UM10712

SSL5511DB1214 100 V 20 W buck-boost converter

Rev. 1.1 — 10 December 2015 **User manual**

Document information

Info	Content
Keywords	SSL5511DB1214, analog/PWM dimmable, LED driver, buck-boost converter, single stage converter, LED down-light/fixtures
Abstract	This user manual describes the operation of the SSL5511DB1214. The device is an analog/PWM dimmable LED driver featuring the SSL5511 using a buck-boost topology. The SSL5511DB1214 demo board provides a suitable evaluation platform for an analog/PWM dimmable LED pendant lamp for LED fixtures and down-lights.

Revision history

Rev	Date	Description
V.1.1	20151210	updated issue
v.1	20140620	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 SSL5511DB1214 100 V 20 W Low Total Harmonic Distortion (LTHD) analog/Pulse Width Modulation (PWM) dimmable LED driver featuring the SSL5511. The buck-boost converter topology provides a simple and efficient single-stage solution for analog/PWM dimmable LED light applications.

The SSL5511DB1214 demo board complies with EMI and safety regulations.

Figure 2 shows the SSL5511DB1214 demo board dimensions. The design and the components used ensure that the board fits in LED pendant lamp, fixtures and base lights.

Figure 3 shows the top view and bottom view of the SSL5511DB1214 demo board.

2. Safety warning

The SSL5511DB1214 100 V 20 W buck-boost converter demo board input is connected to the 100 V mains. 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 that identify these devices.

a. Isolated

b. Not isolated

Fig 1. Isolation symbols

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3. Specifications

Table 1 lists the specifications of the demo board.

Table 1. SSL5511DB1214 specifications

Symbol	Parameter	Value
V_{mains}	AC mains supply voltage	100 V ±20 %
I_{mains}	AC mains input current	200 mA
V_{LED}	output voltage	80 V (range:50 V to 90 V)
I_{LED}	output current	214 mA
$\Delta I_{LED}/\Delta V_{LED}$	output voltage rejection	95 μA/V
$I_{o(ripple)LED}$	LED output current ripple	< 10 %
η	efficiency	> 88 %
PF	Power Factor	> 0.9
THD	Total Harmonic Distortion	< 20 %
T_{oper}	operating temperature	−40 °C to +80 °C
f_{sw}	switching frequency	90 kHz
$t_{startup}$	start-up time	130 ms (time from mains supply to the start of switching)

Figure 2 shows the dimensions of the demo board.

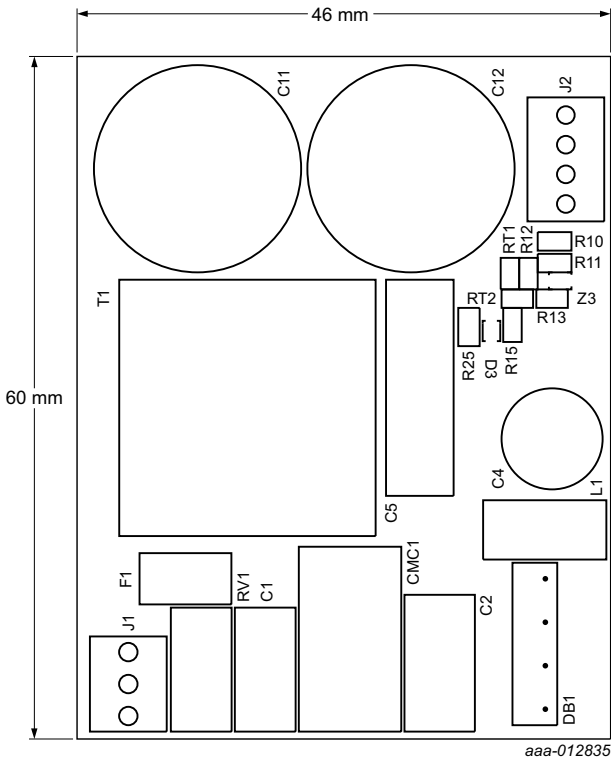

Fig 2. SSL5511DB1214 demo board dimensions

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4. Board photographs

a. Top view

b. Bottom view

Fig 3. SSL5511DB1214 demo board

5. Board connections

The board is optimized for a 100 V/50 Hz or 100 V/60 Hz mains supply. In addition to the mains voltage optimization, the board is designed to work with multiple LEDs or an LED module with a high forward voltage. The mains connection of the SSL5511DB1214 demo board is different from other general demo boards. Connect the mains to the screw connector J1 (see Figure 4).

Remark: The maximum rated voltage of the board is 125 V (AC).

The anode of the LED load is connected to pin 4 of connector J2, marked LED+. The cathode is connected to pin 3 of connector J2, marked LED–. Use an LED string with a forward voltage between 50 V and 90 V on this demo board. Under the expected conditions, the output current is 214 mA when set to 100 % output. Output current is set with a voltage source between pin 2 (DIM_IN) and pin 1 (GND) of connector J2. Without source voltage, the output current is set to 0. The source voltage ranges from 0 V to 10 V (0 % to 100 %)(see Figure 3, Top view).

PWM dimming is selected if the voltage on the PWM pin exceeds 1.2 V after start-up. For more information, see the *SSL5511 data sheet*.

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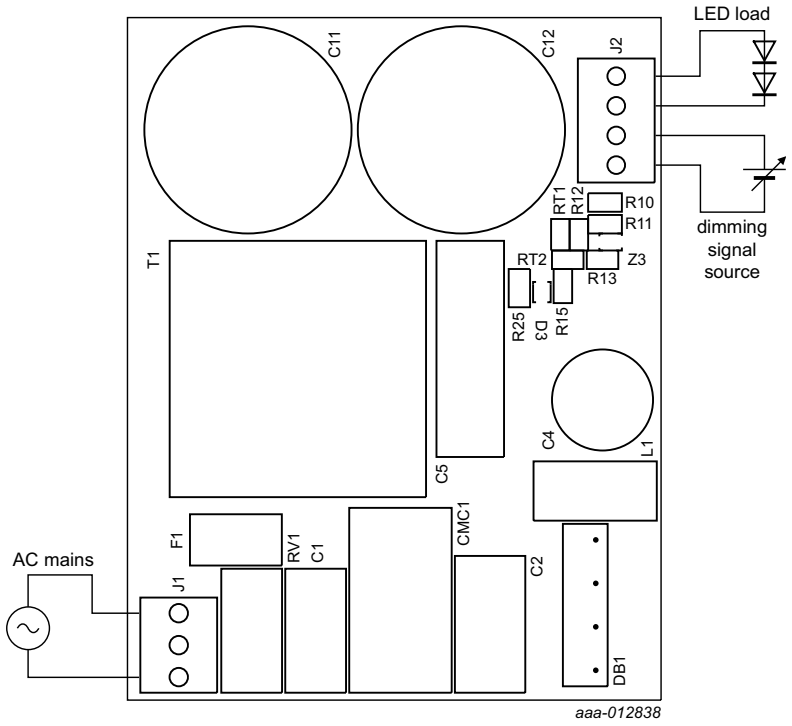

Fig 4. SSL5511DB1214 board connections

6. Performance

The performance was measured using an LED with an 80 V forward voltage at a 212 mA output load. Figure 5 to Figure 11 show the performance data.

6.1 Efficiency

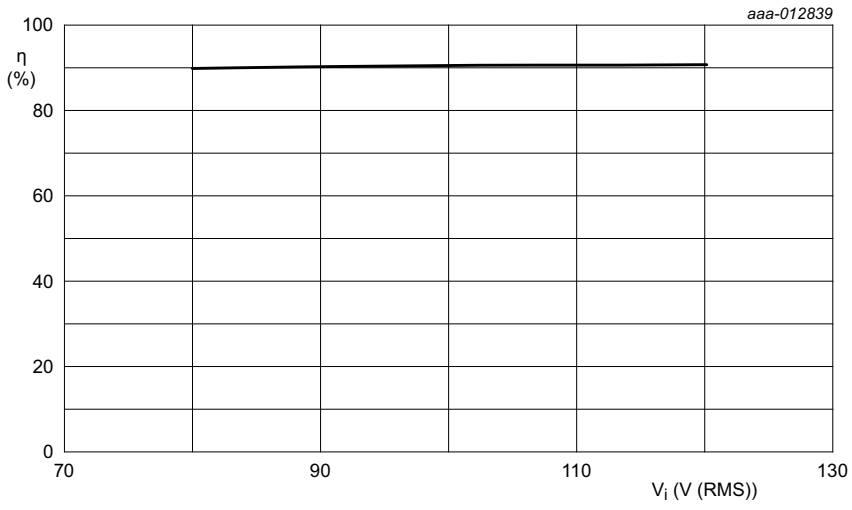

Fig 5. Efficiency as a function of AC mains input voltage

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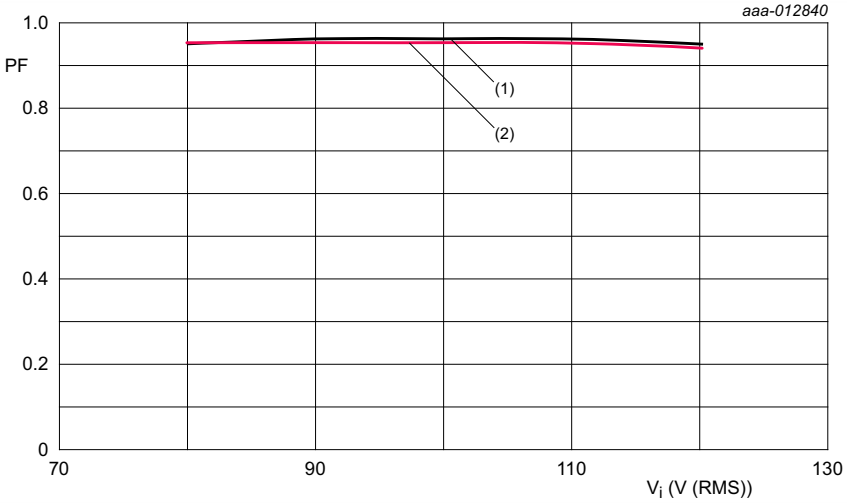
6.2 Power Factor (PF)

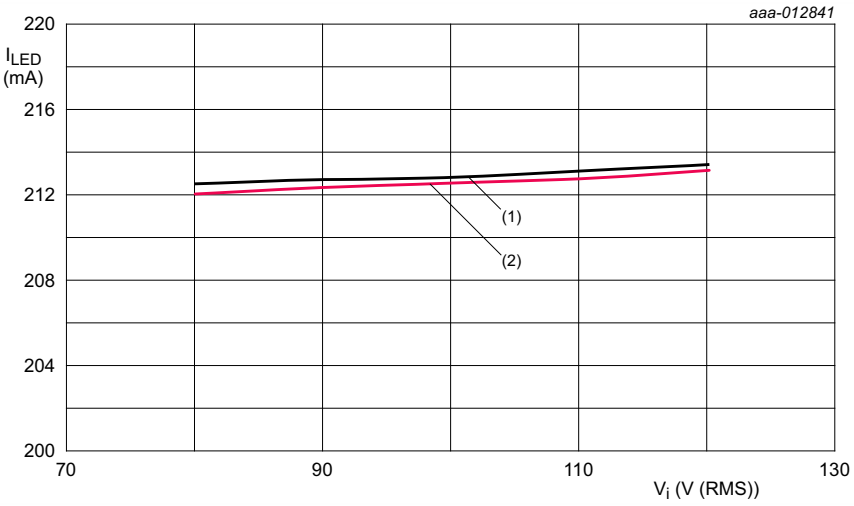


(1) 50 Hz

(2) 60 Hz

Fig 6. Power factor as a function of AC mains input voltage

6.3 Line regulation



(1) 50 Hz

(2) 60 Hz

Fig 7. Output current as a function of AC mains input voltage

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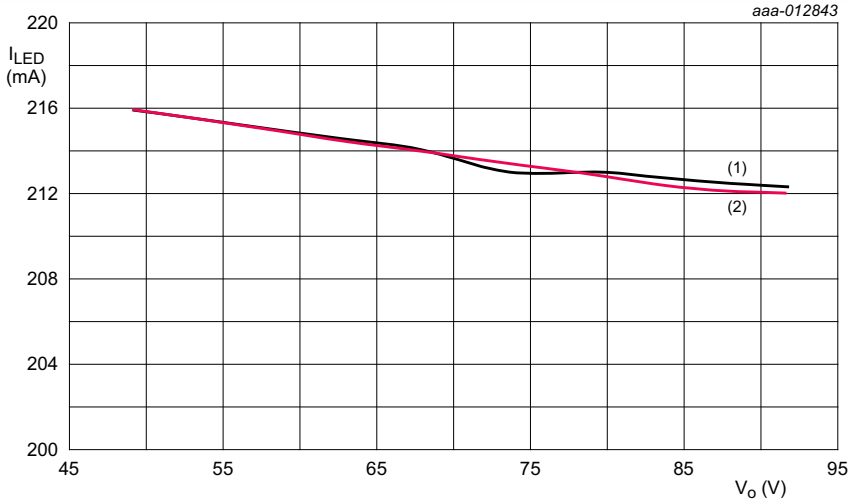
6.4 Load regulation



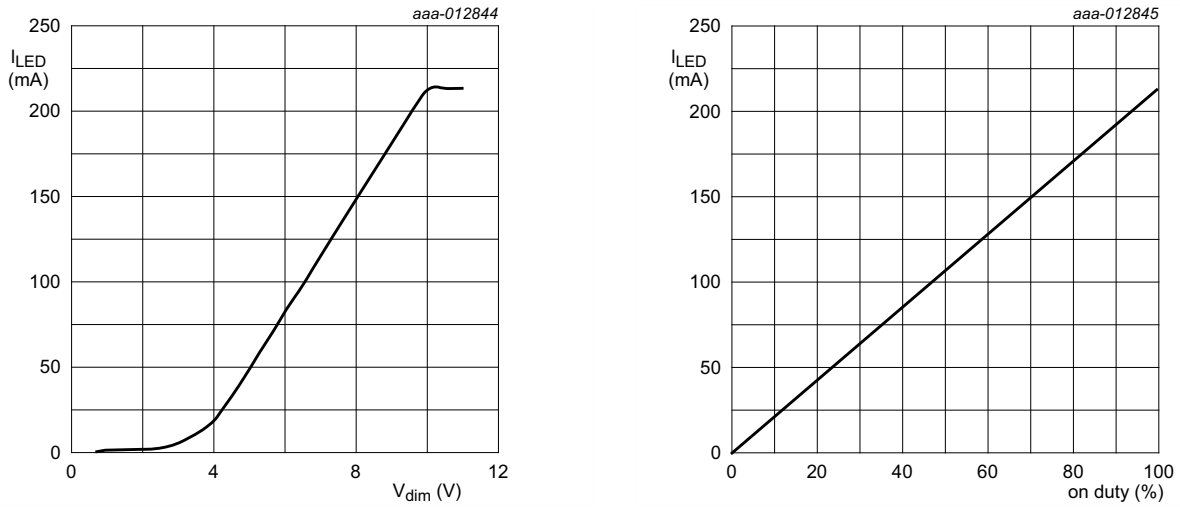
(1) 50 Hz

(2) 60 Hz

Fig 8. Output current as a function of output voltage

6.5 Dimming curves

Figure 9 shows the output current for analog dimming and for PWM dimming.



a. Analog dimming

b. PWM dimming

Fig 9. Output current as a function of dimming signal

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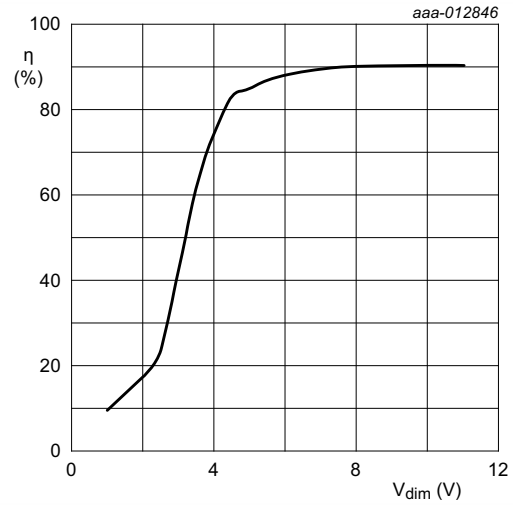
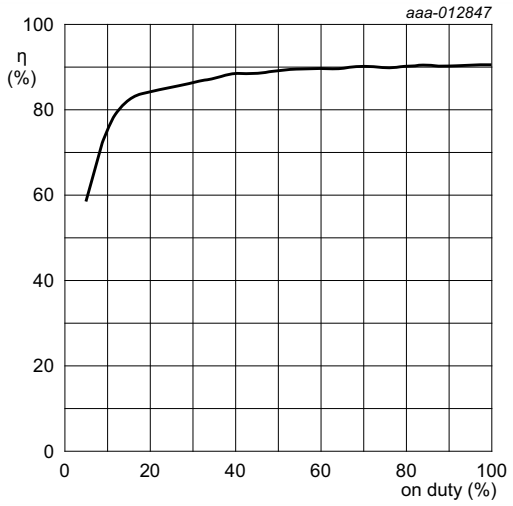
6.6 Efficiency

Figure 10 shows the efficiency when a dimming signal is applied. Measurement with PWM signal dimming was done by changing components around PWM pin. For the test settings, see Section 10.



a. Analog dimming

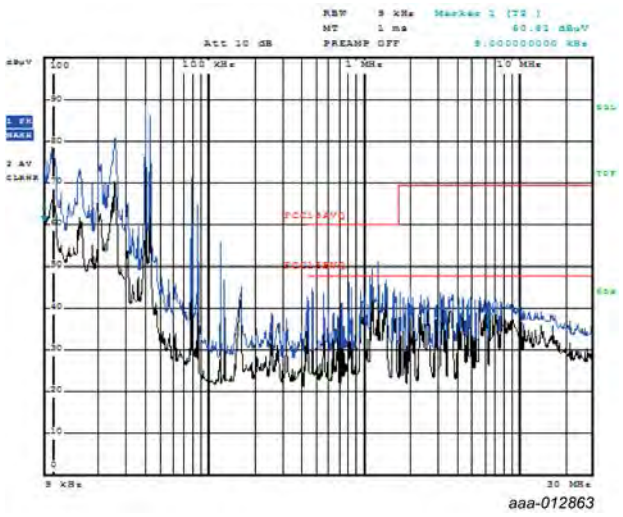


b. PWM dimming

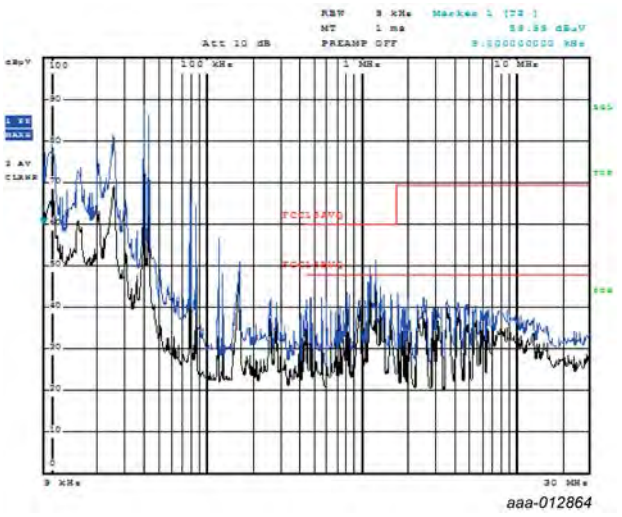
Fig 10. Efficiency as a dimming setting

6.7 ElectroMagnetic Interference (EMI)

The ElectroMagnetic Interference (EMI) was measured according to the EN55015 standard. The board complies with the requirement (see Figure 11).



a. Live



b. Neutral

Fig 11. Conducted emission performance

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7. Protections

The IC incorporates the following protections:

- UnderVoltage LockOut (UVLO)
- OverCurrent Protection (OCP)
- Brownout protection
- Output Short Protection (OSP)
- Output open OverVoltage Protection (OVP)
- Internal OverTemperature Protection (OTP)
- Mains synchronization loss protection
- Leading-Edge Blanking (LEB)

Output open OVP is a latched protection. Power-off cycling is required to exit the latched state. All other protections are not latched and lead to a safe restart of the converter. For more information about the protections, see the *SSL5511 data sheet* (Ref. 1).

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8. Schematic

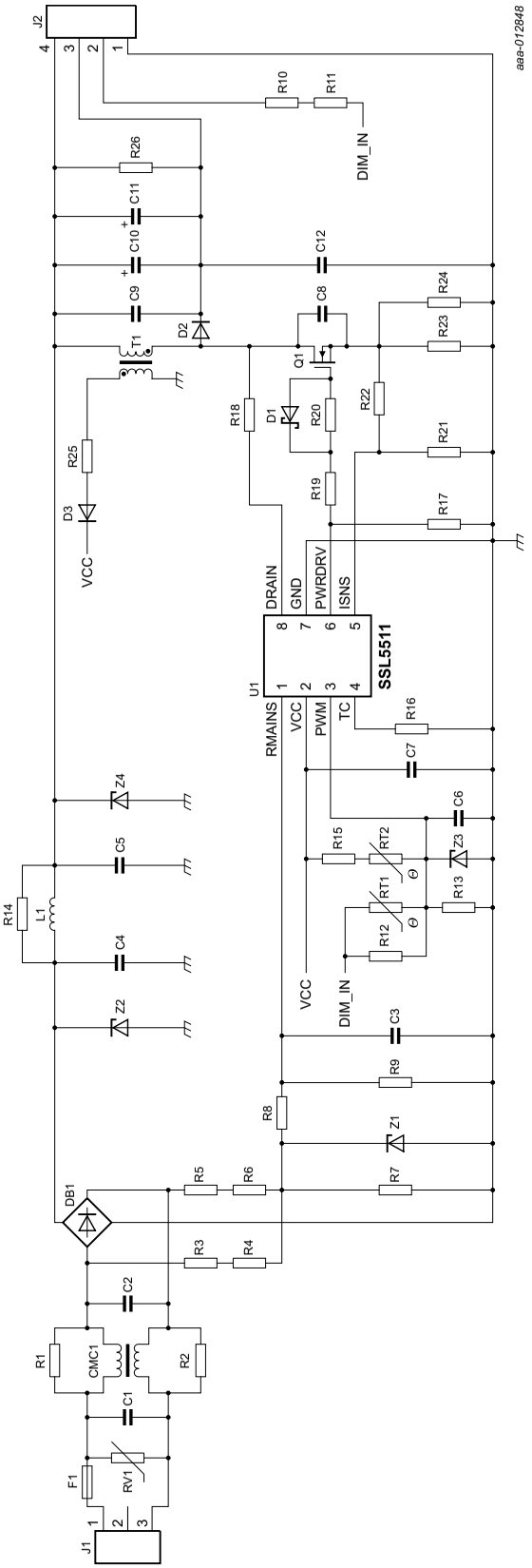

Fig 12. SSL5511DB1214 demo board schematic

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9. Bill Of Materials (BOM)

Table 2. SSL5511DB1214 bill of materials

Reference	Description and values	Part number	Manufacturer
C1	0.047 μF; 125 V (AC); 5 %	B32620A3473J	EPCOS
C2	0.1 μF; 125 V (AC); 5 %	B32620A3104J	EPCOS
C3	220 pF; 50 V; 10 %; C0G; 1608	GRM1885C1H221JA01D	Murata
C4	0.22 μF; 250 V	ECQ-E2224KB	Panasonic
C5	0.68 μF; 250 V	ECQ-E2684JF	Panasonic
C6	1 μF; 10 V; 10 %; 1608	GRM188R71A105KA61J	Murata
C7	2.2 μF; 50 V; 10 %; X7R; 3216	GRM31CR71H225KA88K	Murata
C8; C9; C12	not mounted; 3216	-	-
C10; C11	330 μF; 100 V	100YXH330M18X20	Rubycon
CMC1	common mode choke; 6 mH, 500 mA	750311895	Würth Elektronik
D1	Schottky diode; 30 V; 200 mA; SOD323F	BAT54J	NXP Semiconductors
D2	diode; superfast; 600 V; 3 A; SMB	STTH3BCF060U	ST Micro
D3	diode; high speed; SOD323F	BAS21J	NXP Semiconductors
DB1	bridge rectifier; 600 V; 1.5 A; 4-pin DIP	KBP06G	Diodes Incorporated
F1	fuse; 1 A; 125 V (AC)	RST1	Bel Fuse
J1	terminal block; 3 positions	282834-3	TE connectivity
J2	terminal block; 4 positions	282834-4	TE connectivity
L1	inductor; 220 μH; 750 mA	744732221	Würth Elektronik
MOV1	varistor; 240 V	ERZ-E08A241	Panasonic
Q1	MOSFET-N; 600 V; 7 A; DPAK	STD7NM60N	ST Micro
R1; R2; R14	resistor; 1.5 kΩ; 1 %; 0.25 W; 3216	ERJ-8ENF1501V	Panasonic
R3; R4; R5; R6	resistor; 51 kΩ; 1 %; 0.25 W; 3216	ERJ-8ENF5102V	Panasonic
R7	resistor; 4.3 kΩ; 1 %; 0.1 W; 1608	ERJ-3EKF4301V	Panasonic
R8; R22	resistor; 5.6 kΩ; 1 %; 0.1 W; 1608	ERJ-3EKF5601V	Panasonic
R9; R12; R15; R17; R21; RT2	resistor; not mounted; 1608	-	-
R10	resistor; 3.9 kΩ; 1 %; 0.1 W; 1608	ERJ-3EKF3901V	Panasonic
R11	resistor; 4.7 kΩ; 1 %; 0.1 W	ERJ-3EKF4701V	Panasonic
R13	resistor; 1 kΩ; 1 %; 0.1 W; 1608	ERJ-3EKF1001V	Panasonic
R16	resistor; 0 Ω; 1608	ERJ-3GEY0R00V	Panasonic
R17	resistor; 15 kΩ; 1 %; 0.25 W; 3216	ERJ-8ENF1502V	Panasonic
R18	resistor; 15 kΩ; 1 %; 0.25 W; 1608	ERJ-3EKF1000V	Panasonic
R19	resistor; 100 Ω; 1 %; 0.1 W; 1608	ERJ-3EKF82R0V	Panasonic
R20	resistor; 82 Ω; 1 %; 0.1 W; 1608	ERJ-3EKF82R0V	Panasonic
R23	resistor; 1.0 Ω; 1 %; 0.25 W; 3216	CRCW12061R00FKEA	Vishay
R24	resistor; 1.1 Ω; 1 %; 0.25 W; 3216	CRCW12061R10FKEA	Vishay
R25	resistor; 22 Ω; 1 %; 0.125 W; 2012	ERJ-6ENF22R0V	Panasonic
R26	resistor; 56 kΩ; 1 %; 0.25 W; 3216	ERJ-8ENF5602V	Panasonic
RT1	PTC thermistor; 1608	PRF18BC471QB5RB	Murata

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Table 2. SSL5511DB1214 bill of materials *...continued*

Reference	Description and values	Part number	Manufacturer
T1	transformer; primary; 220 μH, 3.2 : 1; RM8	750342216	Würth Elektronik
U1	digital LED controller; SO8	SSL5511T	NXP Semiconductors
Z1; Z3	Zener diode; 4.7 V; SOD323F	PZU4.7B	NXP Semiconductors
Z2	TVS diode; 200 V; SMA	SMAJ200A	Littelfuse
Z4	not mounted; SOD323F	-	-

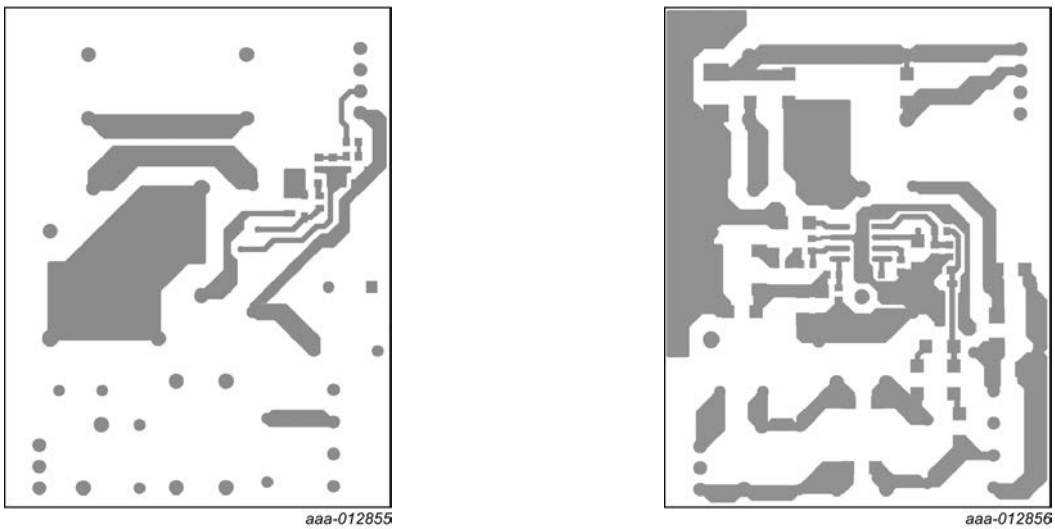
10. Tuning options

The original design of the SSL5511DB1214 demo board is optimized for analog dimming. The voltage divider resistors, R10, R11, RT1, and R13 determine the dimming signal input range. The original configuration delivers the maximum output current when the voltage on the DIM_IN pin exceeds 10 V. Optimize values of these resistors according to the system requirements (example: MCU DAC output voltage).

To optimize the demo board for PWM dimming, change the components from the DIM-IN pin to the PWM pin. Change the R10 and R11 values to 1 kΩ and the R13 value to 5.6 kΩ. Then remove capacitor C6 to achieve a suitable configuration for a 3.3 V PWM dimming signal. If the signal source is open-drain, install resistors R15 and RT2 in alignment with the system settings.

11. Board layout

Figure 13 to Figure 16 show the SSL5511DB1214 demo board layout of both layers.



a. Top layer pattern

b. Bottom layer pattern

Fig 13. SSL5511DB1214 demo board layout - layer pattern

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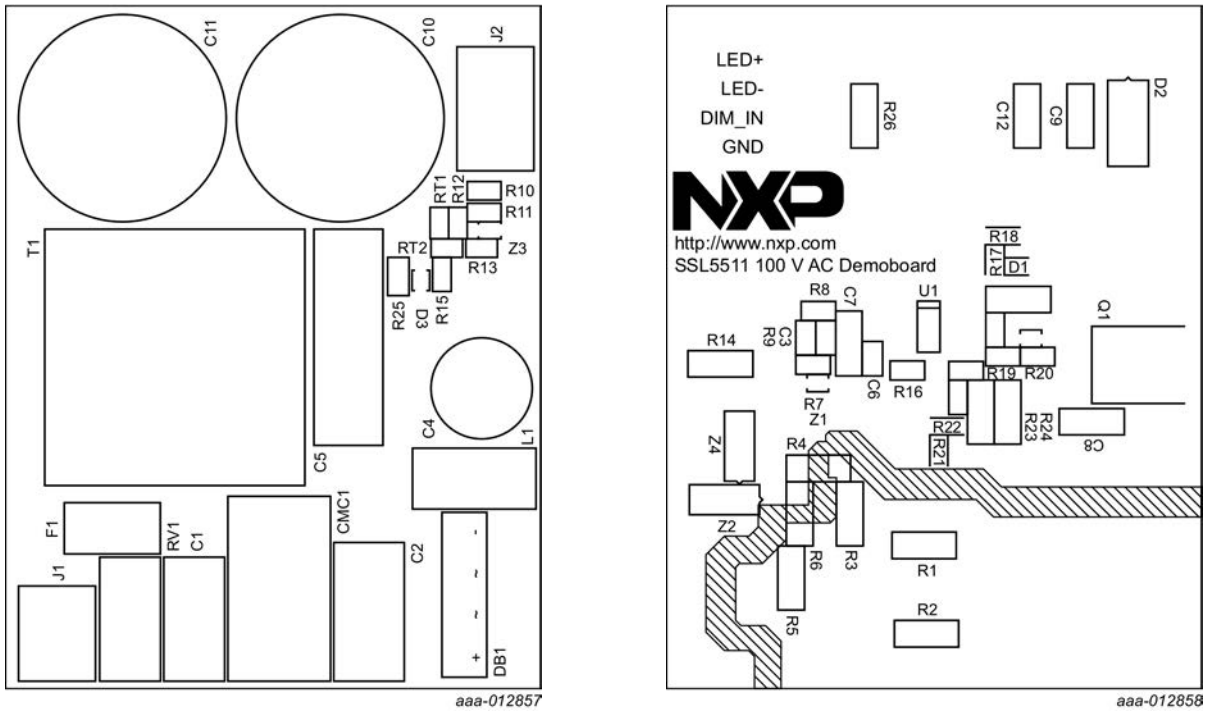
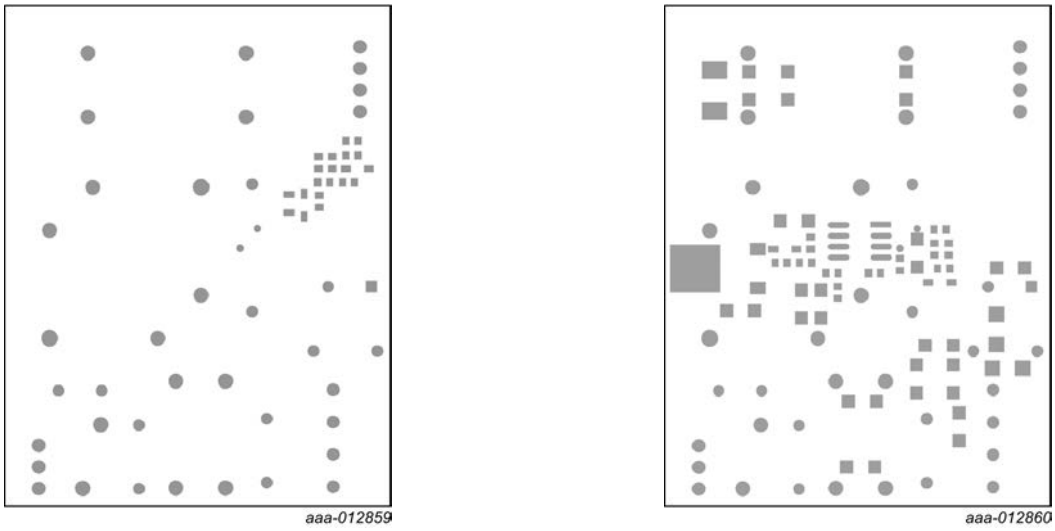


a. Top layer silk

b. Bottom layer silk

Fig 14. SSL5511DB1214 demo board layout - layer silk



a. Top layer resist

b. Bottom layer resist

Fig 15. SSL5511DB1214 demo board layout - layer resist

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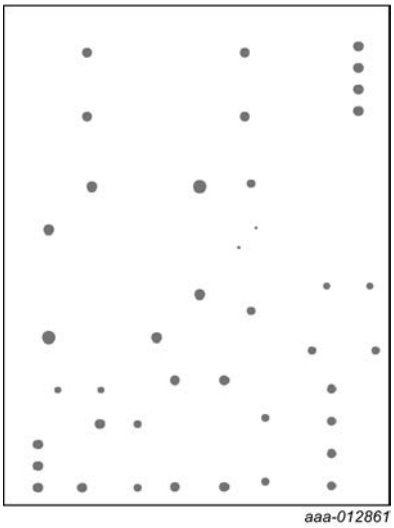

Fig 16. SSL5511DB1214 demo board layout - drill

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12. Transformer specification

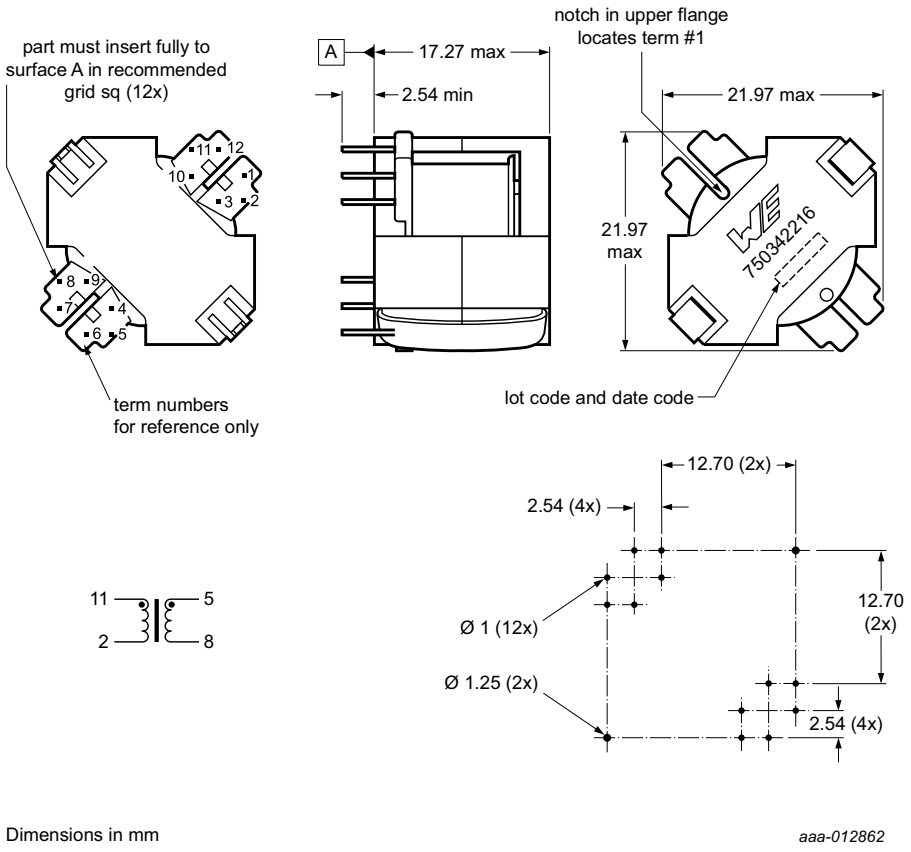

Fig 17. Specification of transformer L2 with EPX7 coil and bobbin

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13. Abbreviations

Table 3. Abbreviations

Acronym	Description
EMI	ElectroMagnetic Interference
LED	Light Emitting Diode
LTHD	Low Total Harmonic Distortion
PF	Power Factor
PWM	Pulse Width Modulation
SSL	Solid-State Lighting

14. References

[1] SSL5511 data sheet — GreenChip controller for LED lighting with DIM pin

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