdf
5. STS8DN3LLH5 - Dual N-channel 30 V, 0.0155 Ω , 10 A, SO-8 STripFET™ V Power MOSFET - see www.st.com/stonline/products/literature/ds/16967.pdf
6. STPS1L30M - LOW DROP POWER SCHOTTKY RECTIFIER - see www.st.com/stonline/products/literature/ds/8902.pdf
7. TS821- 1.225V micropower shunt voltage reference - see www.st.com/stonline/products/literature/ds/6877.pdf.

6 Revision history

Table 4. Document revision history

Date	Revision	Changes
07-May-2009	1	Initial release.
14-May-2010	2	STS8DNH3LL device replaced by STS8DN3LLH5 device - updated Figure 2 , Table 3 , Section 5 , corrected typo in Section 1 , Table 1 , Figure 9 and Table 3 .

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