UM10341_1

SSL2101/2102 12 W mains dimmable LED driver

Rev. 00.01 — 28 April 2009 User manual

Document information

Info	Content
Keywords	dimmable, SSL2101, SSL2102, SSL1523, driver, Mains supply, AC/DC conversion, LED driver, User manual
Abstract	This document is a user manual for the SSL2101/SSL2102 mains dimmable 12 W LED driver demo boards.

founded by Philips

Revision history

Rev	Date	Description
01	<tbd>	First draft

Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

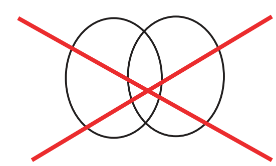
1. Introduction

The SSL2101/2102 12 W LED driver is a solution for a professional application with multiple high power LEDs that requires galvanic isolation and a safe output voltage. It is mains dimmable for both forward phase (TRIAC) dimmers, and reverse phase (Transistor) dimmers. It can generate up to 16 W output power, which is equal to a 100 W incandescent lamp (at 63 Lumen/W). Examples are shelf lighting, down lighting, LED lighting for bathrooms etc.The design gives an example of how to make a drive that is suitable for small form factor applications like retrofit lamps.

2. Safety warning

The board needs to be connected to mains voltage. Touching the reference board during operation must be avoided at all times. An isolated housing is obligatory when used in uncontrolled, non laboratory environments. Even though the secondary circuit with LED connection has a galvanic isolation, this isolation is not according to any regulated norm. Galvanic isolation of the mains phase using a variable transformer is always recommended. These devices can be recognized by the symbols shown in Figure 1:

a. Isolated



b. Not Isolated

Fig 1. Variac isolation symbols

3. Connecting the board

The board can be optimized for a 230 V (AC) (50 Hz) or for a 120 V (AC) (60 Hz) mains source. Besides the mains voltage optimization, the board is designed to work with multiple high power LEDs with a total working voltage of between 9 V and 23 V. The output current can be limited using trimmer R20. On request, a dedicated LED load can be delivered that is to be connected to K3. Connector K2 can be used to attach other LED loads. The output voltage is limited to 25 V. When attaching a LED load to an operational board (hot plugging) an inrush peak current will occur due to discharge of capacitor C6. After frequent discharges, the LEDs may deteriorate or become damaged.

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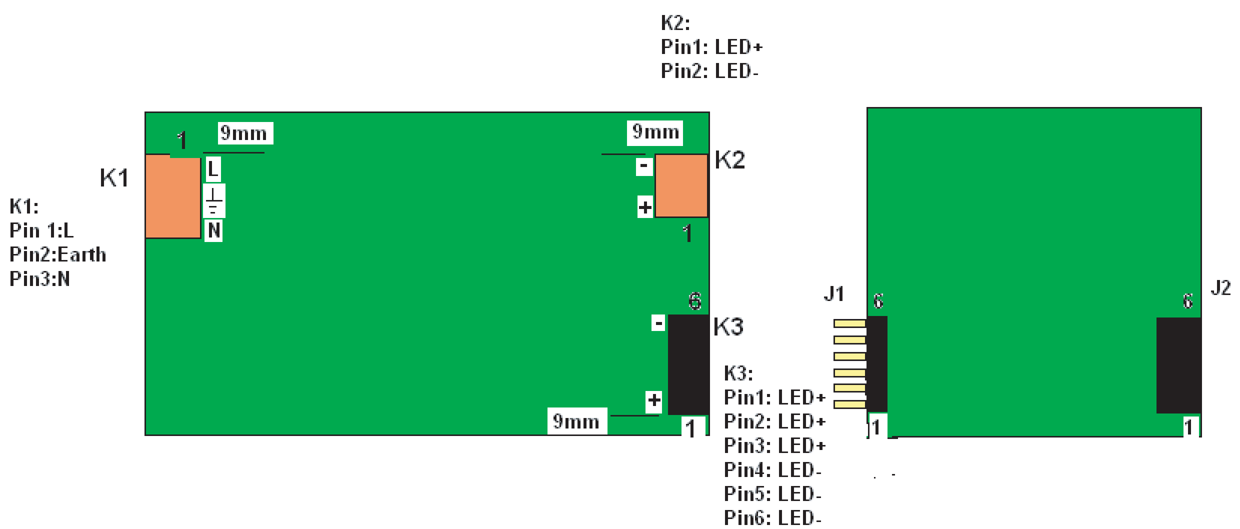

Fig 2. Board connection diagram

If a galvanic isolated transformer is used, it should be placed in between the AC source and the dimmer/demo board. Connect a user defined LED (string) to the connector K2 as shown in Figure 2. Note that the anode of the LED (string) is connected to the bottom side of this connector.

Remark: When the board is placed in a metal enclosure, the middle pin of connector P1 can be connected to the metal casing for grounding.

4. Specifications

Table 1 gives the specifications for the SSL2101/2102 12 W LED driver

Table 1. Specifications

		Comment
AC line input voltage	85 V (AC) to 276 V (AC)	Board has been optimized for 230 V (AC) or 120 V (AC) ± 10 % variation
Output voltage (LED voltage)	9 V (DC) to 23 V (DC)	
Output voltage protection	25 V (DC)	
Output current (LED current)	400 mA to 800 mA	Adjustable with trimmer
Output voltage /load current dependency	<+-4 % / Volt in regulated range	See attached graphs
Current ripple	+/-150 mA	at 500 mA
Maximum output power (LED power)	17 W	At V_{out} + 21 V
Efficiency	70 %-78 %	At t_{amb}= 25°C See attached graphs

Table 1. Specifications

		Comment
Power Factor: 120 V(AC) 230 V(AC)	0.99 0.94 0.90	at 15 W output power at 15 W output power at 11 W output power
Switching frequency	60-75 kHz	
Dimming range	100% – 0%	
Board dimensions	103mm x 50mm x 20mm	L x W x H
Operating temperature	0 to 85 ° Celsius	
Isolation voltage	+/-4 KV	Between primary and secondary circuit
Input voltage /load current dependency	+5/ –6 % in the range of 130 V (AC) to 110 V (AC) +3/ –3 % in the range of 250 V (AC) to 210 V (AC)	

5. Board photos

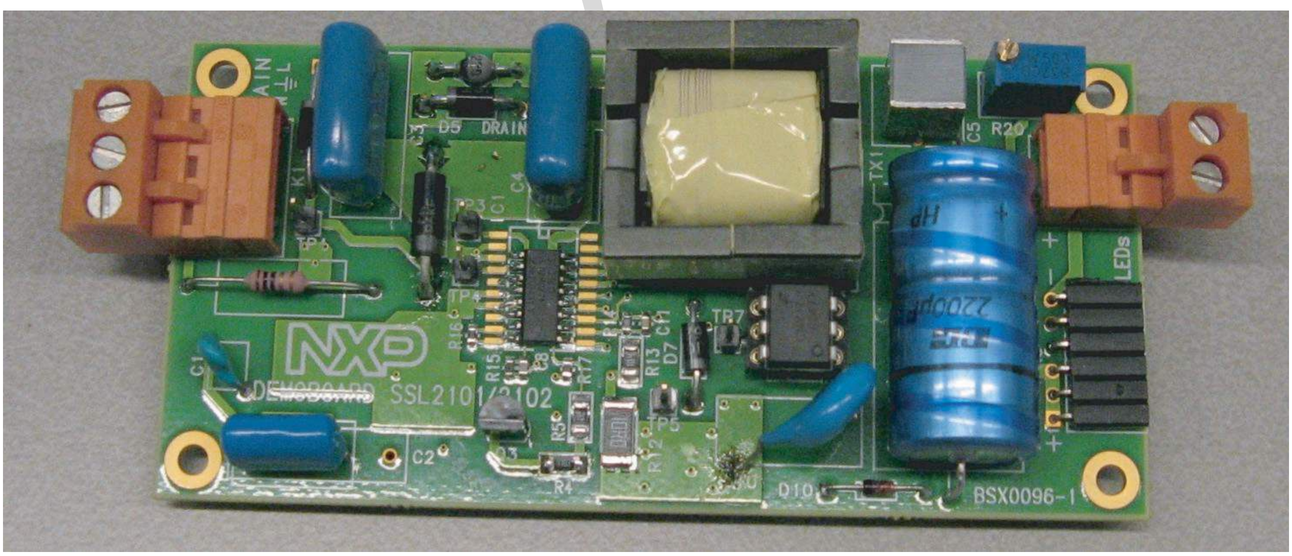

Fig 3. Demo board (top)

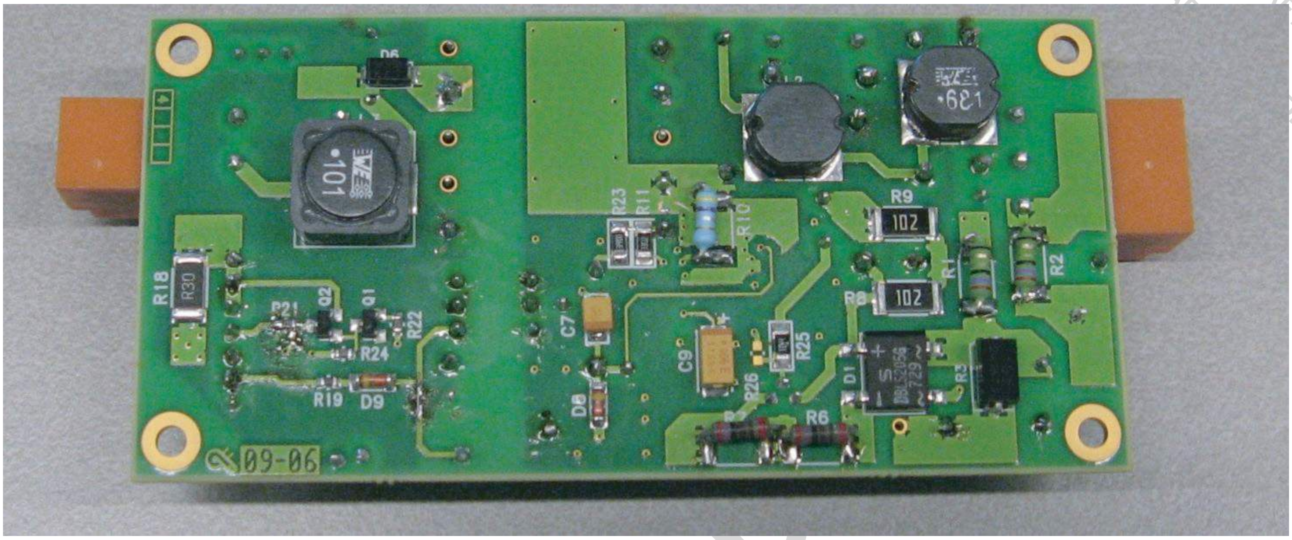

Fig 4. Demo board (bottom)

6. Dimmers

Several TRIAC based dimmers have been tested by NXP Semiconductors. As different dimmers have different specifications, the dimming performance of the board may vary. Table 2 shows the range of dimmers that have been tested with the board:

Table 2. Dimmer selection

Manufacturer	Type	Voltage V (AC)	Power range (W)	Load	Min. dimming range
Opus	852.390	230	60-400	Ha/Inc	0.6%
Opus	852.392	230	20-500	Inc	0.05%
Bush-Jaeger	2250U	230	20-600	Ha/Inc	0.03%
Bush-Jaeger	2247U	230	20-500	Ha/Inc	0.07%
Bush-Jaeger	6519U	230	40-550	Ha/Inc	8.4%
Gira	1184	230	60-400	Inc	1%
Everflourish	EFO700D	230	50-300	Ha/Inc	0.2%
Drespa	0817	230	20-315	Ha/Inc	3.4%
Ehmann	39 Domus	230	20-500	Ha/Inc	1%
Drespa	815	230	20-500	Inc	1.1%
Lutron	TG-600PH-WH	120	600	Inc	0 %(off)
Levitron	L12-6641-W	120	600	Inc	0 %(off)
Levitron	L02-700-W	120	600	Inc	0 %(off)
Levitron	6602-IW	120	600	Inc	0 %(off)
Levitron	6683-W	120	600	Inc	0 %(off)

Table 2. Dimmer selection

Manufacturer	Type	Voltage V (AC)	Power range (W)	Load	Min. dimming range
Levitron	R12-6631-LW	120	600	Inc	0 %(off)
Cooper	6001	120	600	Inc	0 %(off)
Lutron	MIR-600THW-WH	120	600	Ha/Inc	0.9 %

7. Functional description

The board can be equipped with either the SSL2101 or SSL2102, depending on the operating conditions and output power. The SSL2102 has lower thermal resistance and is thus more suitable for higher temperatures and higher loads. The IC has several internal functions. It controls and drives the flyback converter part, and it ensures proper dimmer operation. In the IC itself, there are several high voltage switches integrated. One of these switches controls the flyback input power, and it is situated between the Drain pin and Source pin. On closing, a current will start to run, which stores energy in the transformer TX1. This current is interrupted when the duty factor has exceeded the level set by the PWM_{Limit} pin, with a maximum of 75 %, or when the voltage on the Source pin exceeds 0.5 V. At the next cycle, the energy stored in the transformer is discharged to D6 and the output capacitors C5 and C6, and finally absorbed by the load. The converter frequency is set with an internal oscillator, the timing of which is controlled by external RC components on pins RC and RC2. The frequency can be modulated using the brightness pin to an upper and lower value. The ratio between R15 and R16 sets the frequency variation.

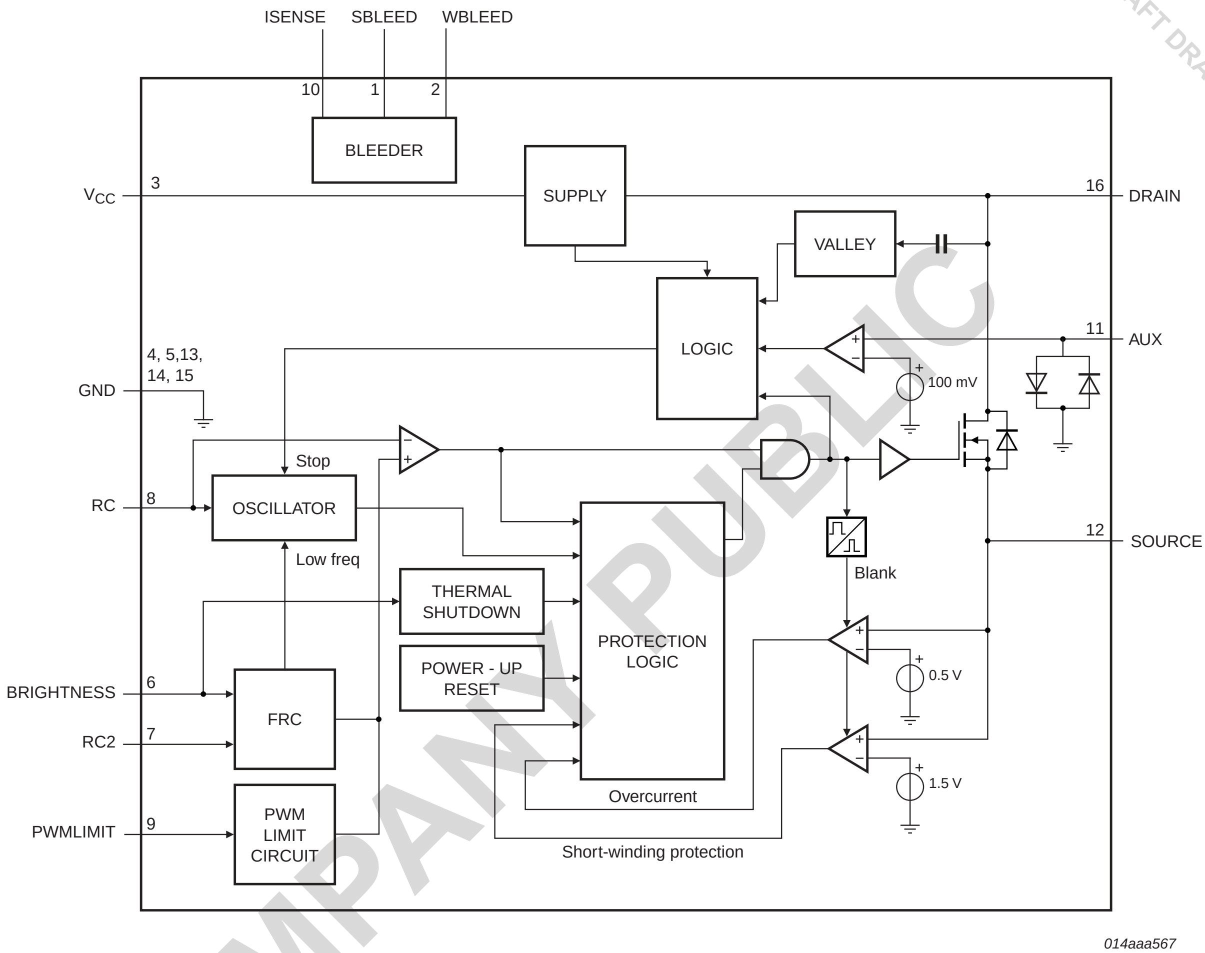

Fig 5. Block diagram SSL2101

The two other switches are called the weak-bleeder (pin W_{bleed}), and the strong bleeder (pin S_{bleed}). When the voltage on both these pins is below a certain value (typical 52 V) the S_{bleed} switch closes, providing a current path that loads the dimmer during zero voltage crossing. This resets the dimmer timer. When the voltage on both these pins is above 52 V, and the voltage on the I_{sens} pin is above 100 mV, the weak-bleeder switch closes. Using Q3, this current is boosted and provides a current path that loads the dimmer when the converter draws insufficient current to have the dimmer latching stable. Whilst the strong bleeder is always enabled, the weak-bleeder will activate only when the output power drops below 8 W. This happens when the LEDs are dimmed, or when the maximum LED power is tuned below 8 W. See Figure 6 and Figure 7 that show bleeder voltage versus time in dimmed and un-dimmed position (low voltage = active):

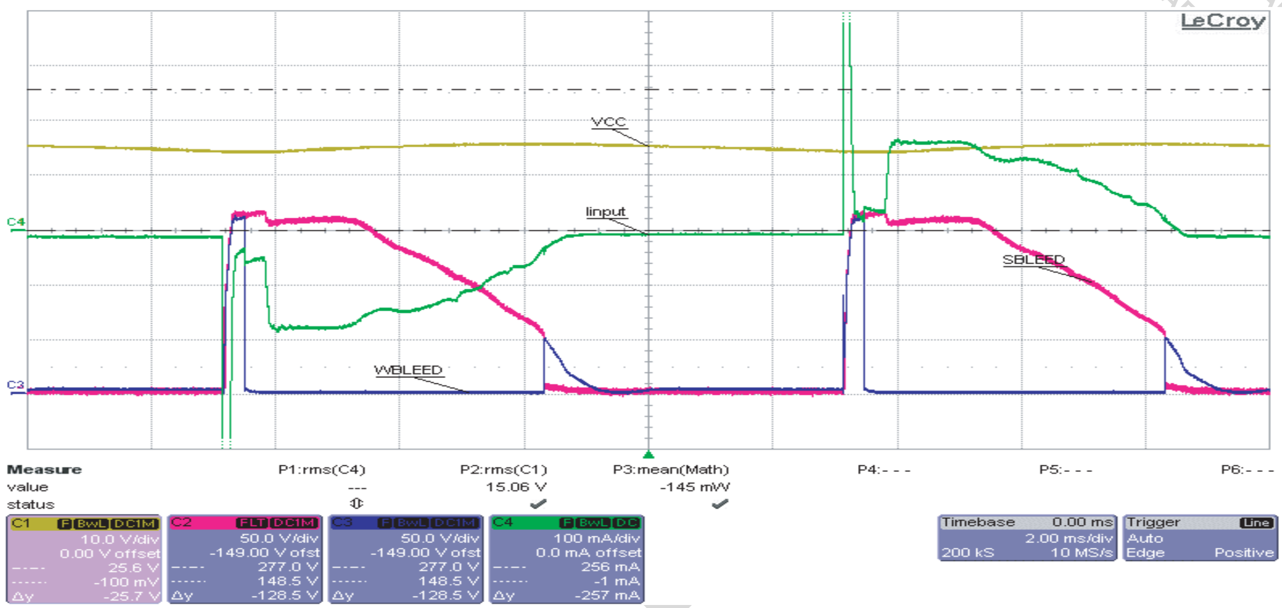

Fig 6. Dimmed bleeder operation

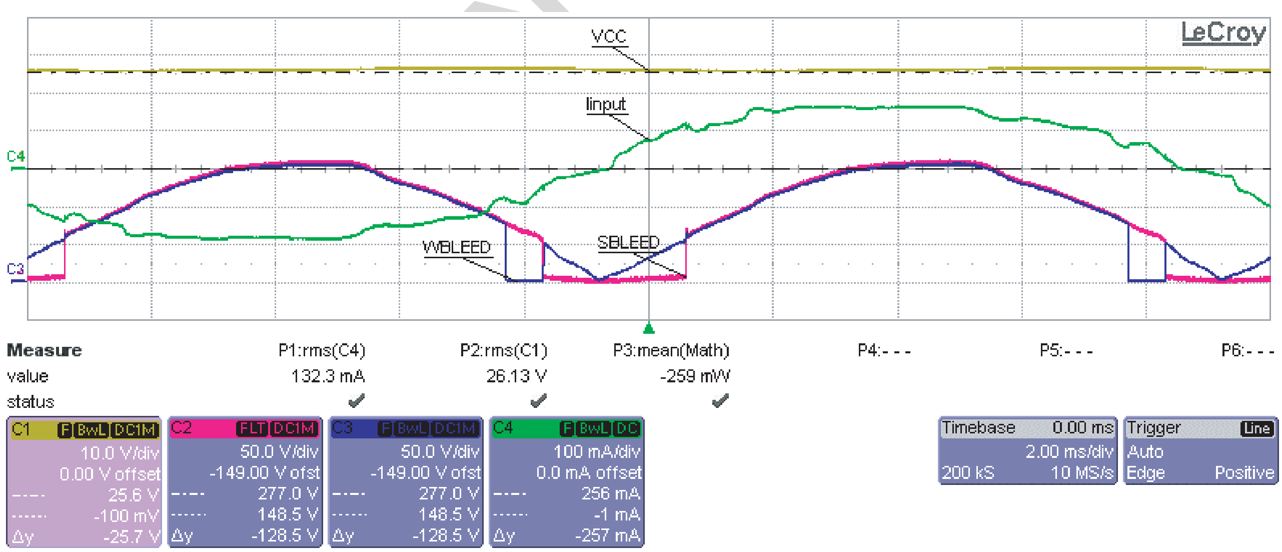

Fig 7. Un-dimmed bleeder operation

This board is optimized to work with a power factor above 0.9. In order to achieve this, the converter operates at constant t_{on} mode. The output power of the converter is buffered by capacitor C6. Due to this configuration, the circuit has a resistive input current behaviour in un-dimmed operation (see Input in Figure 7). In dimmed operation however, not only the dimmer latch and hold current must be maintained, but a damper must be added to dampen the inrush current and to dissipate the electric power that was stored in the LC filter within the dimmer. Though at low power ranges (<10 W) a serial resistor can be used for this, at higher power ranges a single series resistor is not efficient because the converter supply current will cause significant voltage drop and thus dissipation through this resistor. On the demonstration board, a combination of serial resistance and a parallel damper has been chosen to improve efficiency. The serial resistor is made up of F1, R1, R2 and R12. The parallel damper is made of C2 and R3. See Figure 8.

The input circuit of the converter must be equipped with a filter that is partially capacitive. The combination of C1, L1, L2, C3 and C4 makes a filter that blocks most of the disturbance generated by the converter input current. A drawback of this filter is a reduction of power factor, due to the capacitive load. A lower converter power in relation to the capacitive value of this filter/buffer will cause a lower power factor. At the 230 V (AC) design using 150 nF capacitors, a power factor of 0.9 is reached at 11 W output power.

The board is equipped with a feedback loop that limits the output current. This feedback loop senses the LED current over sense resistor R18, and a current mirror is made of Q1/Q2. Using R20, the current level can be set. The same feedback loop is also used for overvoltage protection. If the LED voltage exceeds 23 V, a current through R19 and D9 will start running. The current through the opto coupler IC2 will pull down the PWM_Limit and brightness pin. At a value below 400 mV, the on time is zero. The feedback loop has proportional action only, and the gain is critical because of phase shift caused by the converter and C6. The relation between PWM_Limit and output current is quadratic in nature. The resulting output current spread will be acceptable for most LED applications.

The dimming range is detected by sensing the average rectified voltage. R4, R5 and R17 make a voltage divider, and C9 filters the resulting signal. The converter sets its duty factor and converter frequency accordingly.

8. Board optimization

The following modifications can be done in order to meet different customer application requirements:

8.1 Changing the output voltage and LED current

One of the major advantages of a flyback converter over other topologies, is that it is suitable for driving other output voltages. Essentiality, changing the winding ratio whilst maintaining the value of the primary inductance, will shift the output working voltage accordingly. Part of the efficiency of the driver is linked to the output voltage. A lower output voltage will increase the transformation ratio, and cause higher secondary losses. In practice, a mains dimmable flyback converter will have an efficiency between 80 % for high output voltages (like 60 V) down to 50 % for low output voltages (like 3 V). At low voltages, synchronous rectification might become advisable to reduce losses. The NXP TEA1791 can be applied for this purpose. For exact calculations of transformer properties and peak current, we refer to application note *AN10754_1*, “How to design an LED driver using the SSL2101”, and the excel spreadsheet that goes with it.

8.2 Changing the output ripple current

The output current ripple is mostly determined by the LED voltage, the LED dynamic resistance and the output capacitor. Whilst the value of C6 has been chosen to optimize capacitor size with light output. A ripple of ± 25 % will result in an expected deterioration of light output <1 %.

The size for the buffer capacitor can be estimated from the following equation

$$C_6 = \frac{I}{\Delta I} \cdot \frac{1}{6 \cdot f_{net} \cdot R_{dynamic}}$$

As example: For a ripple current of ± 5%, and a mains frequency of 50 Hz, and a dynamic resistance of 0.6 Ω, C6 becomes 20/(300*0.6) = 111 mF. For a ripple current of 25 % and a dynamic resistance of 6 Ω, 4/(300*6) = 2200 μF. Using a series of LEDs, the dynamic resistance of each LED can be added to the total dynamic resistance.

8.3 Adapting to high power reverse phase (transistor) dimmers.

Reverse phase (transistor) dimmers differ in two ways that can be beneficial but can also cause problems with dimming detection:

- The negative phase causes no inrush current when the dimmer triggers. At TRIAC dimmers, there will be a sudden voltage difference over the input leading to a steep charge of the input capacitors. The resulting peak current will lead to higher damper dissipation. Because this steep charge is missing, the input capacitors will have less stress, and the input circuit is less prune to audible noise.
- Transistor dimmers contain active circuitry that require a load charge during the time that the dimmer is open. The dimensioning of the circuit generating the internal supply voltage inside the dimmer is made critical in order to avoid excessive internal dimmer losses. This means that the remaining voltage drop over the lamp must be low enough to reach this charge. For dimmers like the Busch-Jaeger 6519U, the minimum lamp load is specified at 40 W which is equivalent to a 1.3 kΩ resistor load at 230 V(AC). Such a load would result in highly inefficient operation at low output power levels, since most energy is waisted in order to drive the dimmer, and not to produce light.

On the demo board, the weak bleeder value R6/R7 is choosen is such way, that losses are still acceptable (about 2 W to 3 W) and only occur in dimmed position. The voltage drop with some transistor dimmers is however not sufficient to cause full dimming range control (minimum 10 % instead of <1 %), because at the SSL2101 the dimming range is sensed by taking the average rectified voltage as input. To compensate for the reduced voltage difference, voltage detection can be made more sensitive by replacing R4 with a Zener diode, like the BZV85-C200 for 230 V(AC), or the BZV85-C68 for 120 V (AC) applications. Because of increased sensitivity, the dimming curve when using TRIAC dimmers, will also be steeper and shifted.

8.4 Changing the load curve

The load curve can be divided into two regions: A part where the control loop limits the duty cycle of the converter, and where the output current is regulated, and a part where the duty factor feedback is not dominant anymore. This last part occurs at output voltages below 13 V. In this area, constant output power becomes the dominant control mechanism. Changing the winding ratio of the transformer to match the output load will also change this load curve.

8.5 Multiple driver support

It is possible to attach multiple converters to a single dimmer. At the use of TRIAC dimmers the inrush current will rise, though not proportionally to the number of converters. Transistor dimmers are more suitable for usage with multiple converters because the dimming range will increase due to the added bleeder action, and there is no inrush current.

9. Board schematic

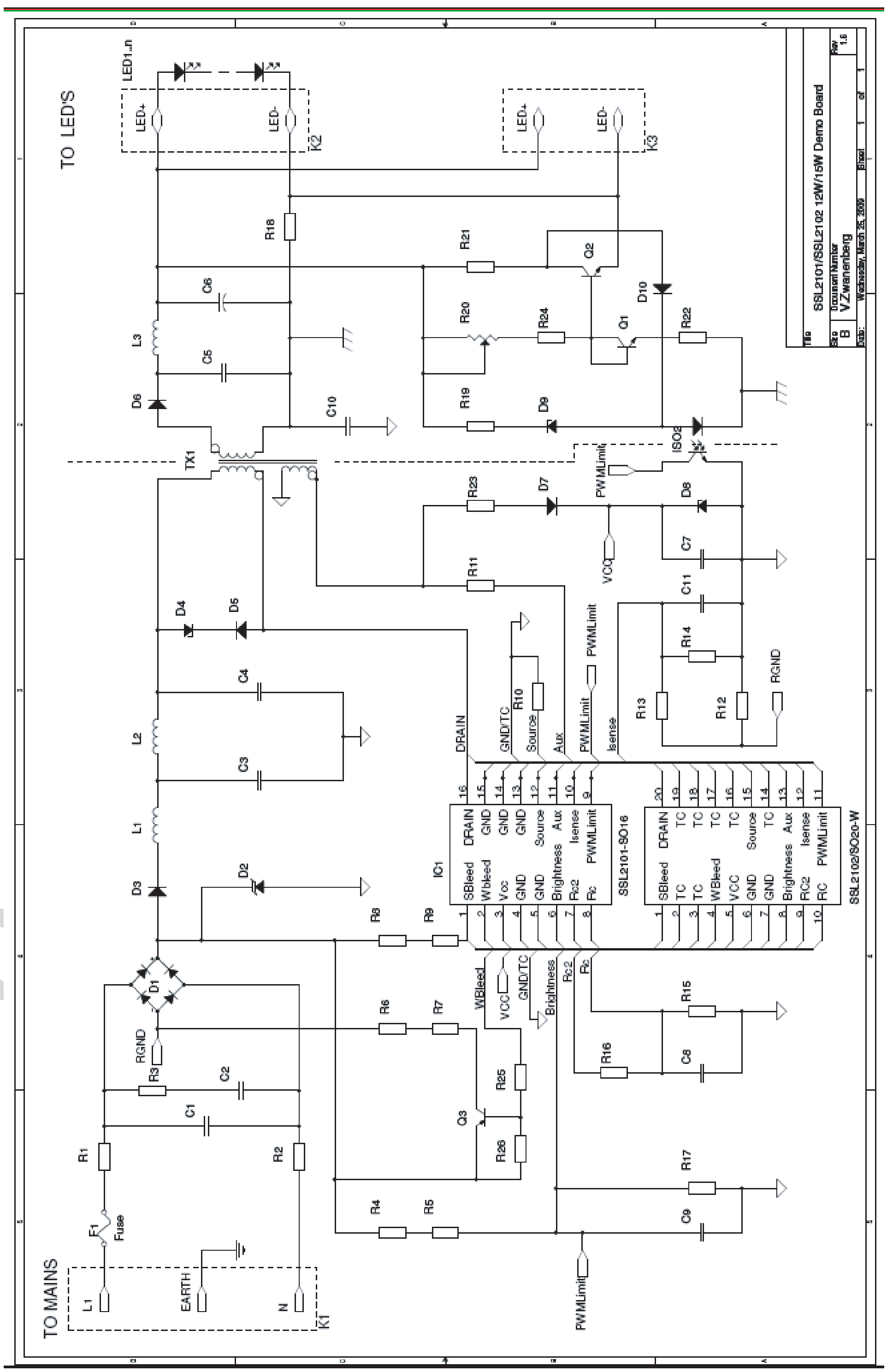

Fig 8. Board schematic diagram

10. Bill of materials (BOM)

Table 3. Bill of materials 230 V (AC)

Part No.	Ref. Des.	Part	Value	Pwr	Tol.	Volt	Package	Type	Manuf.	Amount
1	K1	Conn 3pin 2u ang	m					SL 5.08/3/90	Weidmuller	1
2	K1'	Conn 3pin 2u	f					BL 5.08/3	Weidmuller	1
3	K3	Conn 6pin 1u	f					BL3.36Z	Fischer	1
4	K2	Conn 2pin 2u ang	m					SL 5.08/2/90	Weidmuller	1
5	K2'	Conn 2pin 2u	f					BL 5.08/2	Weidmuller	1
6	F1	Fusistor	6.8E	1 W	10 %		Free			1
7	R1	Resistor	39 Ω	1 W	5 %		Free			1
8	R2	Resistor	39 Ω	1 W	5 %		Free			1
9	R3	Resistor	1 KΩ	2 W	5 %		Free			1
10	R4	Resistor	470 KΩ	0.25	1 %		Free			1
11	R5	Resistor	470 KΩ	0.25	1 %		Free			1
12	R6	Resistor	10 KΩ	1 W	5 %	200	Free			1
13	R7	Resistor	10 KΩ	1 W	5 %	200	Free			1
14	R8	Resistor	2.2 KΩ	1 W	5 %	200	Free			1
15	R9	Resistor	2.2KΩ2	1 W	5 %	200	Free			1
16	R10	Resistor	0.4 Ω	1 W	1 %		Free			1
17	R11	Resistor	33 KΩ	0.25	5 %	200	Free			1
18	R12	Resistor	15 Ω	1 W	5 %	200	Free			1
19	R13	Resistor	100 KΩ	0.1	1 %	200	Free			1
20	R14	Resistor	22 KΩ	0.1	1 %		Free			1
21	R15	Resistor	470K	0.1	1 %		Free			1
22	R16	Resistor	4.7 KΩ	0.1	1 %		Free			1
23	R17	Resistor	12 KΩ	0.1	1 %		Free			1
24	R18	Resistor	0.3 Ω	1W	1 %		Free			1
25	R19	Resistor	10 KΩ	0.1	5 %		Free			1
26	R20	Resistor	50 KΩ Lin	0.1	5 %		Horizontal		Bourns	1
27	R21	Resistor	22 KΩ	0.1	1 %		Free			1
28	R22	Resistor	330 Ω	0.1	1 %		Free			1
29	R23	Resistor	470 Ω	0.25	5 %		Free			1
30	R24	Resistor	3.9 KΩ	0.1	5 %		Free			1
31	R25	Resistor	470 KΩ	0.25	5 %		Free			1
32	R26	Resistor	10 KΩ	0.1	5 %		Free			1
33	C1	Capacitor	470 pF	Cer	10 %	1 K		DEBB33A471KC1B	Murata	1
34	C2	Capacitor	150 nF	Poly	10 %	400		NRM-S154K400F	NIC	1
35	C3	Capacitor	150 nF	Poly	10 %	400		NRM-S154K400F	NIC	1
36	C4	Capacitor	150 nF	Poly	10 %	400		NRM-S154K400F	NIC	1
37	C5	Capacitor	4.7μF	Poly	10 %	63		B32560J475K	Epcos	1

Table 3. Bill of materials 230 V (AC)

Par t No.	Ref. Des.	Part	Value	Pwr	Tol.	Volt	Package	Type	Manuf.	Amount
38	C6	Capacitor	2200 μF	105°	10 %	25		2222 021 16222	Vishay	1
39	C7	Capacitor	4.7 μF	105°	10 %	25	Free			1
40	C8	Capacitor	330 pF	Cer	5 %		Free			1
41	C9	Capacitor	10 μF	105°	10 %	25	Free			1
42	C10	Capacitor	2.2 nF	Cer	10 %	4 K		DECE33J222ZC4B	Murata	1
43	C11	Capacitor	10 nF	Cer	10 %	25	Free			1
44	L1	Inductor	680 μH					744776268	Wurth	1
45	L2	Inductor	330 μH					744776233	Wurth	1
46	L3	Inductor	100 μH					74477120	Wurth	1
47	TX1	Transformer	N87/3F3		5 %		EFD25	750340505	Wurth	1
48	D1	Rect Bridge	2 A				SO-4	DBLS205G	Taiwan semi	1
49	D2	TVS diode	600 W					P6KE400A	Fairchild	1
50	D3	Diode	1 A 800 V					HER107	Taiwan semi	1
51	D4	Zener	270 V 3 W					BZT03-C220	Vishay	1
52	D5	Diode	1 A 800 V					HER107	Taiwan semi	1
53	D6	Diode	3 A 100 V					SK310A	Taiwan semi	1
54	D7	Diode	1 A 800 V					HER107	Taiwan semi	1
55	D8	Zener	30 V		5 %			BZV55-C30	NXP	1
56	D9	Zener	20 V		5 %			BZV55-C20	NXP	1
57	D10	Diode	75 V					1N4148	NXP	1
58	Q1	Transistor	NPN					BC847B	NXP	1
59	Q2	Transistor	NPN					BC847B	NXP	1
60	Q3	Transistor	PNP					ZTX758	Zetex	1
61	ISO2	Optocoupler						4N27	Vishay	1
62	U1	IC	SSL2101 SSL2102		SO-1 6SO- 20 W	Y	SSL2101/ SSL2102		1	

Table 4. Bill of materials 120 V (AC)

Part No.	Ref. Des.	Part	Value	Pwr	Tol.	Volt	Package	Type	Manuf.	Amount
1	K1	Conn 3pin 2u ang	m					SL 5.08/3/90	Weidmuller	1
2	K1'	Conn 3pin 2u	f					BL 5.08/3	Weidmuller	1
3	K3	Conn 6pin 1u	f					BL3.36Z	Fischer	1

Table 4. Bill of materials 120 V (AC)

Part No.	Ref. Des.	Part	Value	Pwr	Tol.	Volt	Package	Type	Manuf.	Amount
4	K2	Conn 2pin 2u ang	m					SL 5.08/2/90	Weidmuller	1
5	K2'	Conn 2pin 2u	f					BL 5.08/2	Weidmuller	1
6	F1	Fusistor	6.8E	1 W	10 %		Free			1
7	R1	Resistor	27 Ω	1 W	5 %		Free			1
8	R2	Resistor	27 Ω	1 W	5 %		Free			1
9	R3	Resistor	2.7 KΩ	1 W	5 %		Free			1
10	R4	Resistor	470 KΩ	0.25	1 %		Free			1
11	R5	Resistor	0 Ω	0.25	5 %		Free			1
12	R6	Resistor	2.7 KΩ	1 W	5 %	200	Free			1
13	R7	Resistor	2.7 KΩ	1 W	5 %	200	Free			1
14	R8	Resistor	1 KΩ	1 W	5 %	200	Free			1
15	R9	Resistor	1 KΩ	1 W	5 %	200	Free			1
16	R10	Resistor	0.4 Ω	1 W	1 %		Free			1
17	R11	Resistor	33 KΩ	0.25	5 %	200	Free			1
18	R12	Resistor	10 Ω	1 W	5 %	200	Free			1
19	R13	Resistor	100 KΩ	0.1	1 %	200	Free			1
20	R14	Resistor	15 KΩ	0.1	1 %		Free			1
21	R15	Resistor	470 KΩ	0.1	1 %		Free			1
22	R16	Resistor	10 KΩ	0.1	1 %		Free			1
23	R17	Resistor	12 KΩ	0.1	1 %		Free			1
24	R18	Resistor	0.3 Ω	1W	1 %		Free			1
25	R19	Resistor	10 KΩ	0.1	5 %		Free			1
26	R20	Resistor	50 KΩ Lin	0.1	5 %		Horizontal		Bourns	1
27	R21	Resistor	22 KΩ	0.1	1 %		Free			1
28	R22	Resistor	330 Ω	0.1	1%		Free			1
29	R23	Resistor	3.9 KΩ	0.25	5 %		Free			1
30	R24	Resistor	3.9 KΩ	0.1	5 %		Free			1
31	R25	Resistor	100 KΩ	0.25	5 %		Free			1
32	R26	Resistor	NP				Free			1
33	C1	Capacitor	470 pF	Cer	10 %	1 KV		DEBB33A471KC1B	Murata	1
34	C2	Capacitor	100 nF	Poly	10 %	400		NRM-S104K400F	NIC	1
35	C3	Capacitor	330 nF	Poly	10 %	400		NRM-S334K400F	NIC	1
36	C4	Capacitor	330 nF	Poly	10 %	400		NRM-S334K400F	NIC	1
37	C5	Capacitor	4.7 µF	Poly	10 %	63		B32560J475K	Epcos	1
38	C6	Capacitor	2200 µF	105°	10 %	25		2222 021 16222	Vishay	1
39	C7	Capacitor	4.7 µF	105°	10 %	25	Free			1
40	C8	Capacitor	330 pF	Cer	5 %		Free			1
41	C9	Capacitor	10 µF	105°	10 %	25	Free			1
42	C10	Capacitor	2.2 nF	Cer	10 %	4 K		DECE33J222ZC4B	Murata	1

Table 4. Bill of materials 120 V (AC)

Part No.	Ref. Des.	Part	Value	Pwr	Tol.	Volt	Package	Type	Manuf.	Amount
43	C11	Capacitor	10 nF	Cer	10 %	25	Free			1
44	L1	Inductor	680 μH					744776268	Wurth	1
45	L2	Inductor	330 μH					744776233	Wurth	1
46	L3	Inductor	100 μH					74477120	Wurth	1
47	TX1	Transformer	N87/3F3		5 %		EFD25	750340505	Wurth	1
48	D1	Rect Bridge	2 A				SO-4	DBLS205G	Taiwan semi	1
49	D2	TVS diode	600 W					P6KE270A	Fairchild	1
50	D3	Diode	1 A 800 V					HER107	Taiwan semi	1
51	D4	Zener	270 V 3 W					BZT03-C220	Vishay	1
52	D5	Diode	1 A 800 V					HER107	Taiwan semi	1
53	D6	Diode	3 A 100 V					SK310A	Taiwan semi	1
54	D7	Diode	1 A 800 V					HER107	Taiwan semi	1
55	D8	Zener	30 V		5 %			BZV55-C30	NXP	1
56	D9	Zener	20 V		5 %			BZV55-C20	NXP	1
57	D10	Diode	75 V					1N4148	NXP	1
58	Q1	Transistor	NPN					BC847B	NXP	1
59	Q2	Transistor	NPN					BC847B	NXP	1
60	Q3	Transistor	PNP					MPSA92	NXP	1
61	ISO2	Optocoupler						4N27	Vishay	1
62	U1	IC	SSL2101 SSL2102		SO-16 SO-20 W	Y	SSL2101/ SSL2102		1	

11. Transformer specification

Figure 9 shows the transformer schematic:

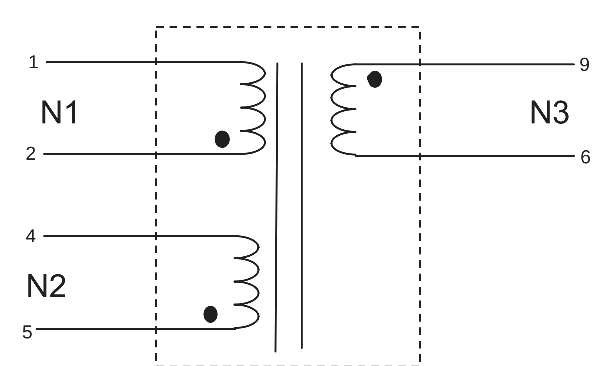

Fig 9. Transformer schematic

11.1 Winding specification

Table 5. Winding specification

No.	Section	Wire	Layers	Turns	Pin	
					Begin	End
1	N1	1X0.315	1	43	2	
2	ISO	0.2				
3	N3	40X0.071	1	21	9	6
4	ISO	0.2				
5	N2	1X0.2	1	42	5	4
6	ISO	0.2				
7	N1	1X0.315	1	42		1
8	ISO	0.2				

11.2 Electrical characteristics

Table 6. Inductance

Section	Inductance
N1	910 μH ± 5 %, at 2.3 A
N2	70 μH
N3	270 μH

- Nominal frequency = 100 kHz
- $V_{breakdown}$ N1...N2 = 4 KV

11.3 Core and bobbin

- Core: EFD25, 3F3/N87, airgap center 1100 μM
- Bobbin: CSH-EFD25-1S-10P

11.4 Physical dimensions

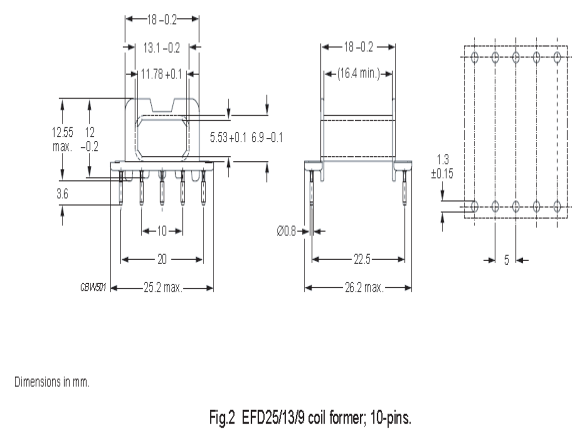

Fig 10. Transformer dimensions

12. Appendix A - Load curves

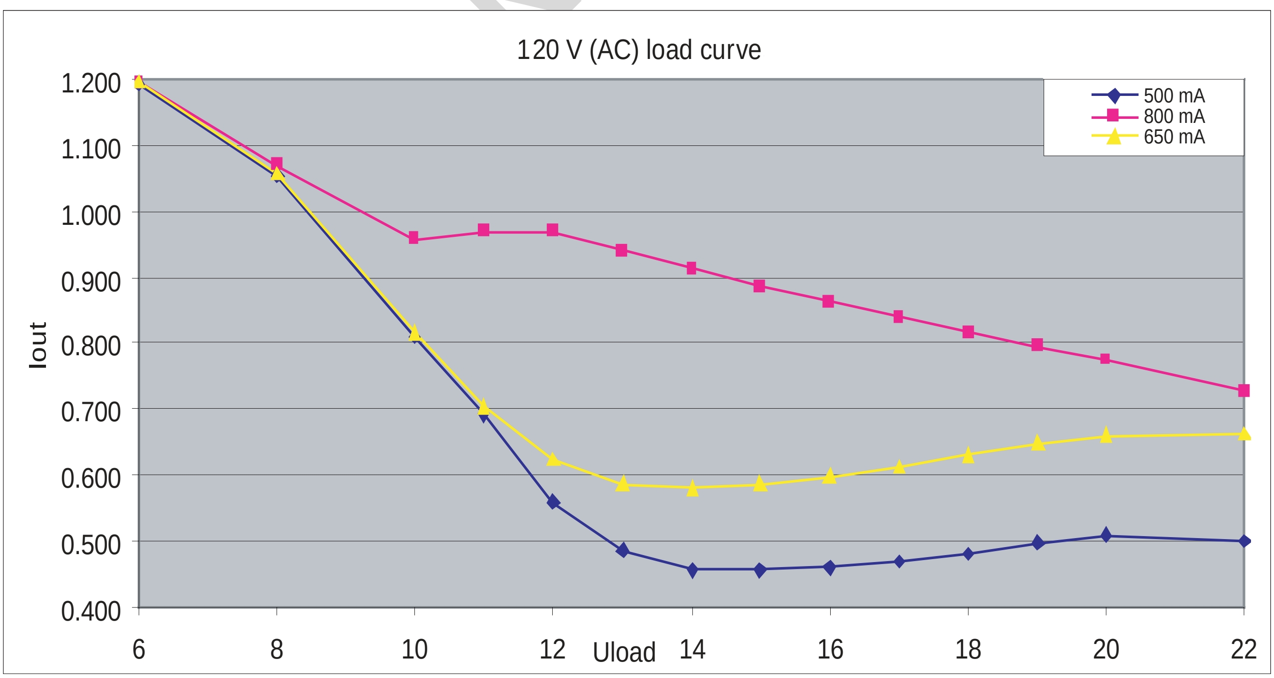

Fig 11. 120 V (AC) load curve

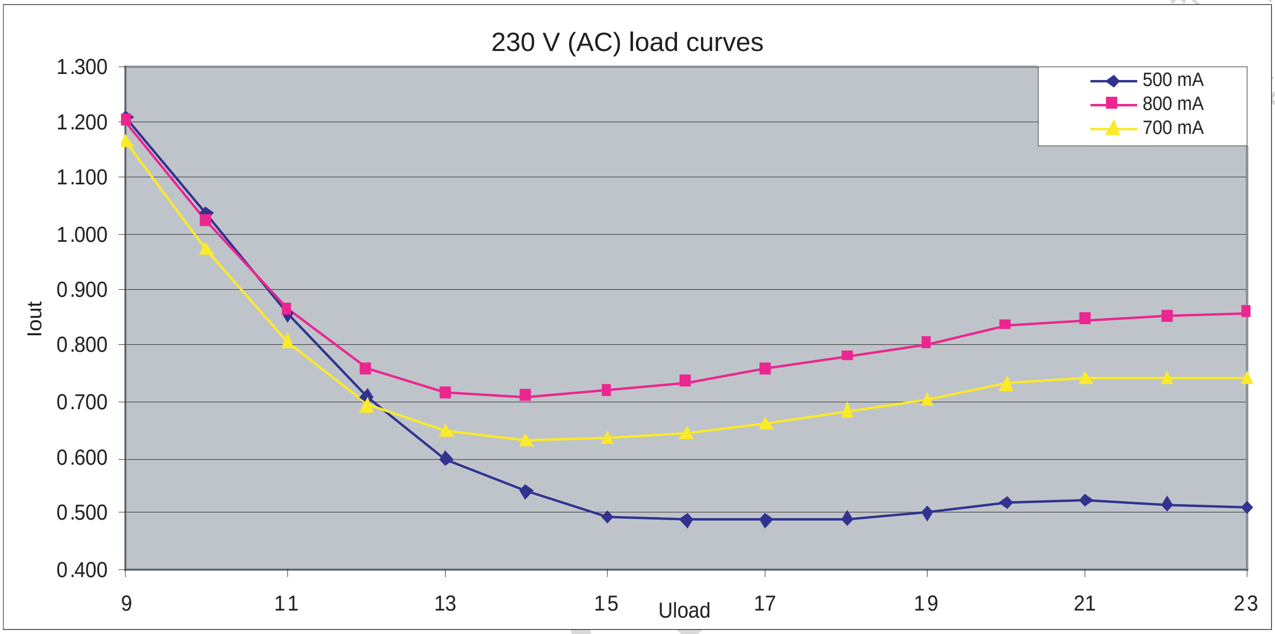

Fig 12. 230 V (AC) load curve

13. Appendix B - Efficiency curves

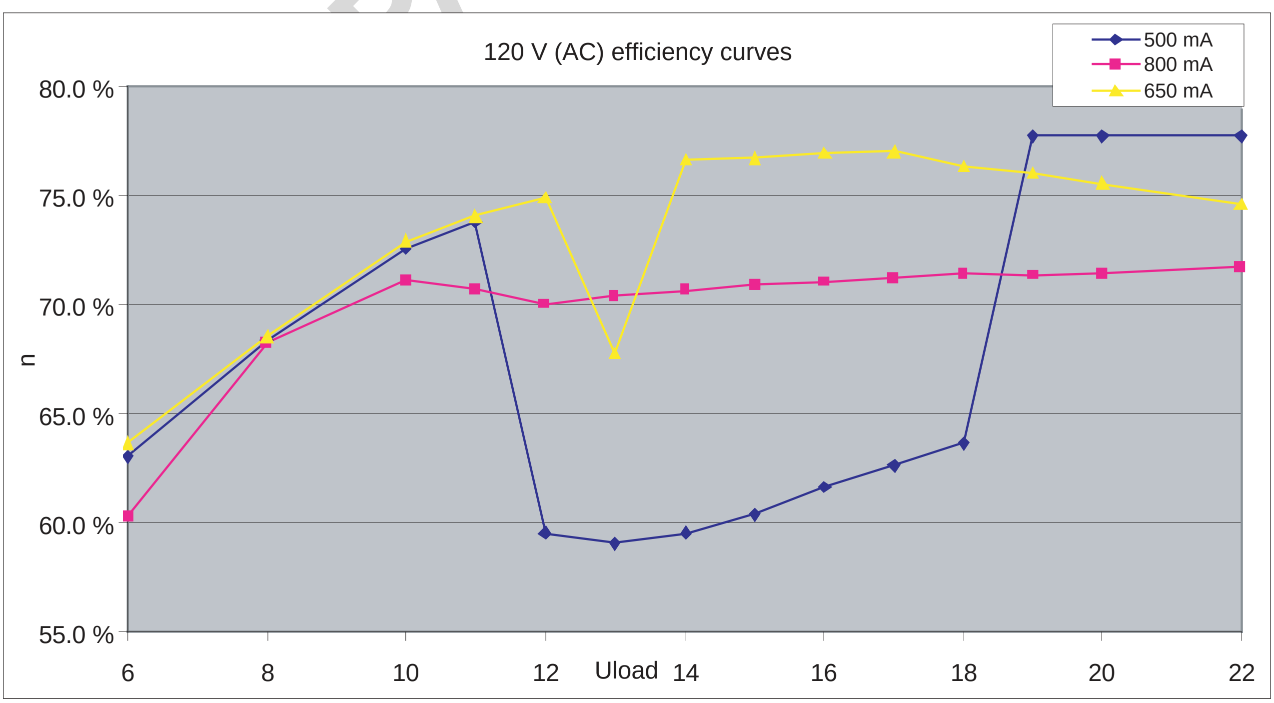

Fig 13. 120 V (AC) efficiency curve

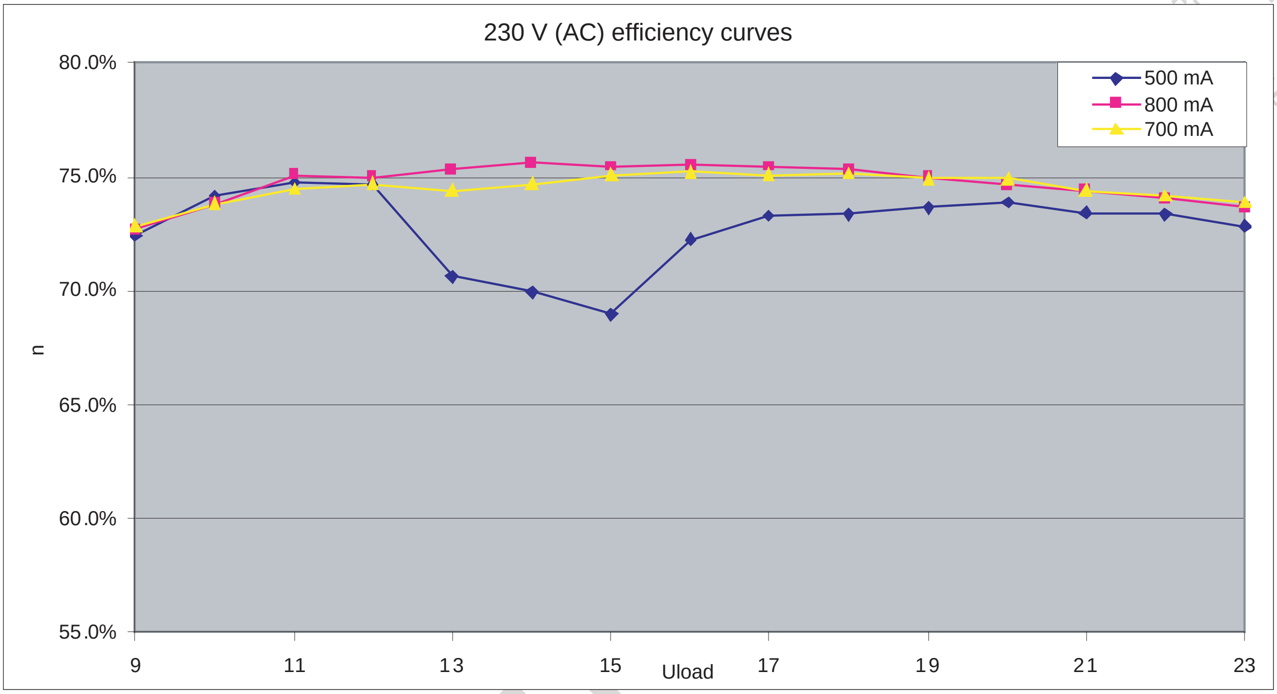

Fig 14. 230 V (AC) effeciency curve

14. Appendix C - Input voltage dependency

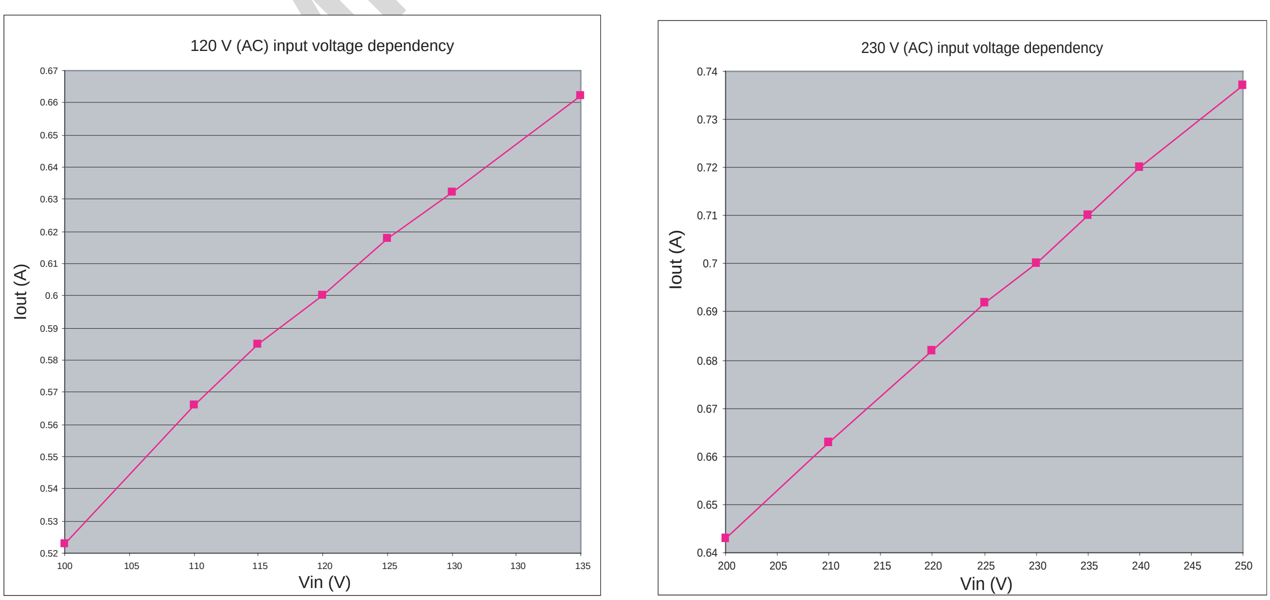

Fig 15. Input voltage/output current dependency

15. Appendix D - Mains conducted harmonics

Table 7. Mains conducted harmonic values

Harmonic	230 V (AC) 50 Hz Amplitude (%)	120 V (AC) 60Hz Amplitude (%)
1	100	100
2	0	0
3	13.2	9
4	0	0
5	3.8	2.1
6	0	0.1
7	1.2	1.9
8	0.1	0.1
9	3.2	2
10	0	0.1
11	0.5	0
12	0	0.1
13	2.5	1.3
14	0	0.1
15	1.8	1.2
16	0	0.1
17	2.1	0.5
18	0	0
19	2.9	0.1
20	0	0
THD	15.94	10.80
PF	0.94	0.98

16. References

[1] **AN10754_1 —** How to design an LED driver using the SSL2101

[2] **SSL2101 —** Datasheet

[3] **SMPS —** IC for dimmable LED lighting

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18. Contents

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