UM10857

SSL6203DB1276 120 V 12 W linear LED driver

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

Document information

Info	Content
Keywords	SSL6203DB1276, SSL6203TW, TRIAC dimmable, linear LED driver
Abstract	This user manual describes the operation of the SSL6203DB1276 120 V 12 W mains dimmable LED driver featuring the SSL6203TW linear LED driver used in Solid-State Lighting (SSL) applications. The demo board is an example of a dimmable LED module which has the driver IC and the HV LED in the same base plate.

Revision history

Rev	Date	Description
v.1	20150113	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.

This user manual describes the operation of the SSL6203DB1276 120 V 12 W dimmable LED driver featuring the SSL6203. The demo board integrates driver IC and LED in the same plate, which provides a simple and good dimming performance solution for mains dimmable LED light applications.

The SSL6203DB1276 12 W 120 V (AC) demo board has a very good dimmer compatibility and a dimming curve that is similar to that of an incandescent lamp.

The SSL6203DB1276 demo board complies with the EN55015 EMI standard and the IEC 61000-4-12 ring wave test.

Figure 2 shows the dimensions of the SSL6203DB1276 demo board. The demo board has been designed with components allowing enough headroom for the board to fit into LED bulb base.

Figure 3 shows the assembled top board views.

2. Safety warning

The SSL6203DB1276 demo board input is connected to the 120 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 on how to recognize these devices.

a. Isolated

b. Not isolated

Fig 1. Isolation symbols

3. Specifications

Table 1 lists the specification of the SSL6203DB1276 demo board.

Table 1. SSL5021BDB1267 specifications

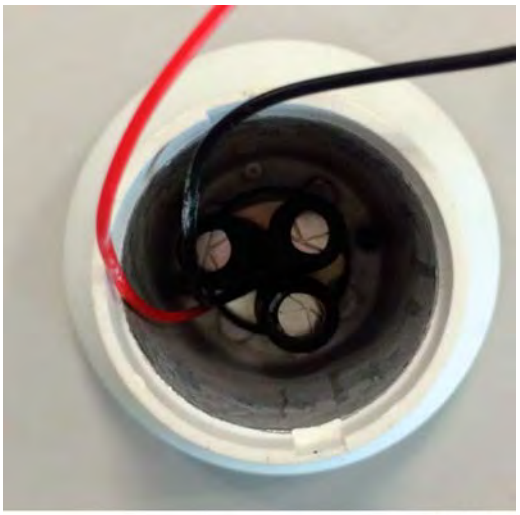
Symbol	Parameter	Value
V_{mains}	AC mains supply voltage	120 V (AC); ±10 %
f_{mains}	AC frequency	60 Hz
I_{mains}	AC mains input current	100 mA (typical)
V_{LED}	output voltage	144 V (three strings)
I_{LED}	output current	59 mA
$I_{LED(ripple)}$	output current ripple	±33 % (typical); $I_{LED(ripple)}/I_{LED}$
η	efficiency	73.4 %
PF	power factor	> 0.95 at V_{mains} = 120 V (AC)
THD	total harmonic distortion	27 %; V_{mains} = 120 V (AC); V_{LED} = 144 V (DC)
T_{oper}	operating temperature	−40 °C to +45 °C
EMI	conductive EMI; radiated EMI	meets CISPR 15 with > 10 dB margin
Light output	Without glass dome; P_{in} = 12.1 W; C_{amb} = 25 °C; after 1 hour	840 lumens
	With glass dome; P_{in} = 12.1 W; C_{amb} = 25 °C; after 1 hour	750 lumens
T_c	color temperature	2700 K

Figure 2 shows the dimensions of the demo board.

Fig 2. SSL6203DB1276 demo board dimensions

4. Board photographs

a. Top view



b. Bottom view

Fig 3. SSL6203DB1276 demo board photographs

5. Board connections

The SSL6203DB1276 demo board is optimized for a 120 V/60 Hz supply. It is designed to work with three strings HVLED (LUXEON 3535 HV) with 48 V forward voltage.

Remark: The maximum rated voltage of the board is 132 V (AC).

Connection of the SSL6203DB1276 demo board is different from other general demo boards. Only two connection lines for the L line and N line of mains are shown which go through the heat sink to the bottom of the demo board. No connection for LED is required because the driver and the LEDs are in the same plate.

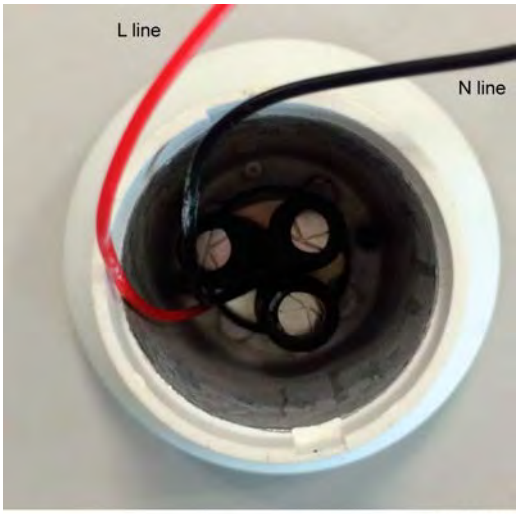


Fig 4. SSL6203DB1276 board connections

6. Performance

6.1 Electrical characteristics

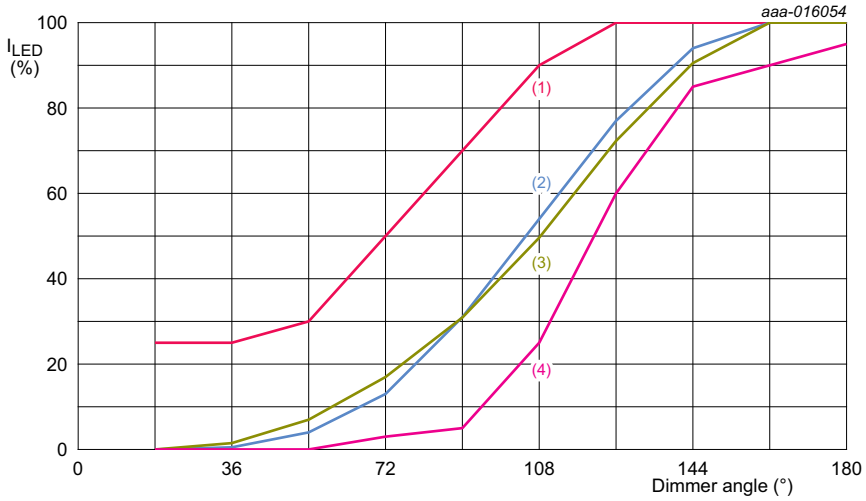
The performance was measured with three 48 V LED strings, totaling 144 V LED as output load. The average current for the strings was 59 mA. Table 2 shows the performance.

Table 2. Electrical characteristic of SSL6203DB1276 demo board

V_{in}	P_{in}	PF	V_{str1} (V)	I_{str1} (mA)	V_{str2} (V)	I_{str2} (mA)	V_{str3} (V)	I_{str3} (mA)	Efficiency (%)
114	11.32	0.97	46.3	58	46.5	62	46.3	56	72.10
120	12.12	0.96	46.6	63	46.7	66	46.5	62	73.44
132	12.4	0.94	46.6	65	46.6	66	46.6	64	73.28

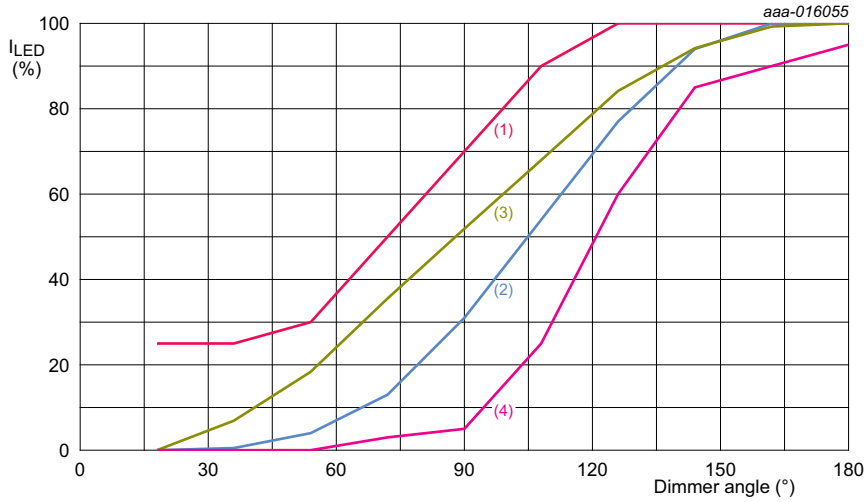
6.2 Dimming curve

Figure 5 and Figure 6 show the dimming curve with output current versus dimming angle for a leading-edge dimmer. The external circuit configuration sets two different dimming curves. The demo uses an average mains dimming curve by default, because it is similar to the incandescent bulb. To use the fix VDD dimming curve, reconnecting resistor RLED between the VDD pin and the LED pin is required.



(1) Upper NEMA limit
(2) Incandescent
(3) SSL6203TW
(4) Lower NEMA limit

Fig 5. Dimming curve: Average mains



(1) Upper NEMA limit
(2) Incandescent
(3) SSL6203TW
(4) Lower NEMA limit

Fig 6. Dimming curve: Fix V_{DD}

Remark: The dimming curves have been tested with a Dimmer Leviton 6681 at 120 V (AC)/60 Hz.

6.3 Dimmer compatibility

Dimming compatibility includes having smooth dimming without any flashing or flickering effects across the complete dimming range. The SSL6203DB1276 demo board has been tested with a wide selection of dimmers. It is compatible with most leading-edge dimmers on the market.

Table 3. List of dimmers

Manufacturer	Dimmer	Maximum power (W)	Minimum power (W)	Flicker
Leviton	6673-P	9.70	0.62	none
Leviton	NO.RPI06	11.90	0.60	none
Leviton	6681-W	11.93	0.30	none
Lutron	CTCL-153P	9.40	0.50	none
Lutron	S-600	11.14	0.50	none
Lutron	D600PH-DK	9.00	0.30	none
Lutron	Diva DV-600P	9.90	0.70	none
Lutron	TG600P	10.50	0.96	none
Lutron	LG600P	9.90	0.75	none
Lutron	S-600P	9.86	0.60	none
Lutron	LX-600PL	10.70	0.90	none
Lutron	LGCL-153P	9.50	0.50	none
Lutron	AY-603P	9.80	1.10	none

6.4 Group dimming

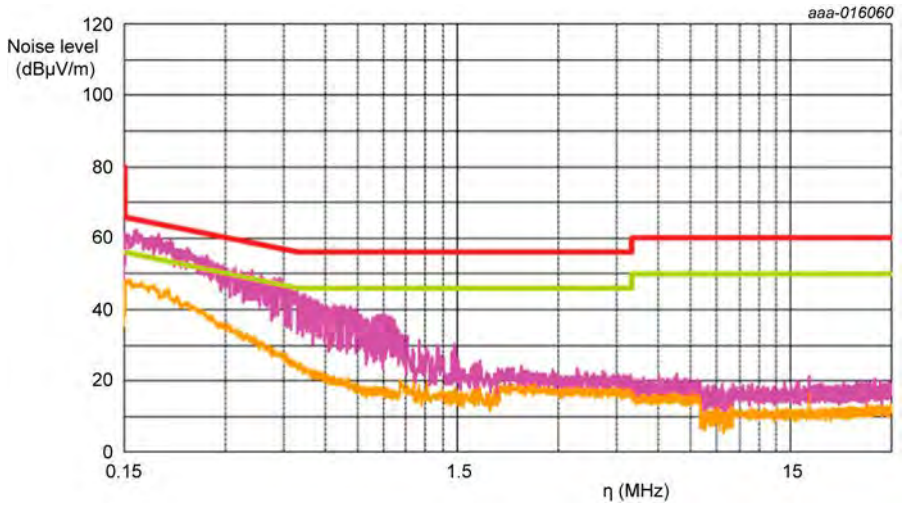
The SSL6203TW linear dimmable solution is naturally suitable for group dimming because the driver does not have any capacitive characteristic. The peak current in the turn-on edge of the dimmer is also smaller than regular switching driver solutions, allowing more boards in parallel with a single dimmer. Table 4 lists 6-board group dimming results. 15-board group dimming has been checked with Lutron DV-600P.

Table 4. Group dimming - list of dimmers

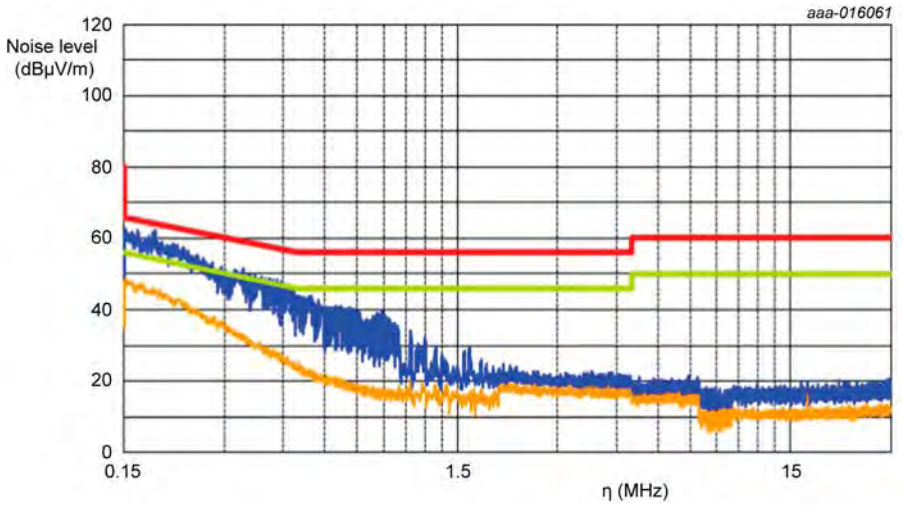
Manufacturer	Dimmer	Flickering
Leviton	6673-P	not applicable
Leviton	NO.RPI06	not applicable
Leviton	6681-W	not applicable
Lutron	CTCL-153P	not applicable
Lutron	S-600	not applicable
Lutron	D600PH-DK	not applicable
Lutron	Diva DV-600P	not applicable
Lutron	TG600P	not applicable
Lutron	LG600P	not applicable
Lutron	TG-10P	not applicable
Lutron	LX-600PL	not applicable
Lutron	LGCL-153P	not applicable
Lutron	6681-W	not applicable

6.5 ElectroMagnetic Interference (EMI)

The ElectroMagnetic Interference (EMI) was measured according to the EN55015 standard. The board complies with the standards requirement (see Figure 7 and Figure 8).

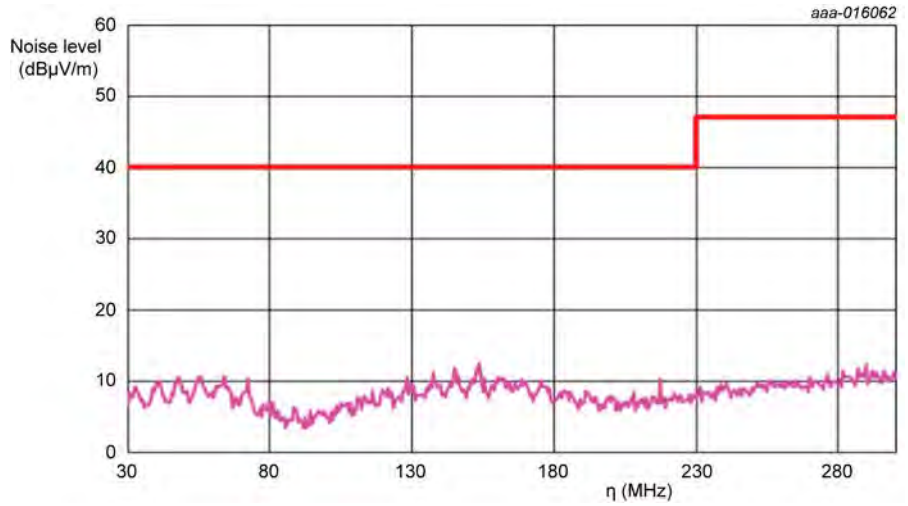


a. Line

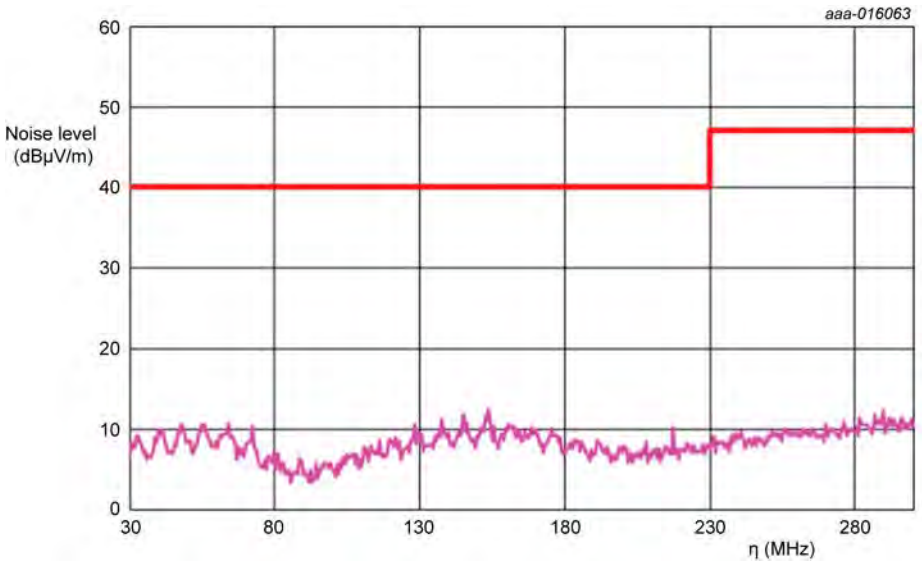


b. Neutral

Fig 7. SSL6203DB1276 demo board conducted emission performance



a. Horizontal



b. Vertical

Fig 8. SSL6203DB1276 demo board radiated emission performance

7. Protections

The IC incorporates the following protections:

- UnderVoltage LockOut (UVLO)
- Short LED Protection (SLP)
- Open LED Protection (OLP)
- Internal OverTemperature Protection (OTP)

See the *SSL6203TW data sheet* (Ref. 1) for more information about the protections.

8. Schematic

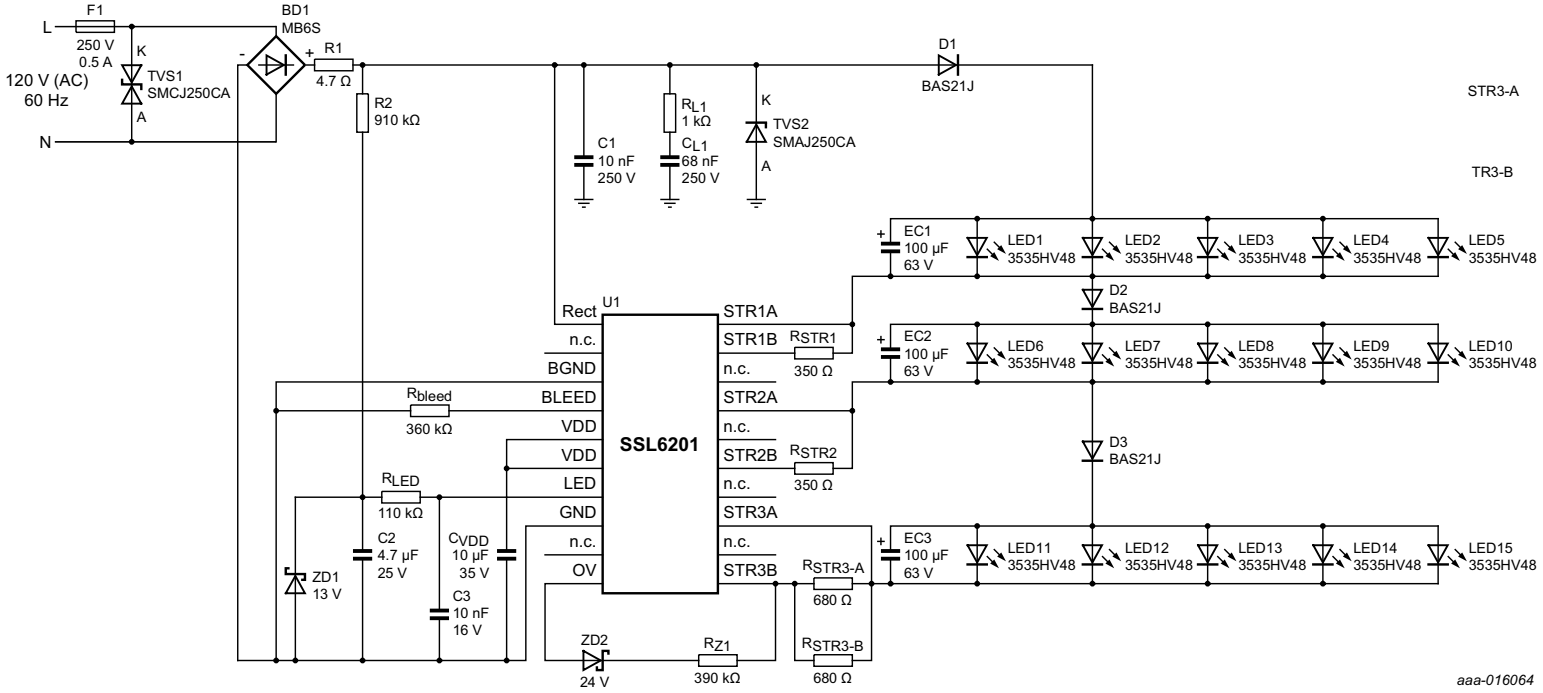


Fig 9. SSL6203DB1276 schematic

9. Bill Of Materials (BOM)

Table 5. SSL6203DB1276 demo board functional bill of materials

Reference	Description and values	Part number	Manufacturer
C1	capacitor; ceramic; 10 nF; 250 V; 1206	GRM31B5C2E103JWA1L+B00	Murata
C2	capacitor; ceramic; 4.7 μF; 25 V; 0603	GRM188C81E475KE11	Murata
C3	capacitor; ceramic; 10 nF; 16 V; 0402	GRM155R71C103KA01D+A01	Murata
CL1	capacitor; 68 nF; 250 V, 1210	GRM32QR72E683KW01L	Murata
C_{VDD}	capacitor; ceramic; 10 μF; 35 V; 0805	GRM21BC8YA106KE11L+A01	Murata
D1; D2; D3	diode; high speed; 200 V; 250 mA; SOD323F	BAS21J	NXP Semiconductors
DB1	bridge diode; 600 V; 0.5 A; MB6S	-	-
EC1; EC2; EC3	capacitor; electrolytic; aluminum; 100 μF; 63 V; ϕ(∅?) 8 mm × 12 mm		Rubycon
F1	fuse; 250 V (AC); 0.5 A; 2410	-	AEM
LED1 to LED15	LED; Luxeon 3535 HV	3535	Philips
R1	resistor; chip; 4.7 Ω; 5 %; 1206	-	Yageo
R2	resistor; chip; 910 kΩ; 1 %; 0805	-	Yageo
R_{BLEED}	resistor; chip; 360 kΩ; 1 %; 0402	-	Yageo
RL1	resistor; 1 kΩ; 5 %; 1210	-	Yageo
R_{LED}	resistor; chip; 110 kΩ; 1 %; 0402	-	Yageo
R_{STR1}; R_{STR2}	resistor; chip; 348 Ω; 1 %; 1206	-	Yageo
R_{STR3A}; R_{STR3B}	resistor; chip; 680 Ω; 1 %; 1206	-	Yageo
RZ1	resistor; chip; 390 kΩ; 5 %; 0603	-	Yageo
TVS1	diode; transient voltage suppression diode; SMC	SMCJ220CA	Littelfuse
TVS2	diode; transient voltage suppression diode; SMA	SMAJ250CA	BrightKing
U1	IC; SSL6203TW	HSSOP2	NXP Semiconductors
ZD1	Zener diode; 13 V; SOD323F	TDZ13J	NXP Semiconductors
ZD2	Zener diode; 24 V; SOD323F	BZX84J	NXP Semiconductors

10. Board layout

The LEDs on the SSL6203DB1276 demo board are interleaved for better light quality. A 4-layer PCB with buried vias is used for this design. Low thermal resistance from LED to heat sink is crucial for the best LED efficiency. Cheaper PCBs (1-layer or 2-layer designs) can also be used without deteriorating performance, while the thermal resistance is kept at a minimum.

Figure 10 shows the SSL6203DB1276 demo board layout of four layers. Figure 11 to Figure 13 show the layers of the board with their corresponding silk screen, which indicate the component positions.

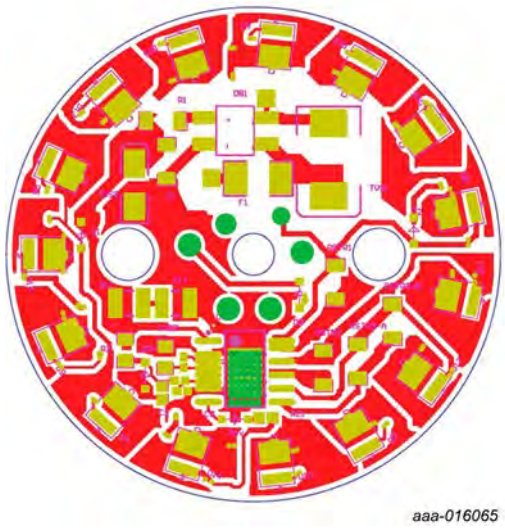
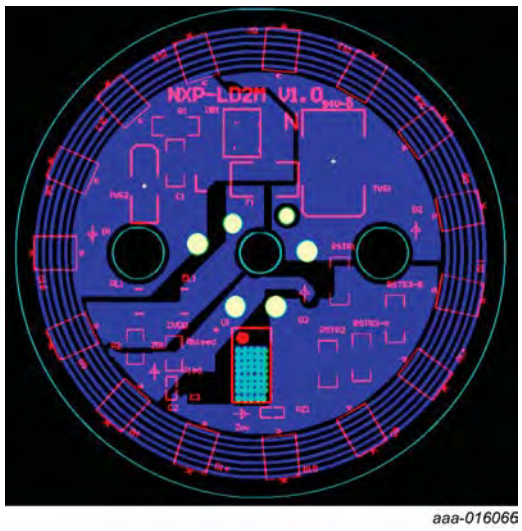


Fig 10. SSL6203DB1276 demo board layout: Top layer



The red colored parts indicate the components of the top layer.

Fig 11. SSL6203DB1276 demo board layout: Middle layer 1

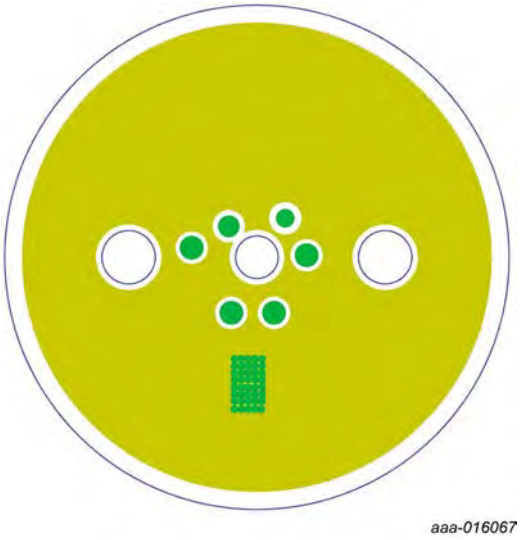


Fig 12. SSL6203DB1276 demo board layout: Middle layer 2

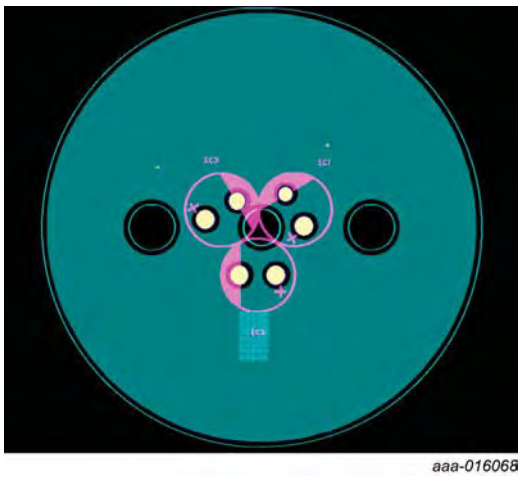


Fig 13. SSL6203DB1276 demo board layout: Bottom layer

11. Abbreviations

Table 6. Abbreviations

Acronym	Description
LED	Light-Emitting Diode
SSL	Solid-State Lighting
PF	Power Factor
EMI	ElectroMagnetic Interference
LE	Leading-Edge (referring to an R or RL dimmer)
TE	Trailing-Edge (referring to an RC dimmer)

12. References

[1] **SSL6203TW data sheet —** 120 V mains dimmable, 12 W linear LED driver

[2] **AN11617 application note —** <tbd>

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