UM10477

SSL2101 120 V (AC) flyback task light 20 V/450 mA driver board

Rev. 1 — 23 June 2011 **User manual**

Document information

Info	Content
Keywords	SSL2101, LED driver, dimmable, task light, 450 mA LED
Abstract	This document describes the SSL2101 task light 120 V (AC), dimmable, 450 mA LED driver board. The board is designed to highlight the high performance dimming, wide compatibility, high-efficiency capability by driving various numbers of LEDs.

Revision history

Rev	Date	Description
v.1	20110623	first issue

Contact information

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1. Introduction

WARNING

Lethal voltage and fire ignition hazard

The non-insulated high voltages that are present when operating this product, constitute a risk of electric shock, personal injury, death and/or ignition of fire.

This product is intended for evaluation purposes only. It shall be operated in a designated test area by personnel qualified according to local requirements and labor laws to work with non-insulated mains voltages and high-voltage circuits. This product shall never be operated unattended.

The SSL2101 task light board is a 120 V (AC), dimmable, 450 mA LED driver board. It employs a flyback converter to drive power LEDs that require galvanic isolation. The board is designed to highlight high performance dimming, wide dimmer compatibility, high efficiency and the capability of driving various numbers of LEDs.

019aac594

Fig 1. SSL2101 task light board

2. Safety warning

Connect the board to the mains voltage. Avoid touching the board while it is connected to the mains voltage at all times. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation of the mains phase using a variable transformer is always recommended.

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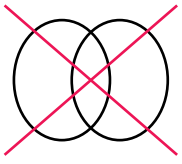
a. Isolated



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b. Not isolated

Fig 2. Variac isolation symbols

3. Specifications

Table 1. Specifications for the reference board

Unless otherwise stated, these specifications were measured at T_{amb} = 25 °C

Description	Conditions	Min	Typ	Max	Unit
input voltage (V_{IN})	at 60 Hz	108	120	132	V
output voltage (V_o)		15	-	30	V
output current (I_o)	V_{IN} = 120 V (AC); V_o = 16.4 V	-	450	-	mA
switching frequency		50	60	70	kHz
peak-to-peak output ripple current	V_{IN} = 120 V (AC); V_o = 16.4 V; I_o = 450 mA	-	30	-	%
Power Factor	V_{IN} = 120 V (AC); V_o = 16.4 V; I_o = 450 mA	0.9	0.95	-	
efficiency	V_{IN} = 120 V (AC); V_o = 16.4 V; I_o = 450 mA	77	80	-	%
output current regulation	Line: 106 V (AC) to 135 V (AC); I_o = 450 mA	-	-	6	%
isolation voltage	between primary and secondary winding	-	2.5	-	kV

4. Set-up procedures

The board input voltage is 120 V (AC) and it can drive either a 5-LED or 9-LED string at 450 mA. The output voltage range is from 15 V to a maximum of 30 V.

The LED load is connected to the output terminals as shown in Figure 3. Do not connect LED load to the driver board when the driver board is powered to avoid damage caused to LEDs due to the hot-plugging inrush current.

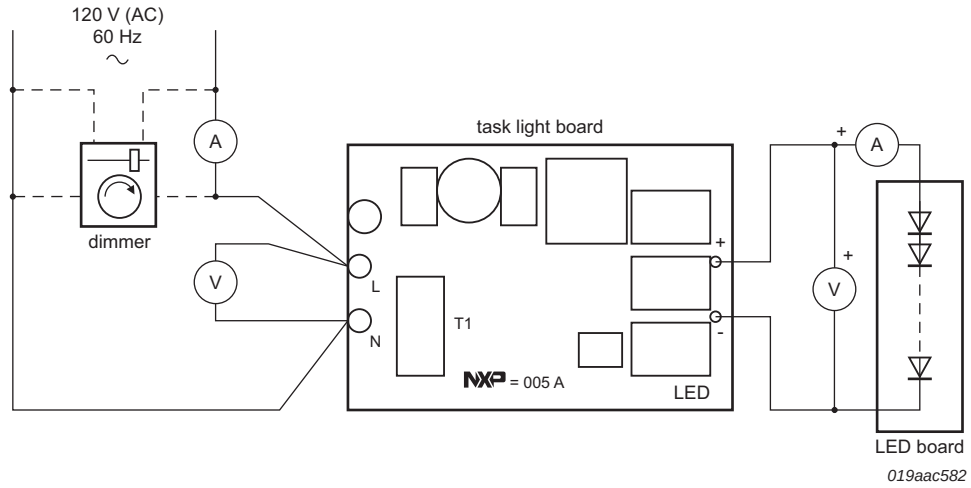

Fig 3. Connection to the driver board

5. Functional description

The SSL2101 IC is used to configure a flyback converter operating at 60 kHz and produces a constant output current (450 mA) to drive up to 9-LEDs. The current corresponds to an output voltage between 15 V and 30 V.

When an input voltage is applied to the SSL2101, it is initially powered by the rectified voltage. Once the SSL2101 starts switching, the SSL2101 is then supplied by the inductor's auxiliary winding to improve efficiency.

The flyback converter operates in Discontinuous Conduction Mode (DCM) to minimize the magnetic component and switching losses. In addition, a high Power Factor (PF) is obtained due to the DCM operation. When operating in Boundary Conduction Mode (BCM) at full load, flyback converter efficiency is optimized and enhanced by the valley switching detection.

When mains dimmers are used, the circuit detects the rectified voltage change. In addition, the circuit reduces the duty cycle and switching frequency to reduce the output current for deep dimming. To increase the dimmer compatibility without sacrificing efficiency, the board uses a highly efficient, bleeding circuit to ensure flicker-free deep dimming with a wide range of mains dimmers. It detects circuit current and if necessary, supplements bleeding current to meet the required hold currents of triac dimmers.

The bleeding circuit ensures the widest dimmer compatibility while keeping heat generation to the minimum.

The circuit also includes an active damper to increase the efficiency and limit the inrush current during the phase cutting transient. An ElectroMagnetic interference (EMI) filter is included to ensure compliance with the EMI requirement of EN55015/FCC15.

Five LEDs were used in the test application for optimal performance of this reference design. The design can be adapted to meet other LED solutions.

6. Schematic

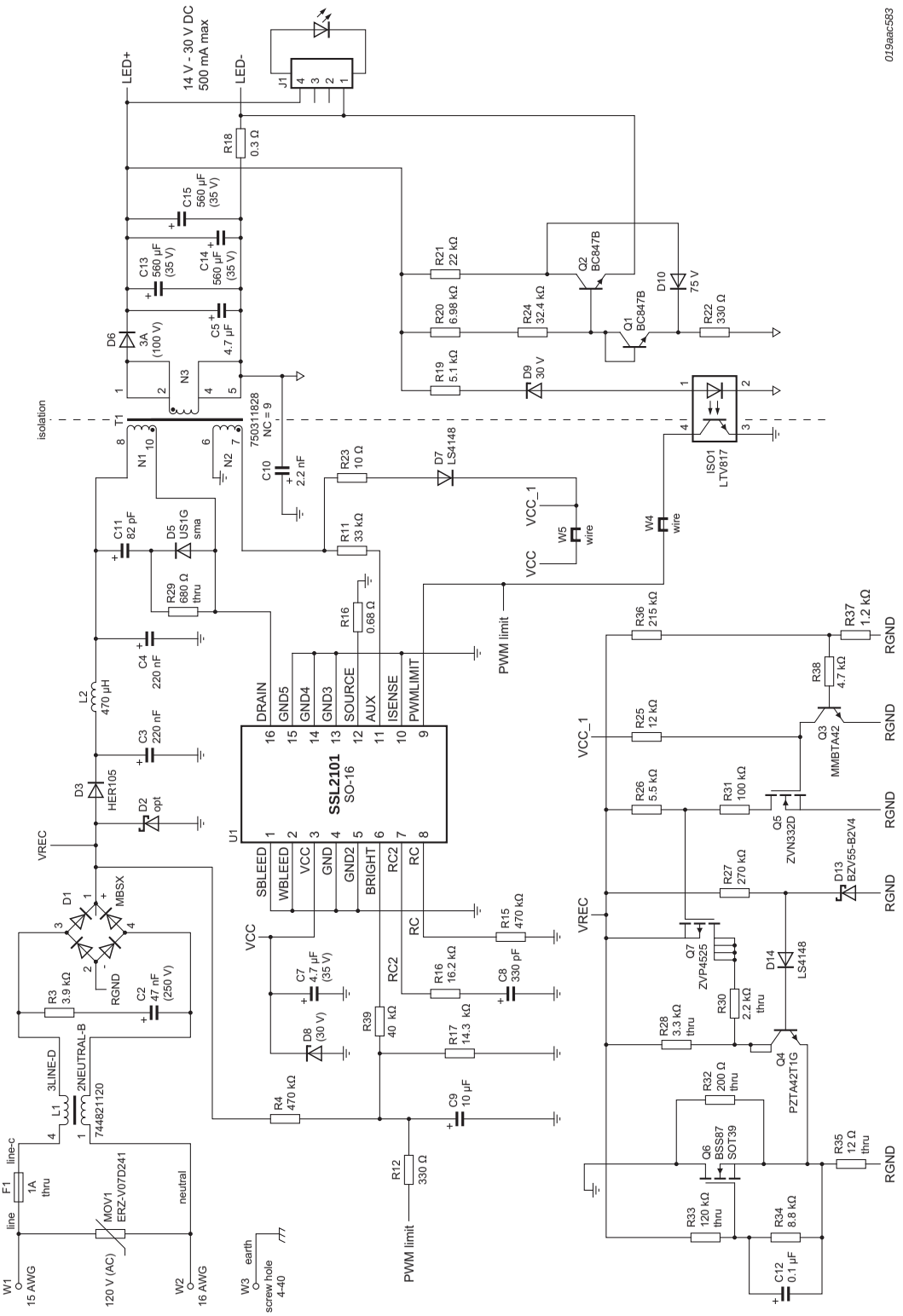

Fig 4. Schematic diagram

7. Bill of materials

Table 2. Bill of materials

Part reference	Qty	Description/value	Manufacturer/part number
D1	1	MBSX; TO-269AA	Fairchild; MB2S
C12	1	0.1 μF; 16 V; ± 10 %; 0603	Murata; GRM188R71C104KA01D
C8	1	330 pF; ± 5 %; 0805	AVX; 06033A331JAT2A
C11	1	82 pF; 250 V; ± 5 %; 0805	Murata; GRM21A5C2E820JW01D
C5	1	4.7 μF; ±10 %; 1206	Murata; UMK316BJ475KL-T
C7	1	4.7 μF; 35 V; ± 10 %; 1206	Murata; GMK325BJ475MN-T
C9	1	10 μF; 16 V; ± 20 %; 1206	Murata; GRM21BR61C106KE15L
C2	1	47 nF; 250 V; ± 10 %; RAD_3P5X7P2X8	EPCOS; B32529C3473K
C10	1	2.2 nF; 2 kV; ± 10 %; RAD_10ODX5X13H	Murata; DEBB33D222KA2B
C3; C4	2	220 nF; 250 V; 5 %; RAD_7P2X7P2X13	WIMA; MKP2 0.22/250/5
C13; C14; C15	3	560 μF; 35 V; ± 20 %; RAD_10DX16L-H	United ChemiCon; EKY-350ELL561MJ25S
D7; D14	2	LS4148; DIO-LL-34	Vishay; LS4148-GS08
D5	1	HER105; DO-41-V	Taiwan Semi; HER105
D6	1	100 V; 3 A; DIO-SMA	MCC; SK310A-TP
D8; D9	2	30 V Zener diode; DIO-SOD80C	NXP Semiconductors; BZV55-B30,115
D13	1	2.4 V Zener diode; DIO-SOD80C	NXP Semiconductors; BZV55-B2V4,115
D10	1	100 mA; 75 V; DO-35-V	NXP Semiconductors; 1N4148+133
D3	1	HER105; DO-41-V	Diodes, Inc.; HER105-TR
F1	1	1 A; 250 V; axial, 5 mm × 15 mm	Littelfuse; 0224001.HXP
L2	1	470 μH; ± 10 %; radial	Murata Power; 13R474C
L1	1	744821120; ± 10 %; radial	Wurth; 744821120
MOV1	1	ERZ-V07D241; disc 7 mm	Panasonic; ERZ-V07D241
ISO1	1	LTV817; 4-DIP	Lite-On; LTV-817
R11	1	33 kΩ; 1 %; 0603	Panasonic; ERJ-3GEYJ333V
R12	1	330 Ω; 1 %; 0603	Yageo; RC0603FR-07330RL
R23	1	10 Ω; 1 %; 0603	Panasonic; ERJ-3GEYJ100V
R25	1	12 kΩ; 1 %; 0603	Panasonic; ERJ-3GEYJ123V
R26	1	5.49 kΩ; 1 %; 0603	Panasonic; ERJ-3EKF5491V
R34	1	6.8 kΩ; 1 %; 0603	Stackpole; RMCF 1/16 6.8K 5% R
R37	1	1.2 kΩ; 1 %; 0603	Yageo; RC0603FR-071K2L
R38	1	4.7 kΩ; 1 %; 0603	Yageo; RC0603FR-074K7L
R39	1	40.2 kΩ; 1 %; 0603	Stackpole; RMCF0603FT40K2
R10	1	0.68 Ω; 1 %; 0805	Rohm; MCR10EZHFLR680
R15	1	470 kΩ; 1 %; 0603	Stackpole; RMCF 1/16 470K 1% R
R16	1	16.2 kΩ; 1 %; 0603	Yageo; RC0603FR-0716K2L
R17	1	14.3 kΩ; 1 %; 0603	Stackpole; RMCF 1/16 14.3K 1% R
R19	1	5.1 kΩ; 1 %; 0603	Stackpole; RMCF 1/16 5.1K 1% R
R20	1	6.98 kΩ; 1 %; 0603	Panasonic; ERJ-3EKF6981V
R21	1	22 kΩ; 1 %; 0603	Stackpole; RMCF 1/16 22K 1% R

Table 2. Bill of materials *...continued*

Part reference	Qty	Description/value	Manufacturer/part number
R22	1	330 Ω; 1 %; 0603	Yageo; RC0603FR-07330RL
R24	1	32.4 kΩ; 1 %; 0603	Panasonic; ERJ-3EKF3242V
R4	1	470 kΩ; 1 %; 1206	Yageo; RC1206FR-07470KL
R18	1	0.3 Ω; 1 %; 1206	Stackpole; CSR 1/4 0.3 1% I
R27	1	270 kΩ; 1 %; 1206	Stackpole; RMCF 1/8 270K 5% R
R31	1	100 kΩ; 1 %; 1206	Yageo; RC1206FR-07100KL
R30	1	2.2 kΩ; 1 W; 1 %; RAX-CFR-25	Tyco or Stackpole; CFR35J2K2 CF1/22.2K5%R
R3	1	3.9 kΩ; 0.25 W; 1%; RAX-CFR-25-V	Tyco or Stackpole; CFR35J3K9 CF1/23.9K5%R
R28	1	3.3 kΩ; 1 W; 1 %; RAX-CFR-25-V	Tyco or Stackpole; CFR35J3K3 CF1/23.3K5%R
R32	1	200 Ω; 0.25 W; 1 %; RAX-CFR-25-V	Tyco or Stackpole; CFR25 5%200R CF1/22005%R
R33	1	120 kΩ; 0.25 W; 1 %; RAX-CFR-25-V	Tyco or Stackpole; CFR25 5% 120K CF1/2120K5%
R35	1	12 Ω; 0.25 W; 5 %; RAX-CFR-25-V	Yageo; CFR-25JB-12R
R36	1	215 kΩ; 0.25 W; 1 %; RAX-CFR-25-V	Yageo; MFR-25FBF-215K
R29	1	680 Ω; 5 %; RAX-CFR-50-V	Yageo; CFR-50JB-680R
U1	1	SSL2101; SO16	NXP Semiconductors; SSL2101T/N1,518
Q4	1	PZTA42T1G; SOT223-4	NXP Semiconductors; PZTA42,115
Q7	1	ZVP4525; SOT23-6	Diodes, Inc.; ZVP4525E6TA
Q1; Q2	2	BC847B; SOT23_C-BE	NXP Semiconductors; BC847BVN,115
Q3	1	MMBTA42; SOT23_C-BE	NXP Semiconductors;MMBTA42,215
Q5	1	ZVN3320; SOT23_D-GS	Diodes, Inc.; ZVN3320
Q6	1	BSS87; SOT89-GDS	NXP Semiconductors; BSS87,115
T1	1	750311770; XFMR-750311627	Wurth-Midcom; 750311770_ r01

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