Candle Lighting LED Driver Module with the Built-in Power MOSFET

AC Input Voltage Range	LED DC Output Voltage/Current	Output Power
$100V_{AC}$/60Hz ~ $264V_{AC}$/50Hz	80V/40mA	3.2W

Key Features

- Universal input from $100V_{AC}$/60Hz to $264V_{AC}$/50Hz, LED DC 80V/40mA output
- Fixed frequency 65kHz buck converter and maximum efficiency > 80%
- Peak current mode control and LED output current variation within ±3%
- Minimum Bill of Material (BOM) for as few as 8 external components
- Dimension : 29mm x 7mm x 10mm
- Typical application : E12/E14/E17/GU10 chandelier lighting

Introduction

This application note describes a constant current candle power module with high integration for full range input voltage from $100V_{AC}$ ~ $264V_{AC}$ by adopting the SQ9920. Based on buck topology, the SQ9920 is able to achieve high current accuracy for chandelier lighting application. This application provides multiple advanced fault protections to enhance the systems safety, including natural open loop protection, V_{DD} under-voltage lockout and thermal shut down. All protections have auto-restart mechanisms. Schematics, PCB Gerber, BOM, as well as typical performance are covered in details by this application note. A complete application circuit is depicted in Figure 4, which can work on universal input voltage range from $100V_{AC}$ ~ $264V_{AC}$.

Specification

The Table 1 contains the specification that this design intends to achieve.

Performance

It is to drive output at 80V/40mA targeting to achieve high efficiency (η_{MAX} > 80%) for AC universal input voltage range $100V_{AC}$ ~ $264V_{AC}$. Actual performance is shown on Table 2. Figure 1, 2 and 3 depict output current, current variation and efficiency at AC input voltage range $100V_{AC}$ ~ $264V_{AC}$ for this module that system designer can adopt it to achieve corresponding performance.

Output Bulk Capacitor

The selection of the bulk capacitor depends on the output current, the admitted over-voltage and the desired voltage ripple. But for LED load application, the requirement is usually for the LED current ripple. In order to meet 30% current ripple limitation, the output voltage ripple should be within 10% of the output voltage.

BOM

BOM is shown in Table 3 on page 4.

PCB Layout

The PCB layout has dimension at 29mm x 7mm x 1.6mm in order to fit candle light space. Detailed layout is shown in Figure 5.

Power Module Photo

Pictures of power module and key components are shown in Figure 6 and 7.

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Table 1. Related Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
AC input voltage	V_{AC}	100		264	V	
LED DC output voltage	V_{OUT}		80		V	
LED output current	$I_{OUT(SET)}$		40		mA	

Table 2. Actual Performance

AC Input	Input Power (W)	OutputCurrent (I_{OUT}, mA)	Output Voltage (V_{OUT}, V)	Current Variation (%) (Note)	Efficiency (η, %)	Note
100V_{AC}/60Hz	4.09	40.85	80.0	2.1	79.9	
110V_{AC}/60Hz	4.10	41.12	79.9	2.8	80.2	
120V_{AC}/60Hz	4.07	41.01	79.9	2.5	80.5	
130V_{AC}/60Hz	4.07	41.04	79.9	2.6	80.6	
180V_{AC}/50Hz	4.01	40.27	79.9	0.7	80.2	
200V_{AC}/50Hz	4.01	40.00	79.9	0.0	79.9	
220V_{AC}/50Hz	4.02	39.68	79.9	-0.8	78.9	
240V_{AC}/50Hz	4.03	39.33	79.9	-1.7	78.0	
264V_{AC}/50Hz	4.01	38.90	79.9	-2.8	77.5	

Note :

Current Variation is defined as follows :

$$\% = \frac{I_{OUT} - I_{OUT(SET)}}{I_{OUT(SET)}} \times 100\%$$

where $I_{OUT(SET)} = 40mA$

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Figure 1. Output Current for AC Input Voltage Range $100V_{AC}$ ~ $264V_{AC}$

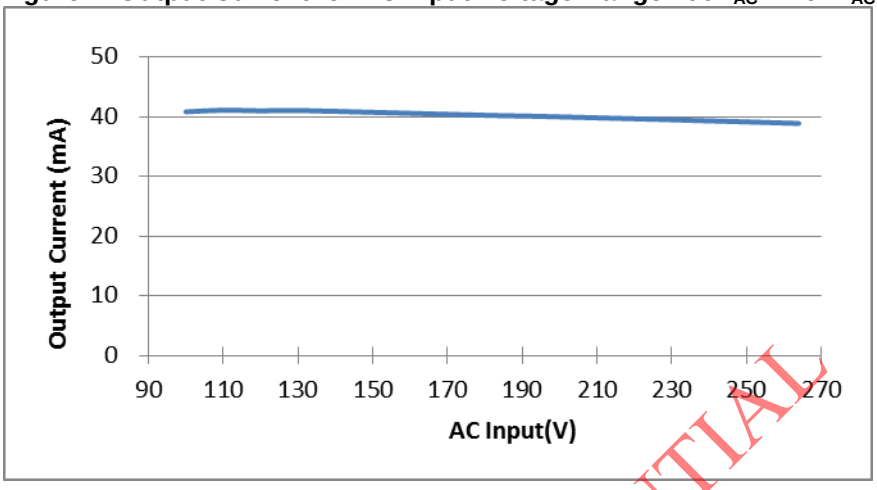

Figure 2. Current Variation for AC Input Voltage Range $100V_{AC}$ ~ $264V_{AC}$

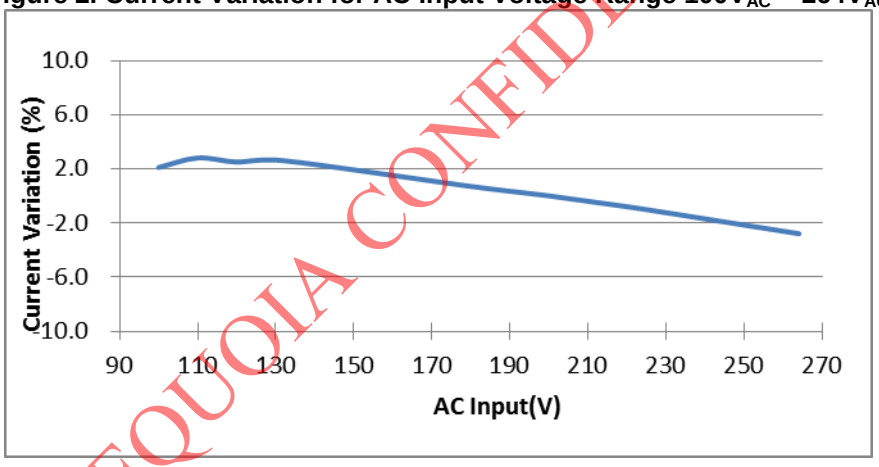

Figure 3. Efficiency for AC Input Voltage Range $100V_{AC}$ ~ $264V_{AC}$

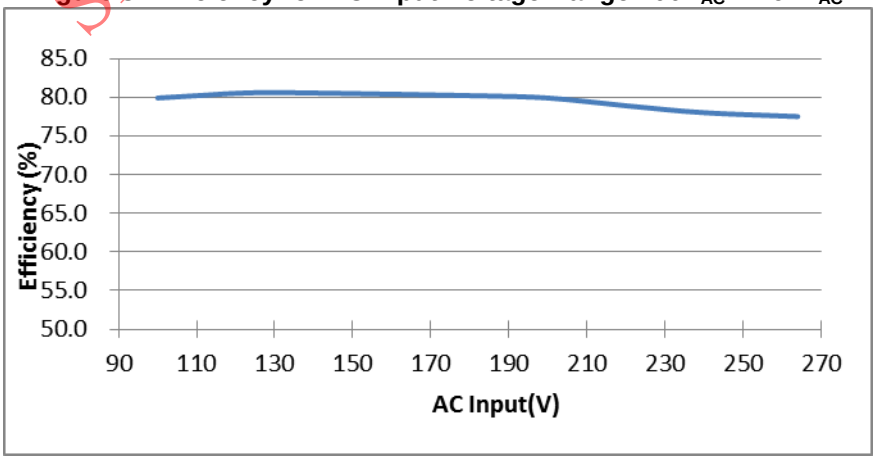

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Figure 4. A Complete Application Circuit by Adopting the SQ9920

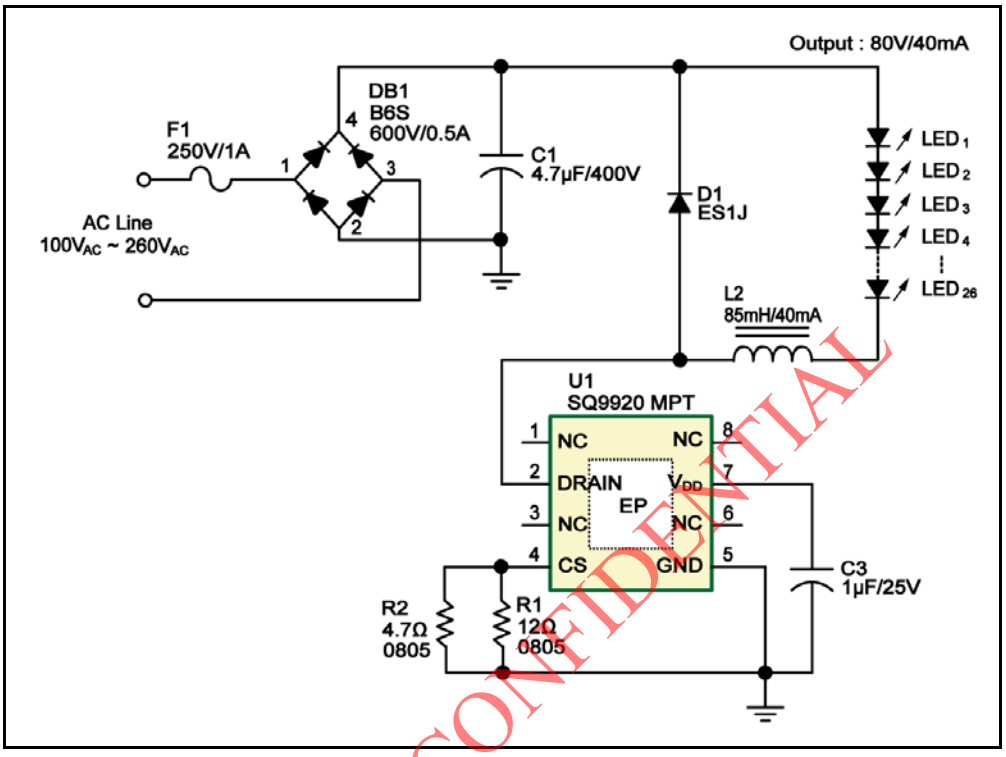

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Table 3 : Bill of Material

Item	Symbol	Description	Category	Qty	Note
1	R1	4.7Ω/0805, 0.125W, 1%	Resistor	1	
2	R2	12Ω/0805, 0.125W, 1%	Resistor	1	
3	C1	4.7μF/400V	Capacitor	1	
4	C3	1μF/25V	Capacitor	1	
5	D1	ES1J	Diode	1	
6	DB1	B6S, 600V/0.5A	Bridge	1	
7	F1	250V/1A, Slow action, 3.6*10mm	Fuse	1	
8	L2	85mH/40mA	Inductor	1	
9	U1	SQ9920 MPT, SO8-EP	IC	1	
10	PCB	L29mm x W7mm x T1.6mm	PCB	1	FR-4

Figure 5. Picture of PCB Layout (Dimension at 29mm x 7mm x 1.6mm)

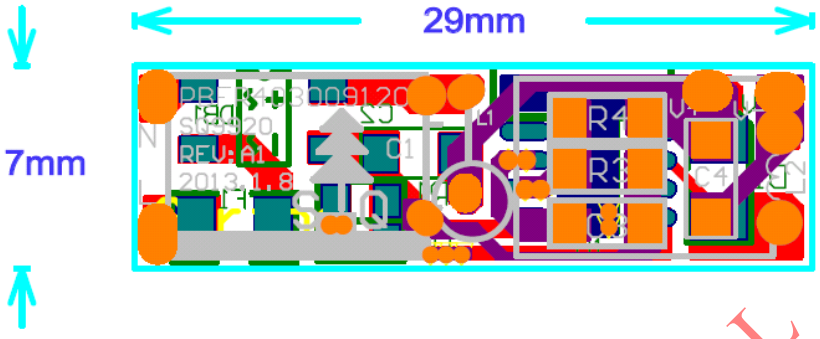

Figure 6. Picture of AC Line (Two White Wires), Capacitor C1 (4.7μF/400V), Inductor L2 (85mH/40mA), and DC LED Output Line (LED+ : Red Wire, LED- : Black Wire)

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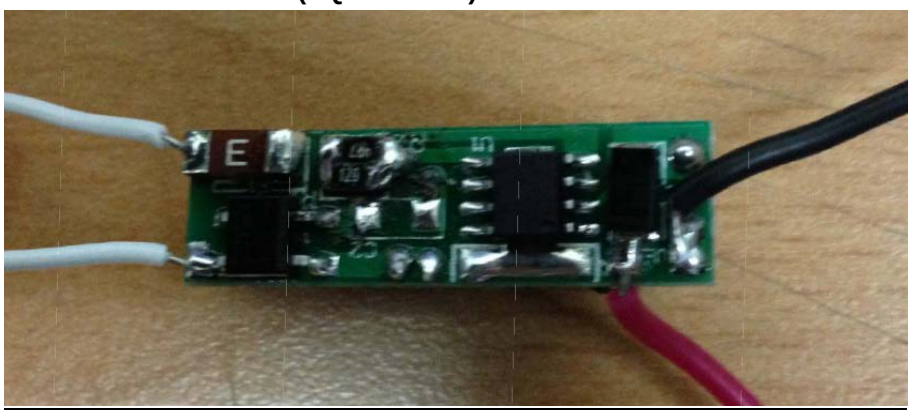
Figure 7. Picture of Fuse F1, Bridge DB1, Resistor R1 and R2, U1 (SQ9920 MPT) and Diode D1



Revision History