UM10847

SSL5236DB1249 230 V/4 W non-isolated buck-boost candle-form dimmable LED driver dual demo board

Rev. 1 — 13 February 2015 **User manual**

Document information

Info	Content
Keywords	SSL5236DB1249, SSL5236TE, non-isolated buck-boost topology, LED driver controller, internal MOSFET switch, dimmable candle-form applications, HSO8 package
Abstract	This user manual describes the performance, technical data, and the connection of the SSL5236DB1249 dual demo board. The demo board uses non-isolated buck-boost topology. This SSL5236DB1249 dual demo board is designed for dimmable candle-form applications. It operates at 230 V (AC) with an input power of 4 W and an output voltage of approximately 90 V.

Revision history

Rev	Date	Description
v.1	20150213	first issue

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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.

This user manual describes the operation of the SSL5236DB1249 demo board. The SSL5236DB1249 demo board features the controller circuit SSL5236TE with an integrated MOSFET switch. The board operates in a 230 V/4 W non-isolated buck-boost dimmable LED driver application. The SSL5236TE is mounted in an HSO8 package with an exposed die-pad, which must be soldered to the floating ground plane of the board to improve thermal behavior.

The SSL5236DB1249 single demo board is designed for driving LED loads with 90 V nominal voltage and 4 W input power.

The PCB dimensions are compatible with candle-form applications.

The SSL5236DB1249 demo board provides a simple, cost-effective, and highly efficient solution for Solid-State Lighting (SSL) applications.

1.1 Features

- Candle-form applications
- Integrated MOSFET switch
- Supports most available dimming solutions
- Deep dimming level
- Flicker-free dimming
- Open/short LED string protection
- OverCurrent Protection (OCP)
- OverTemperature Protection (OTP)
- Power Factor (PF) > 0.86
- Efficiency > 75 % at 230 V (AC) input
- Compliant with IEC61000-3-2 harmonic standard
- Compliant with EN55015 conducted EMI

2. Safety warning

The demo board input is connected to the 230 V (AC) mains voltage. Avoid touching the board while it is connected to the mains voltage and when it is in operation. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation from the mains phase using a fixed or variable transformer is always recommended. Figure 1 shows the symbols on how to recognize these devices.

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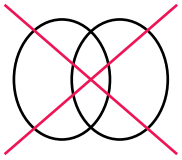
a. Isolated



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b. Not isolated

Fig 1. Isolation symbols

3. Specifications

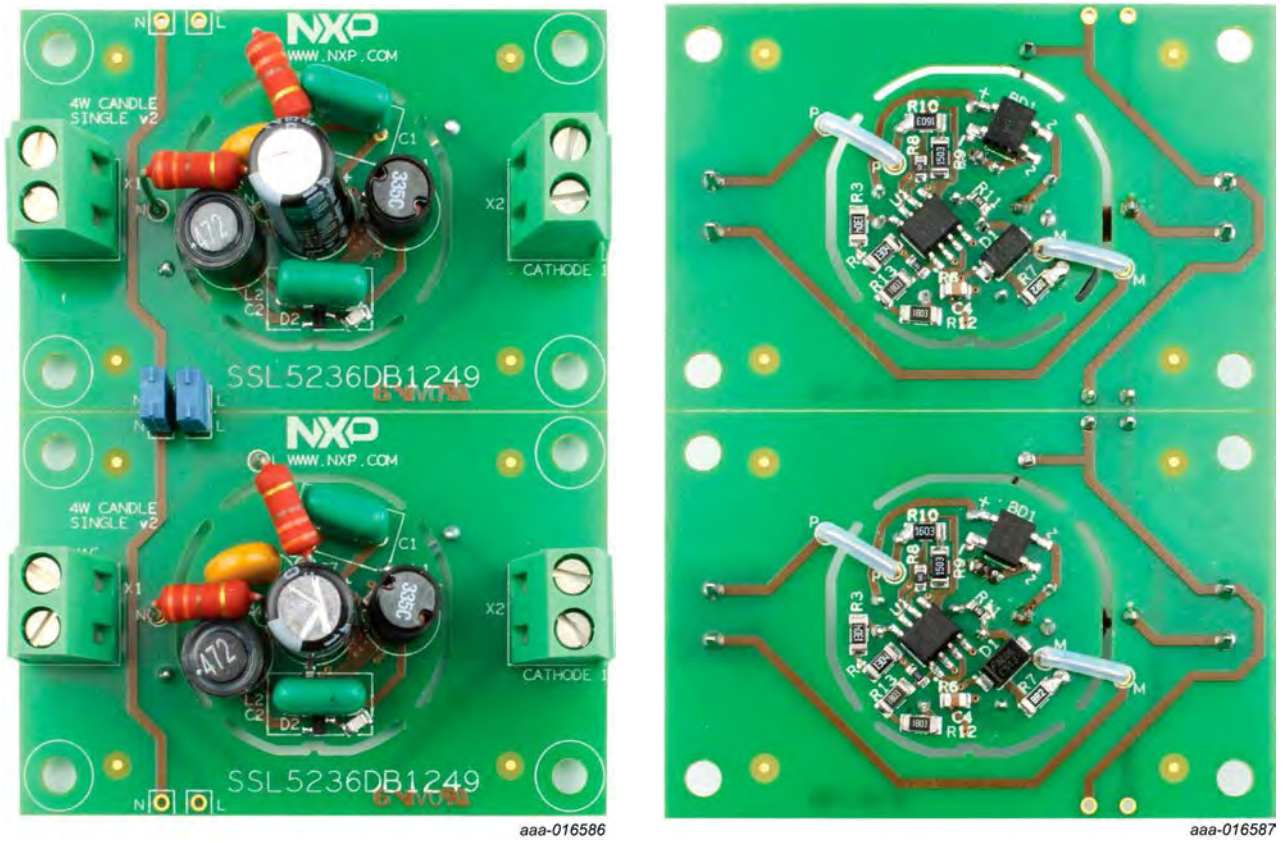
Table 1 lists the specification of the SSL5236DB1249 demo board.

Table 1. SSL5236DB1249 specifications

Symbol	Parameter	Value
V_{mains}	AC mains supply voltage	230 V; ±10 %
P_{in}	input power	4 W
V_{LED}	LED output voltage	90 V
I_{LED}	LED output current	≈ 37 mA
$I_{LED(ripple)}$	LED output current ripple	±25 % (100 Hz)
$\Delta I_{LED}/\Delta V_{mains}$	line regulation	< 3 % at V_{mains} = 230 V; ±10 %
$\Delta I_{LED}/\Delta V_{LED}$	load regulation	±5 % at V_{LED}; −15 % to +7.7 %
η	efficiency	75 %; at 230 V (AC)/50 Hz
PF	power factor	> 0.86; at 230 V (AC)/50 Hz
T_{oper}	operating temperature	−40 °C to +105 °C
-	board dimensions	60 mm × 40 mm
-	conducted ElectroMagnetic Interference (EMI)	EN55015
-	IEC61000-3-2	class D (for P_{in} < 25 W limit)
-	dimmer compatibility (stable light output above on/off point)	80 % dimmer compatibility for ≥ 2 lamps/dimmer

4. Board photographs

Figure 2 shows the top view and bottom view of the SSL5236DB1249 demo board. The board has been designed as a dual board. For dimmer tests, it is assumed that at least two lamps of 4 W are connected to one dimmer. However, the board can also be tested separately by removing the blue jumpers which can be seen in Figure 2(a). At the left connector of the board (Figure 2(a)), the AC mains (230 V) must be added. At the right connector, the LED load (90 V) must be connected. The inner part of the board can be taken out. It has a diameter of 28 mm which fits in a candle lamp.



a. Top view

b. Bottom view

Fig 2. SSL5236DB1249 dual demo board photographs

5. Functional description

5.1 Input filtering

Capacitors C1 and C2 and inductor L1 (see Figure 10) filter the switching current from the buck-boost converter to the mains AC. Capacitors C1 and C2 also provide a low-impedance path for the converter output switching current.

The input series resistance of 660 Ω and capacitor C1 provide adequate protection against transient surge voltages.

5.2 Efficiency improvement for universal mains

Resistors R3 and R4 provide the supply current for the SSL5236DB1249 demo board. The IC draws an additional start-up current ($I_{CC(startup)}$) just before VCC reaches the start-up voltage level ($V_{startup}$). The supply current in operation is therefore lower than during start-up conditions, preventing lamp flicker when the mains voltage is increased or decreased slowly. This mechanism also increases the dimming performance.

Figure 3 shows the basic behavior.

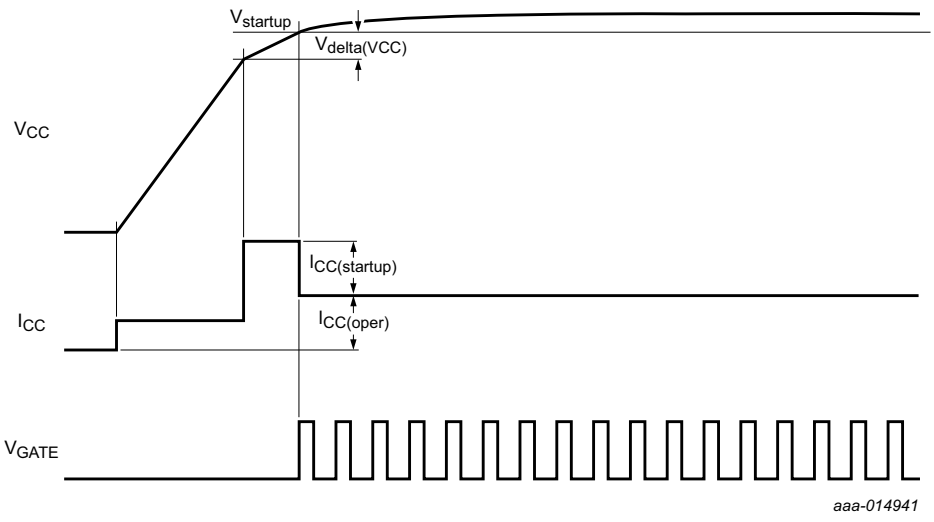


Fig 3. Start-up current waveform

5.3 Output open and output short protection

The driver board is protected when the LED load is accidentally left open. When the LED load is accidentally left open, the output voltage increases. When the OverVoltage Protection (OVP) level is reached on the DEMOVP pin, the OVP protection is triggered. OVP is a non-latched protection. It recovers when the LED string is reconnected. Resistors R8, R9, and R10 determine the OVP level. The voltage rating of output capacitor C7 must be higher than the DC level occurring when the LED load is accidentally left open.

The measured OVP level is about 100 V.

When the LED driver output of the board is shorted, the maximum ISNS voltage ($V_{I(ISNS)max}$) limits the primary converter current. The converter frequency drops to its absolute minimum. This mode is very safe. The input power is very limited.

5.4 ElectroMagnetic Interference (EMI) precautions

For optimal EMI performance, the way of mounting of L1, L2 are important. Make sure that:

- For buck-boost inductor L2:

  The start of winding, which is the wire closest to the core (marked with dot on coil and schematic), must be connected to the switching side of the converter, in this case ground of SSL5236TE. The outer part of the winding acts as a shield for the inner part of the winding.

- For filter inductor L1:

  The start of the winding, which is wire closest to the core (marked with dot on schematic and with the shortest connection lead-on coil), must be connected to the bridge rectifier. The outer part of the winding acts as a shield for the inner part of the winding.

Figure 2(a) shows the orientation of the coils.

6. Performance

During performance tests:

- V_{mains} = 230 V (AC) with a ±20 % margin
- T_{amb} = 25 °C typical
- V_{LED} = 90 V unless otherwise specified

6.1 Efficiency

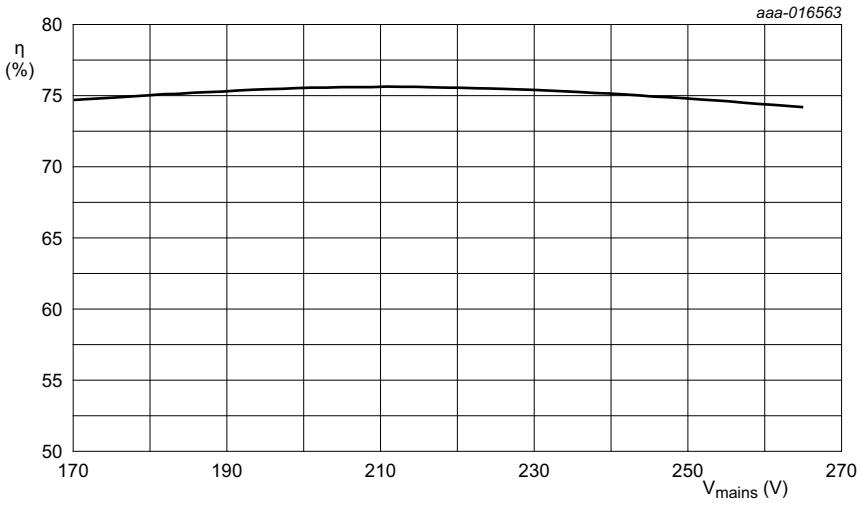


Fig 4. Efficiency as a function of V_{mains}

6.2 Power factor

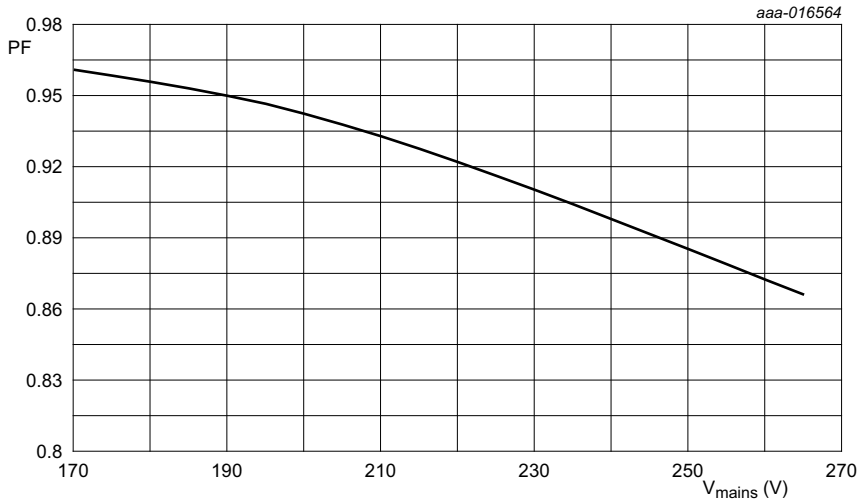


Fig 5. Power factor as a function of V_{mains}

6.3 Line regulation

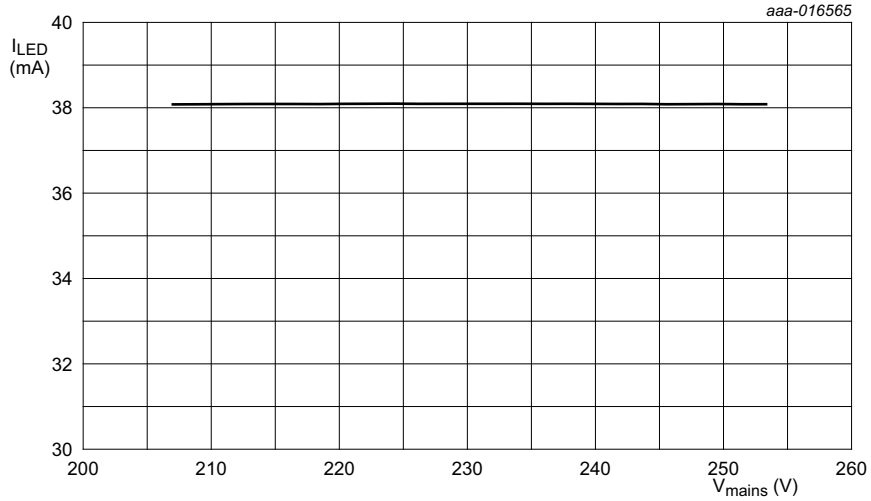


Fig 6. Line regulation

6.4 Load regulation

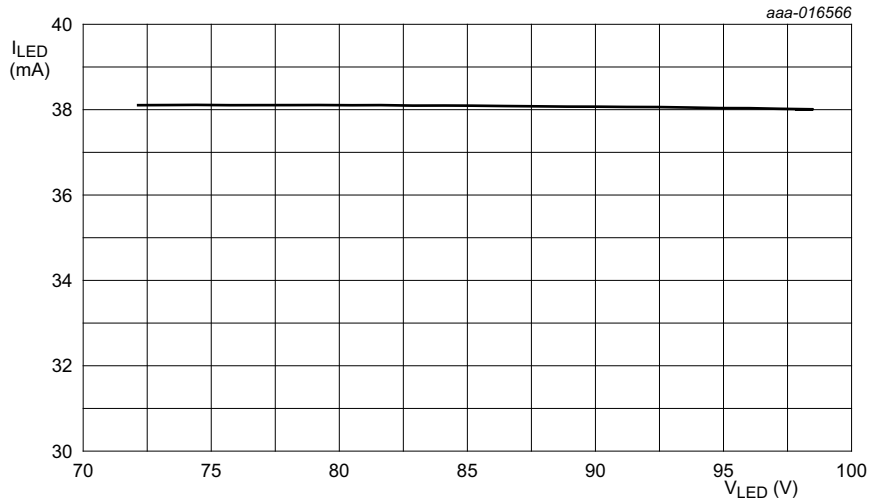


Fig 7. Load regulation

6.5 Output ripple

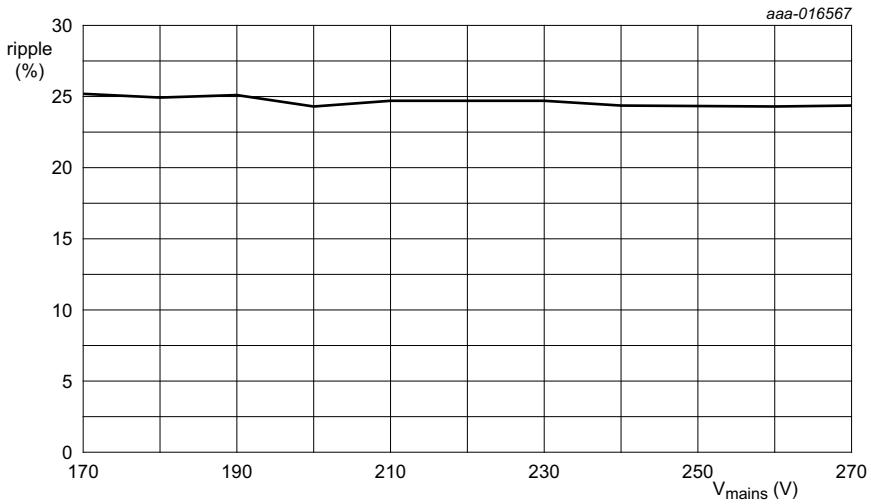


Fig 8. Output ripple as a function of V_{mains}

6.6 ElectroMagnetic Interference (EMI)

Figure 9 shows the conducted EMI result of the SSL5236DB1249 demo board.

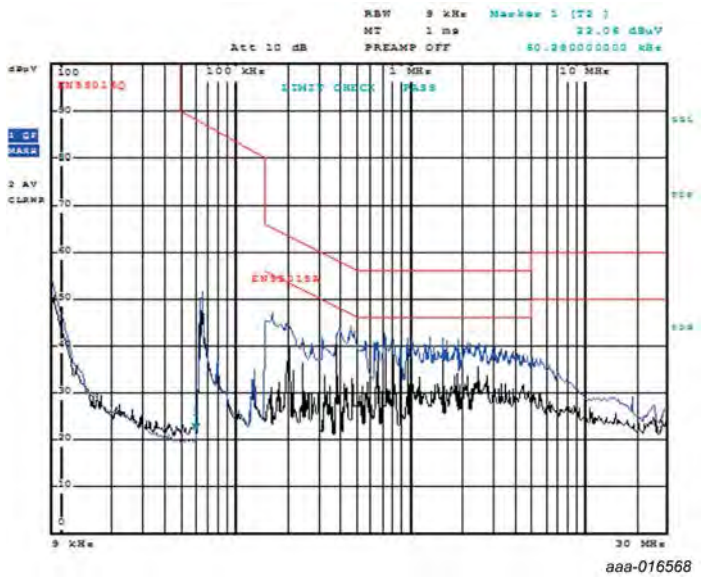


Fig 9. Conducted EMI

7. Schematic

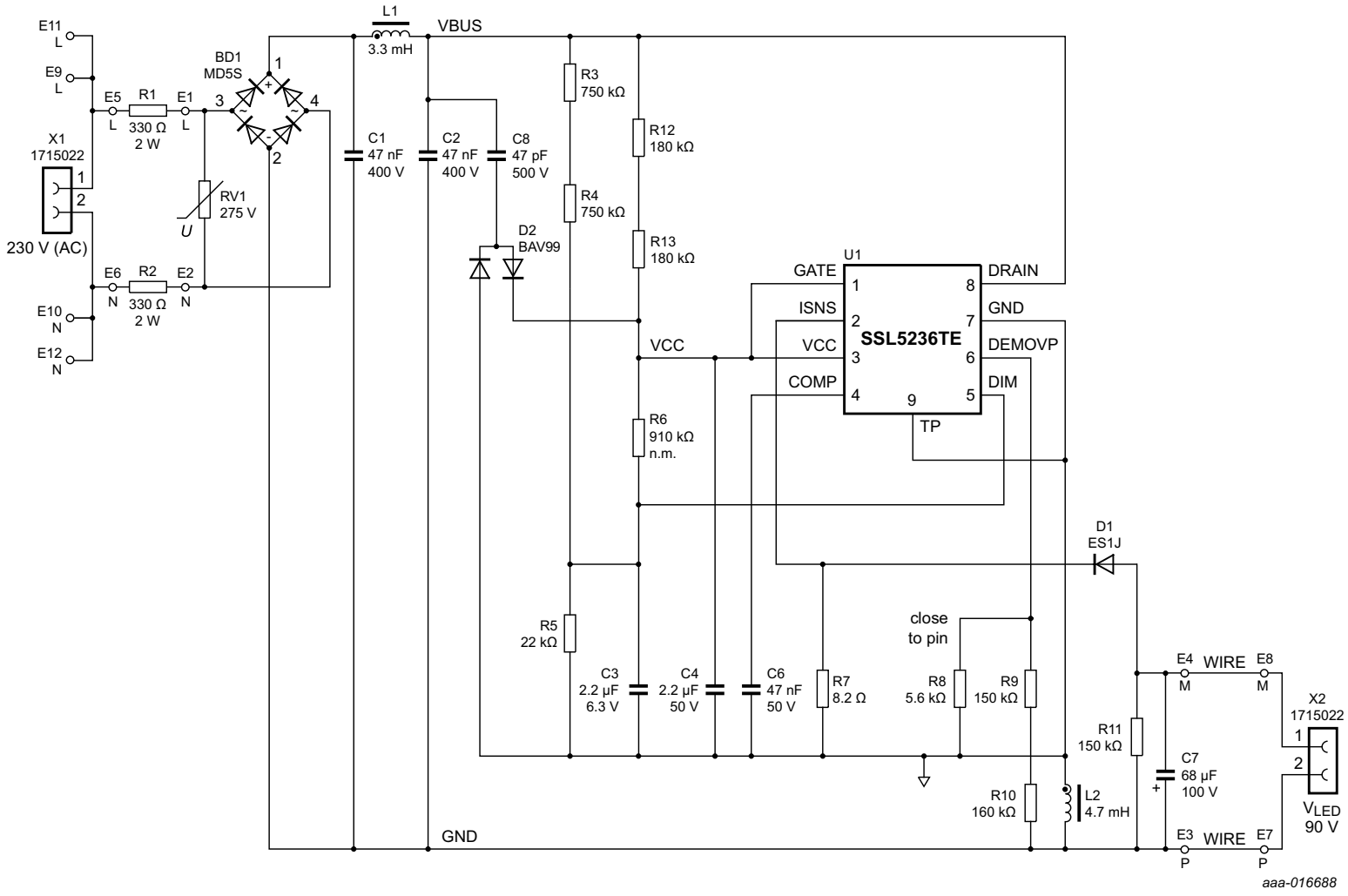


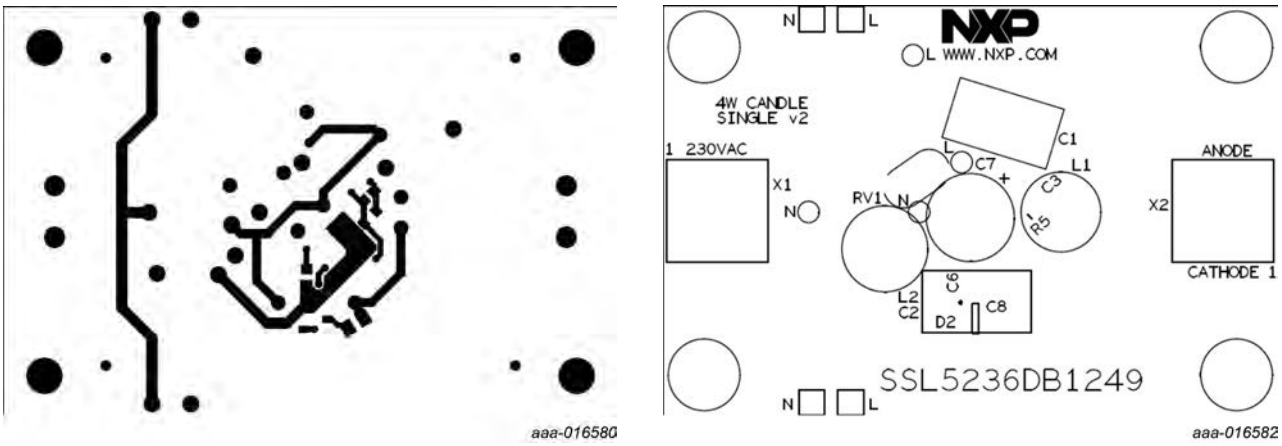
Fig 10. SSL5236DB1249 demo board schematic diagram

8. Bill Of Materials (BOM)

Table 2. SSL5236DB1249 bill of materials

Reference	Description and values	Part number	Manufacturer
BD1	bridge rectifier; 1000 V; 500 mA	MD5S	Rectron
C1; C2	capacitor; 47 nF; 5 %; 400 V; PET; THT	CL21-400V-0.047µF/K	AIDI
C3	capacitor; 2.2 µF; 10 %; 6.3 V; X7R; 0603	C1608X7R0J225K080AB	TDK
C4	capacitor; 2.2 µF; 10 %; 50 V; X7R; 0805	C2012X7R1H225K125AC	TDK
C6	capacitor; 47 nF; 10 %; 50 V; X7R; 0603	-	-
C7	capacitor; 68 µF; 20 %; 100 V; ALU; THT	100ZLJ68M8X20	Rubycon
C8	capacitor; 47 pF; 10 %; 500 V; X7R; 0805	C0805C470KCRACTU	KEMET
D1	diode; 600 V; 1 A	ES1J	Fairchild
D2	diode; 100 V; 215 mA	BAV99	NXP Semiconductors
L1	inductor; 3.3 mH; 100 mA	22R335C	Murata
L2	Inductor; 4.7 mH; 160 mA	744731472	Würth Elektronik
R1; R2	resistor; 330 Ω; 5 %; 2 W; MFP2	MFP2-330RJI	Welwyn Components
R3; R4	resistor; 750 kΩ; 1 %; 250 mW; 1206	-	-
R5	resistor; 22 Ω; 1 %; 63 mW; 0603	-	-
R6	resistor; not mounted; 910 kΩ; 1 %; 63 mW; 0603	-	-
R7	resistor; 8.2 kΩ; 1 %; 250 mW; 1206	-	-
R8	resistor; 5.6 kΩ; 1 %; 63 mW; 0603	-	-
R9	resistor; 150 kΩ; 1 %; 250 mW; 1206	-	-
R10	resistor; 160 kΩ; 1 %; 250 mW; 1206	-	-
R11	resistor; 150 kΩ; 1 %; 63 mW; 0603	-	-
R12; R13	resistor; 180 kΩ; 1 %; 250 mW; 1206	-	-
RV1	resistor; VDR; 275 V; 36 J	-	-
U1	DIM0MCM; SSL5236TE	SSL5236TE	NXP Semiconductors

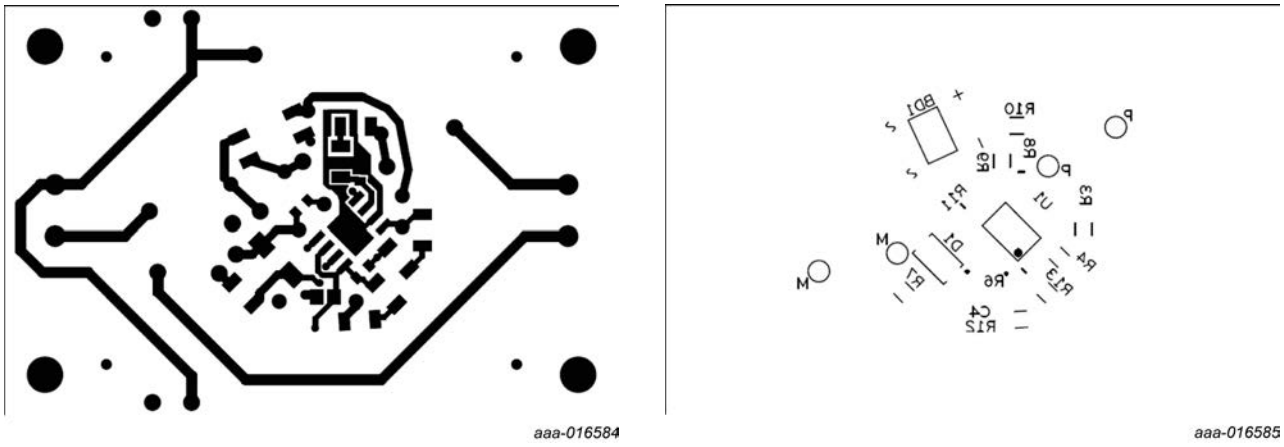
9. Board layout



a. Top view

b. Bottom view

Fig 11. SSL5236DB1249 demo board layout



a. Top view

b. Bottom view

Fig 12. SSL5236DB1249 demo board component placement

10. Abbreviations

Table 3. Abbreviations

Acronym	Description
EMI	ElectroMagnetic Interference
LED	Light-Emitting Diode
OCP	OverCurrent Protection
OTP	OverTemperature Protection
PF	Power Factor
SSL	Solid-State Lighting

11. References

[1] SSL5236TE data sheet — Compact high power factor dimmable LED driver IC

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13. Contents

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