

UM10394

75 W SSL1750 triac dimmable 120 V mains LED driver

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User manual

Document information

Info	Content
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Abstract	User manual for the SSL1750 120 V (AC) mains dimmable 75 W, 1000 mA LED driver board.

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1. Introduction

This SSL1750 board is a 75 W, 1000 mA current regulated, LED driver that is dimmable with standard mains triac dimmers. The board is using the NXP SSL1750 switched mode power supply with integrated power factor correction (PFC) and a flyback controller. The circuitry for communication between both controllers is integrated and needs no adjustment. The PFC output power is on-time controlled for simplicity. It is not necessary to sense the phase of the mains voltage. The flyback output-power is current-mode controlled for good suppression of input-voltage ripple.

The board is very efficient, higher than 85 %, has a high power factor, above 0.95 over the whole voltage input range and the THD falls within the limits for class-C equipment. Making this board ideal for dimmable high power LED lighting systems.

The board has been optimized for triac-based dimmers. As different triac dimmers have different specifications the dimming performance of the reference board might vary based on the used dimmer. Transistor dimmers and other non-triac dimmers are not tested with this board.

1.1 IC description

The SSL1750 is a Switched Mode Power Supply (SMPS) controller IC, suitable for driving LED applications from 25 W up to 250 W. For LED power requirements below 25 W the NXP SSL210x family is preferred.

The SSL1750 combines Power Factor Correction (PFC) and a flyback controller. Its high level of integration allows the design of a cost-effective high efficiency LED power supply with a low number of external components.

The special built-in green functions provide high efficiency at all power levels. This applies to quasi-resonant operation at high power levels, quasi-resonant operation with valley detection, as well as reduced frequency operation at lower power levels. At low power levels, the PFC switches over to burst mode control to maintain high efficiency. In burst mode, soft-start and soft-stop functions are added to eliminate audible noise.

During low power conditions, the flyback controller switches to frequency reduction mode and limits the peak current to 25 % of its maximum value. This will ensure high efficiency at low power while minimizing audible noise from the transformer.

The proprietary high voltage BCD800 process makes direct start-up possible from the rectified universal mains voltage in an effective and green way. A second low voltage Silicon On Insulator (SOI) IC is used for accurate, high speed protection functions and control.

The SSL1750 enables the design of highly efficient and reliable LED drivers at power requirements up to 250 W, it can be designed with a minimum number of external components.

2. Specification

The main specification is given in [Table 1](#)

Table 1. Specification for the SSL1750 dimmable board

Type	Value	Comment
AC line input voltage	120 V \pm 10 %	-
DC output current	1000 mA \pm 10 %	when not dimmed
Output power	75 W \pm 10 %	when not dimmed
DC output voltage	56 V to 82 V	depending on LED forward voltage.
Dimming range	100 mA to 1000 mA	depending on dimmer.
Driver efficiency	> 85 %	over whole input voltage range. With 75 W load and no dimming
Power factor	> 0.95	for 120 V (AC) \pm 10 % mains and no dimmer used

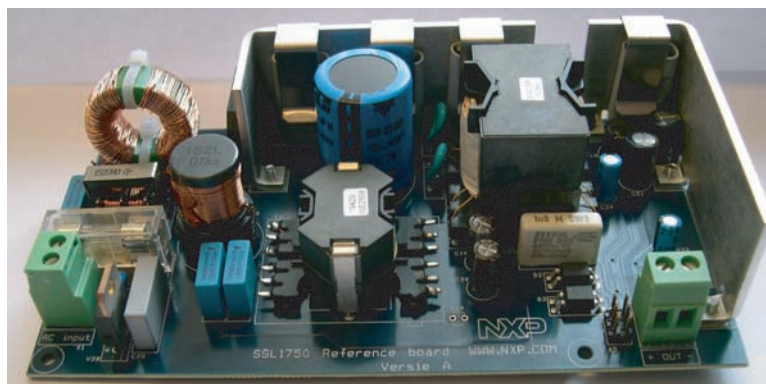


Fig 1. Photo of the dimmable 75 W LED driver board

3. Board connections

3.1 Input

On the AC input, connector X1, you can connect 120 V (AC) (\pm 10 %) 60 Hz. The mains can be connected to the board directly or via a triac dimmer. See [Section 5.3](#) for more details about the different dimmers.

3.2 Output

The anode of the LED strings should be connected to the '+' of connector X2. The cathode should be connected to the '-' of the same connector.

The board is designed to provide 1000 mA of current into a LED load. It is advised to use only one LED string. When more than one LED string is used, care must be taken to balance the current in each string to prevent one LED string having higher currents than other strings. In [Table 2](#) example configurations are listed of different LED loads.

The total forward voltage (V_F) of the LED string should not exceed the maximum output voltage of the board (see [Section 4.5.2](#)). A lower total V_F is allowed, as long as the output stays above the minimum output voltage (see [Section 4.5.1](#)).

Table 2. Example of LED configurations

Current per LED string (mA)	Number of LED strings	Number of LEDs per string	V_F (V)
330	3	24	3.15
500	2	23	3.25
1000	1	22	3.4

4. Functional description

The board is made around the SSL1750 IC. The SSL1750 includes a PFC and a flyback controller integrated in one SO-16 package.

The PFC boost the rectified mains voltage to 380 V, which is enough to have a excellent power factor up to 250 V (AC) input. The PFC output power is on-time controlled for simplicity. It is not necessary to sense the phase of the mains voltage. During low dimming levels the PFC will go into burst mode for higher efficiency.

The board act as a current source for the LED load. The board can be used with and without a dimmer. Without a dimmer the driver will supply 1000 mA of current. With a dimmer the current depends on the phase cut angle of the dimmer. The phase cut signal of a dimmer is converted into a reference voltage so that the phase cut signal determines the level of the output current. The output current is analog regulated, which means that no Pulse With Modulation (PWM) is used.

A simplified functional application diagram is shown in [Figure 2](#). Besides the PFC and flyback, a bleeder, an output current regulation and a dimming phase-angle detection circuit are shown. The function of these circuits are explained in this chapter.

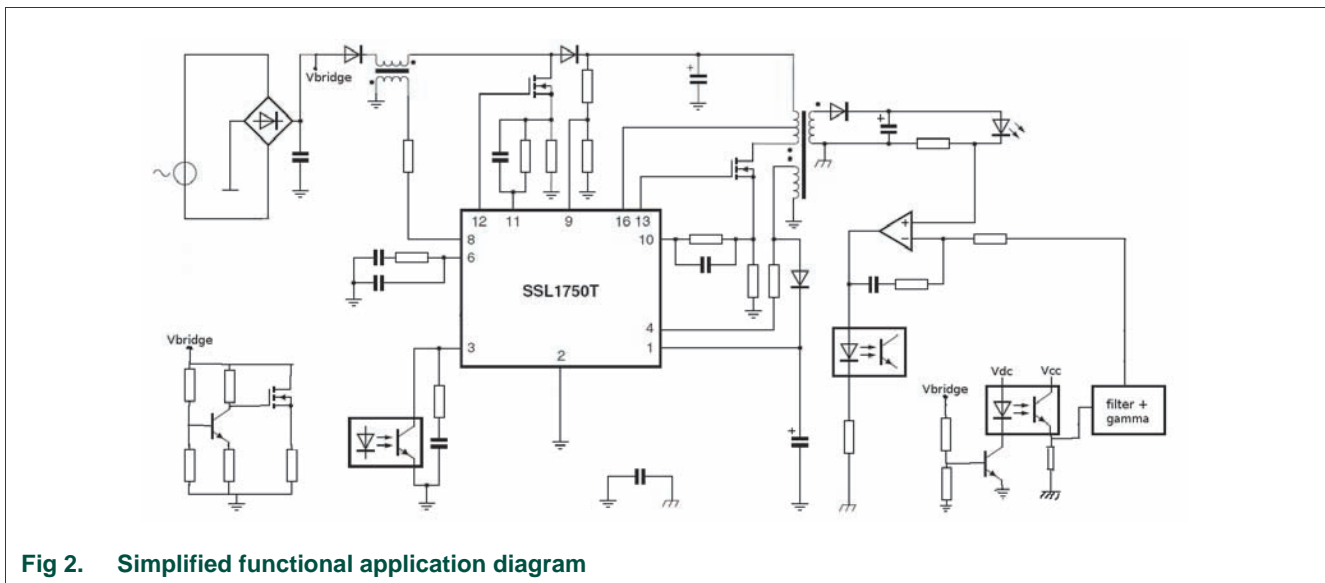


Fig 2. Simplified functional application diagram

4.1 Output current regulation

The output current is sensed with a (1 Ω) sense resistor and compared with a reference voltage. When no dimmer is connected, the reference voltage is such that a 1000 mA current will be supplied to the load on the output. When a dimmer is connected the reference voltage will change and thus the current, depending on the dimmer setting. The triac phase detection circuit will generate this reference voltage.

4.2 Triac phase detection circuit

The triac phase detection circuit, shown in Figure 3, detects the phase angle of the triac dimmer to be able to control the LED current by changing the reference voltage for the current regulation loop. Also shown in Figure 3, is the feedback loop to the flyback controller. A gamma curve is build-in to have a linear perceived-brightness response.

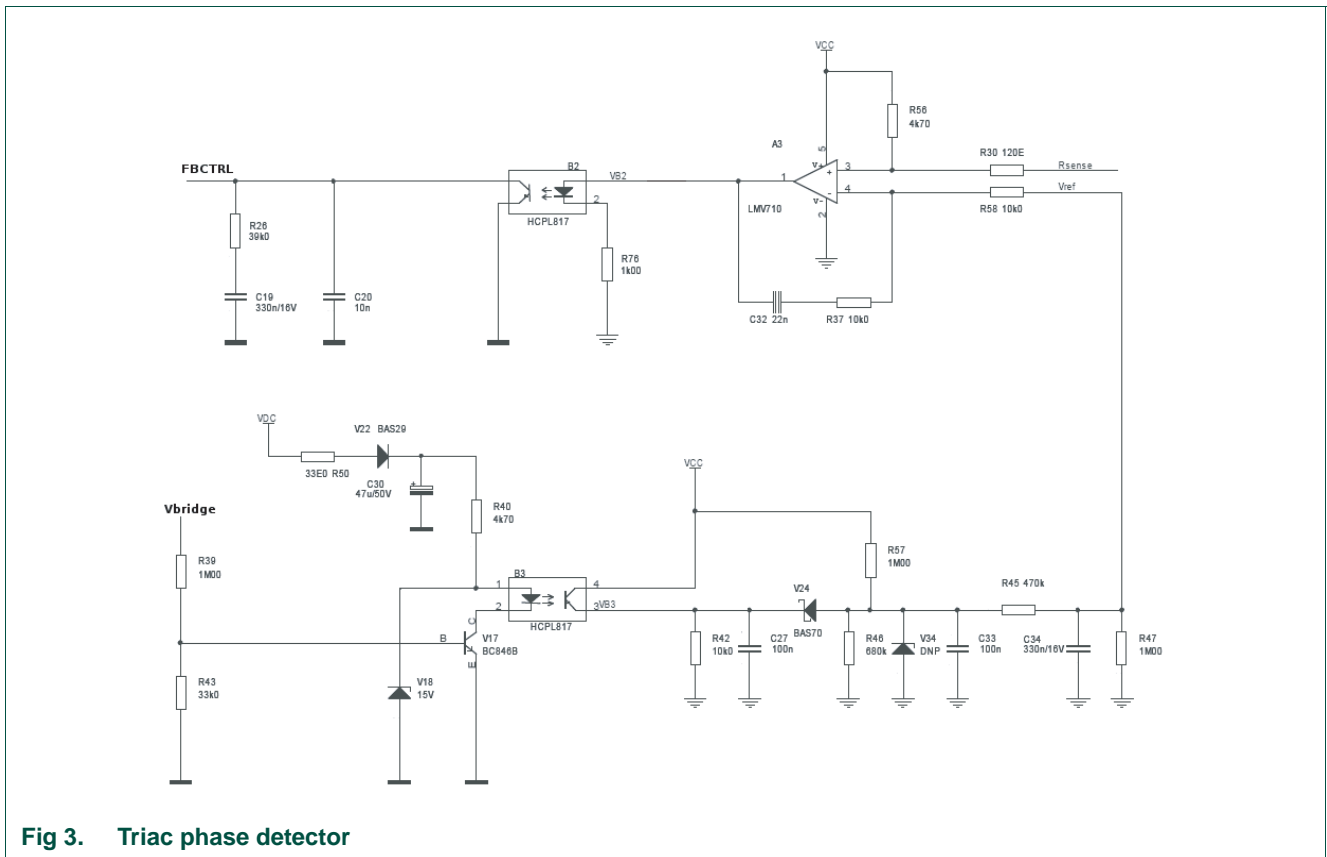


Fig 3. Triac phase detector

The dimmer signal is taken from the bridge rectifier output (V_{bridge}). Transistor V17 will be conducting when a voltage on the mains is detected (> 50 V). When the triac dimmer is not conducting, transistor V17 will be off. Via the opto-coupler, B3, the capacitor C27 will be charged when the triac is on. When the dimmer is at 100 % conducting capacitor C27 is fully charged and diode V24 is not conducting. The resistive divider R57, R46, R45 and R47 will set the voltage level on the inverting input (pin 4) of the error amplifier A3. This voltage sets the maximum current. When the dimmer is set to less than 100 % conducting, the voltage on C27 drops and V24 conducts therefore the voltage on C33 drops. Resulting in a lower reference voltage for the current feedback loop. There the V-I curve of the diode (V24) is of logarithmic nature, the dimming curve will also be of logarithmic nature resulting in the desired gamma curve.

Diode V24 is chosen so that its forward voltage is low. This prevents a too high offset voltage needed at the non-inverting error amplifier input. Also the diode temperature behaviour can influence the reference voltage. A low leakage Schottky type, like the NXP BAS70, is therefore preferable.

The error amplifier is build with operational amplifier A3. It compares the input sense voltage measured across the sense resistors (R66, R70, R72, R73) with the reference voltage. An opto-coupler is directly connected to the flyback control input FBCTRL to control the flyback frequency and mode.

The resistive divider formed by R30 and R65 sets an offset voltage on the current sense input. This makes sure that the load current can be controlled down to zero. The offset voltage corresponds with the minimum voltage present at the inverting input of the error amplifier when the dimmer conducting phase is set to maximum.

The power supply for error amplifier A3, shown in [Figure 4](#), is formed by use of an accurate reference voltage (TL431).

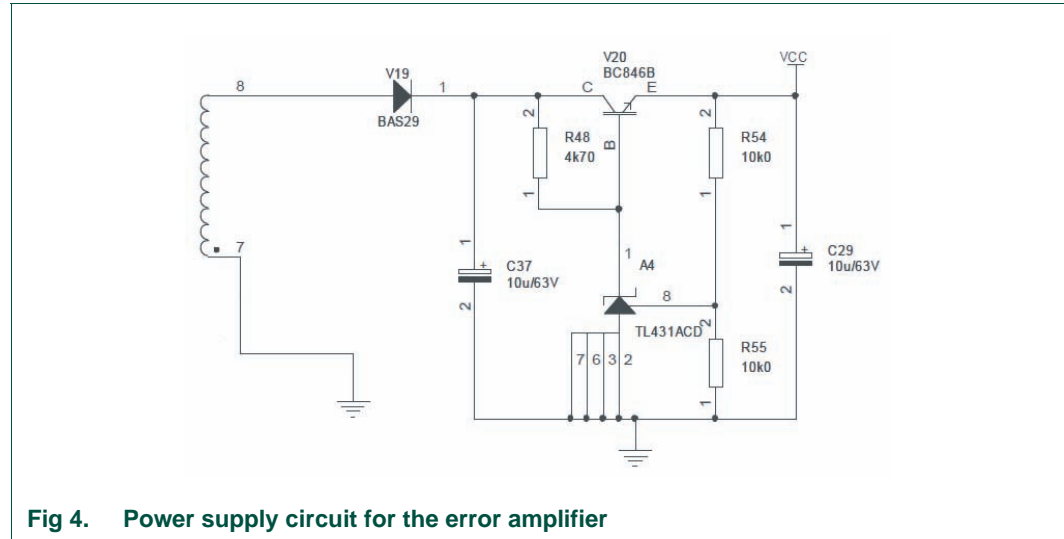


Fig 4. Power supply circuit for the error amplifier

4.3 Bleeder

To be able to work with a large range of dimmers a bleeder circuit is included on the board to provide a load for the dimmer to reset the dimmer timer and provide latch current for the dimmer triac.

In [Figure 5](#) the bleeder circuit diagram is shown. The FET, V28, operates as a current source. The current, $I_{bleeder}$, through R65 depends on the gate voltage which is set by the zener diode:

$$I_{bleeder} = \frac{V_{zener} - V_{th}}{R_{65}} \tag{1}$$

The bleeder circuit has two functions, keeping the triac in conduction and switching of the triac. Keeping the triac in conduction is done with the hold current. The hold current depends on zener V41. Switching off the triac is done with the latch current and depends on V30 and V41 together.

$$I_H = \frac{9.1 - 4.5}{220} = 21mA \tag{2}$$

$$I_L = \frac{(20 + 9.1) - 4.5}{220} = 112mA \tag{3}$$

The latch current will only flow when the bridge voltage V_{bridge} is below the level set by R59, R102, R107, R61 and V_{BE} of transistor V29.

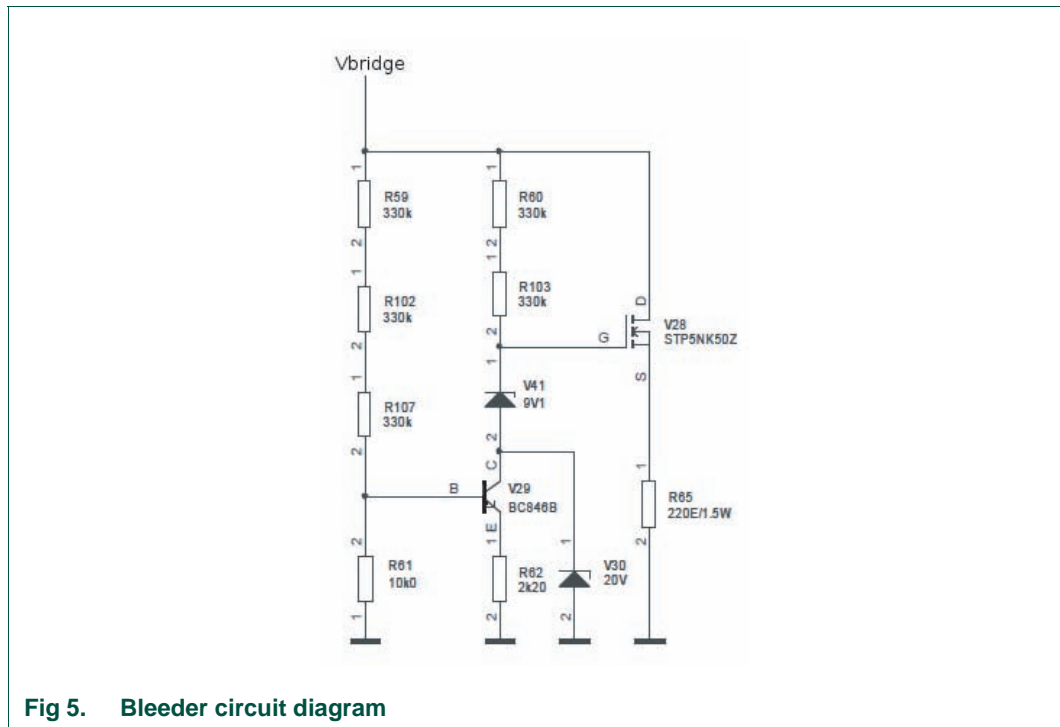


Fig 5. Bleeder circuit diagram

When a higher hold current is needed, additional heat sink area for V29 will be needed as the dissipation in the FET will increase.

The hold current is only needed when the PFC is in burst mode. If the hold current is switched off, with some additional circuit, when the PFC is in normal operation the dissipation in the FET can be reduced considerably.

4.4 Flyback shut down circuit

At the lowest dimming settings the average input voltage is too low for the PFC to operate. The PFC-converter turns off and as a consequence the SSL1750 chip enters in the start up sequence. This causes interruptions in the output current, which are visible as flicker in the LEDs.

Figure 6 shows the circuit used to switch off the flyback controller to prevent flickering dimming when the input voltage is too low.

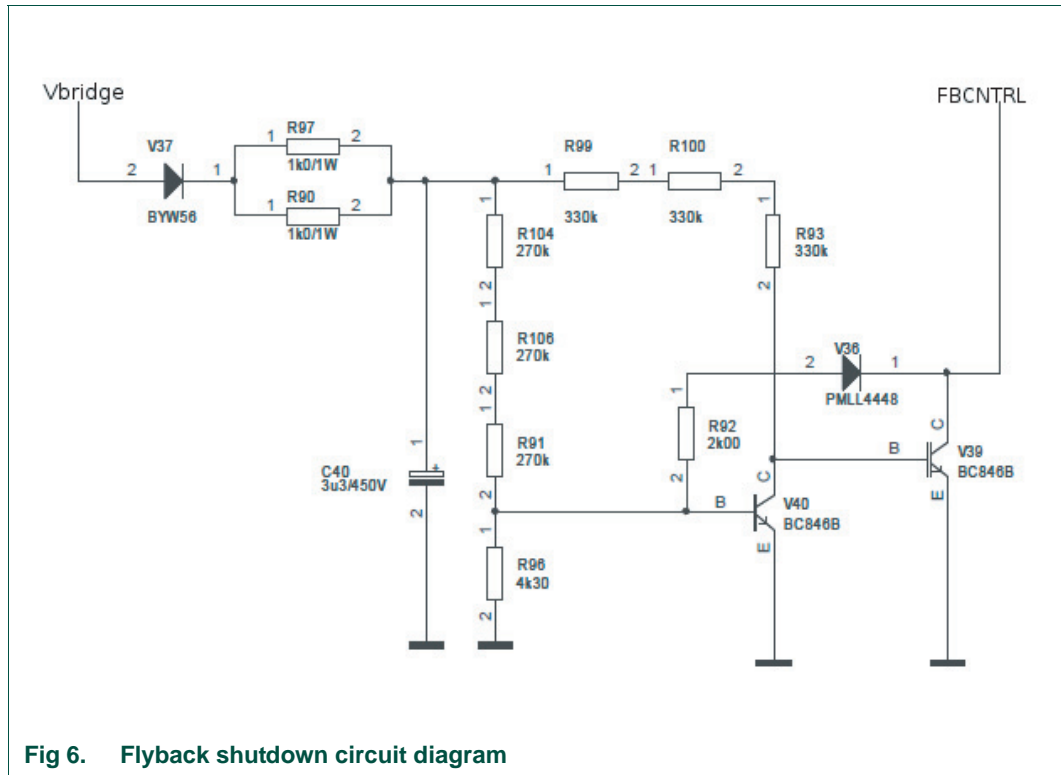


Fig 6. Flyback shutdown circuit diagram

Transistor V39 will pull FBCTRL to ground when the mains input voltage is below the lower trip level, causing the flyback to switch off. The input voltage from the bridge rectifier is detected by V37 and C40. The circuit inhibits a hysteresis. The hysteresis prevents the LED-driver from oscillating. The combination of R96 and R91 determines the lower trip level, V36 and R96 in parallel combined with R91 determines the higher trip level.

The lower trip level must be chosen in such a way that it corresponds with the level of the AC input voltage (output of the dimmer) just slightly above the point at which the PFC-converter turns off.

The higher trip level must be chosen in such a way that the FBCTRL level is open just below the minimum AC input voltage so that the driver is able to switch on under all allowed mains conditions.

The rms levels can be calculated as shown in [Equation 4](#): and [Equation 5](#)

$$V_{low} = \frac{1}{\sqrt{2}} \times V_{BE} \times \frac{R_{91} + R_{96}}{R_{96}} \tag{4}$$

$$V_{high} = \frac{1}{\sqrt{2}} \left(V_{BE} \times \frac{R_{91}}{R_{96}} + (V_{BE} - V_F) \times \frac{R_{91}}{R_{92}} + V_{BE} \right) \tag{5}$$

Where:

$$V_{BE} = 0.63 \text{ V}$$

$$V_F = 0.56 \text{ V}$$

The board is set at $V_{low} = 84 \text{ V rms}$ and $V_{high} = 104 \text{ V rms}$.

4.5 Protections

The board and IC have several protections. In the following sections the main protections are mentioned. For details on protections in the IC please see the datasheet of the SSL1750 IC.

4.5.1 Output under voltage protection

The output under voltage is detected by the $V_{th(UVLO)}$ on the VCC pin. When the VCC level falls below the $V_{th(UVLO)}$ level of 15 V (± 1 V) the flyback will be switch off. The VCC level depends on the output voltage. Therefore the protection will kick-in when the total forward voltage of the LED load is below $N_s/N_{aux} \times V_{th(UVLO)}$. Where N_s is the number of secondary turns and N_{aux} is the number of auxiliary turns of the transformer

$$V_{O(UVLO)} = \frac{N_s}{N_{aux}} \times V_{th(UVLO)} \quad (6)$$

$$V_{O(UVLO)typ} = \frac{28}{8} \times 15 = 52.5V \quad (7)$$

$$V_{O(UVLO)min} = \frac{28}{8} \times 14 = 49V \quad (8)$$

$$V_{O(UVLO)max} = \frac{28}{8} \times 16 = 56V \quad (9)$$

Resulting in a minimum total forward voltage of the LED load to be 56 V.

4.5.2 Output over voltage protection

The output over voltage is detected by the FBAUX pin. The FBAUX pin is connected via R_{FBAUX} to the auxiliary winding.

$$V_{O(ovp)} = \frac{N_s}{N_{aux}} (I_{ovp(FBAUX)} \times R_{FBAUX} + V_{clamp(FBAUX)}) \quad (10)$$

$$V_{O(ovp)typ} = \frac{N_s}{N_{aux}} (300\mu \times 82K + 0.7) = 88.6V \quad (11)$$

$$V_{O(ovp)min} = \frac{N_s}{N_{aux}} (279\mu \times 82K + 0.7) = 82.5V \quad (12)$$

$$V_{O(ovp)max} = \frac{N_s}{N_{aux}} (321\mu \times 82K + 0.7) = 94.6V \quad (13)$$

Where N_s is the number of secondary turns and N_{aux} is the number of auxiliary turns of the transformer. The value of R_{FBAUX} can be adjusted to the turns ratio of the transformer, thus making an accurate OVP detection possible.

To restart after an over voltage event, the mains should be interrupted to reset the internal latch.

4.5.3 PFC bus voltage protection

In case of an over voltage on the PFC bus, the PFC-controller will stop operating.

4.5.4 Temperature protection

The IC does have an internal temperature protection. When the internal temperature is above typical 140 °C the IC switches off to protect itself and the application.

A Negative Temperature Coefficient (NTC) resistor could be placed on the board, which should be connected to the latch pin, to shutdown the circuit if the ambient temperature is too high.

5. Measurements

5.1 Power Factor Correction (PFC)

Due to the integrated PFC controller the board will have a power factor above 0.95 for mains of 120 V (AC) \pm 10 %. [Table 3](#) gives the actual values. Measurements were executed under full load (75 W).

Table 3. Power factor versus mains voltage (50 Hz mains)

Mains V (AC) rms	Power factor
108	0.985
120	0.983
132	0.970

5.2 Efficiency

Without a dimmer, the board can reach an efficiency of 85 % with 120 V (AC) \pm 10 % while delivering 75 W of output power.

The efficiency of the board varies with the dimming level. Measurements with 3 different dimmers showed efficiency from 65 % at the lowest dimming position, up to 84 % at full power. This includes the losses in the dimmer

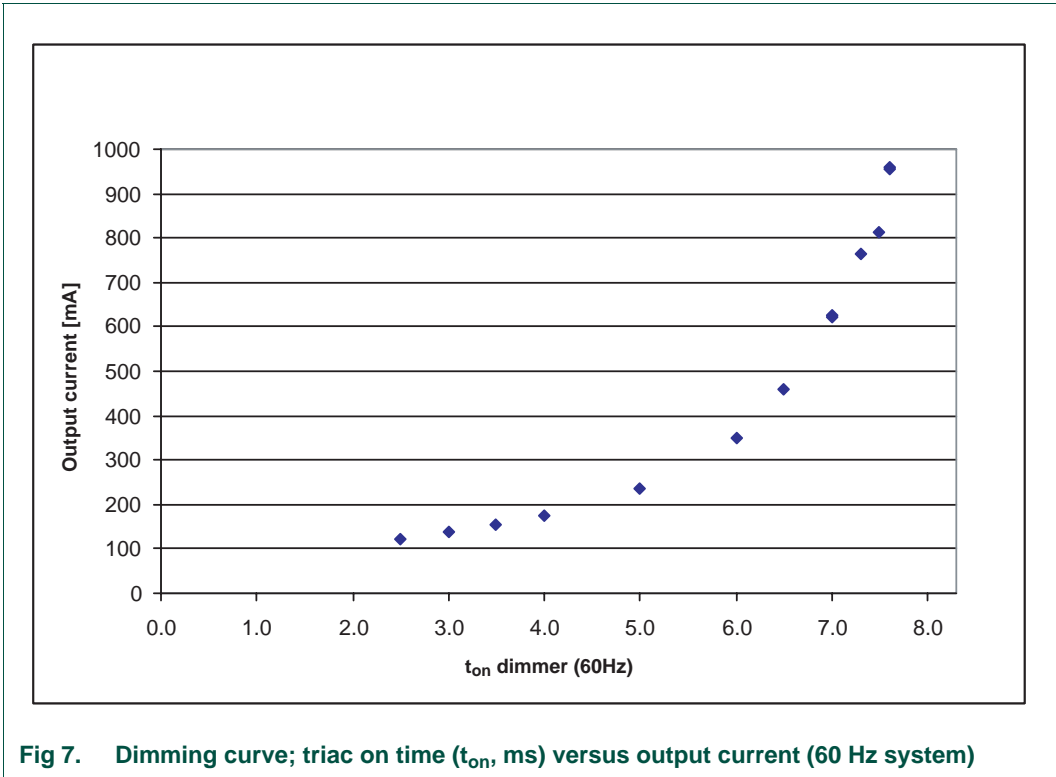
5.3 Dimming

The board has been optimized for triac-based dimmers. Several triac dimmers have been tested by NXP Semiconductors. As different dimmers have different specifications the dimming performance of the reference board might vary based on the used dimmer.

Remark: Non-triac dimmers, like transistor dimmers (also called electronic dimmers), have not been tested with this board.

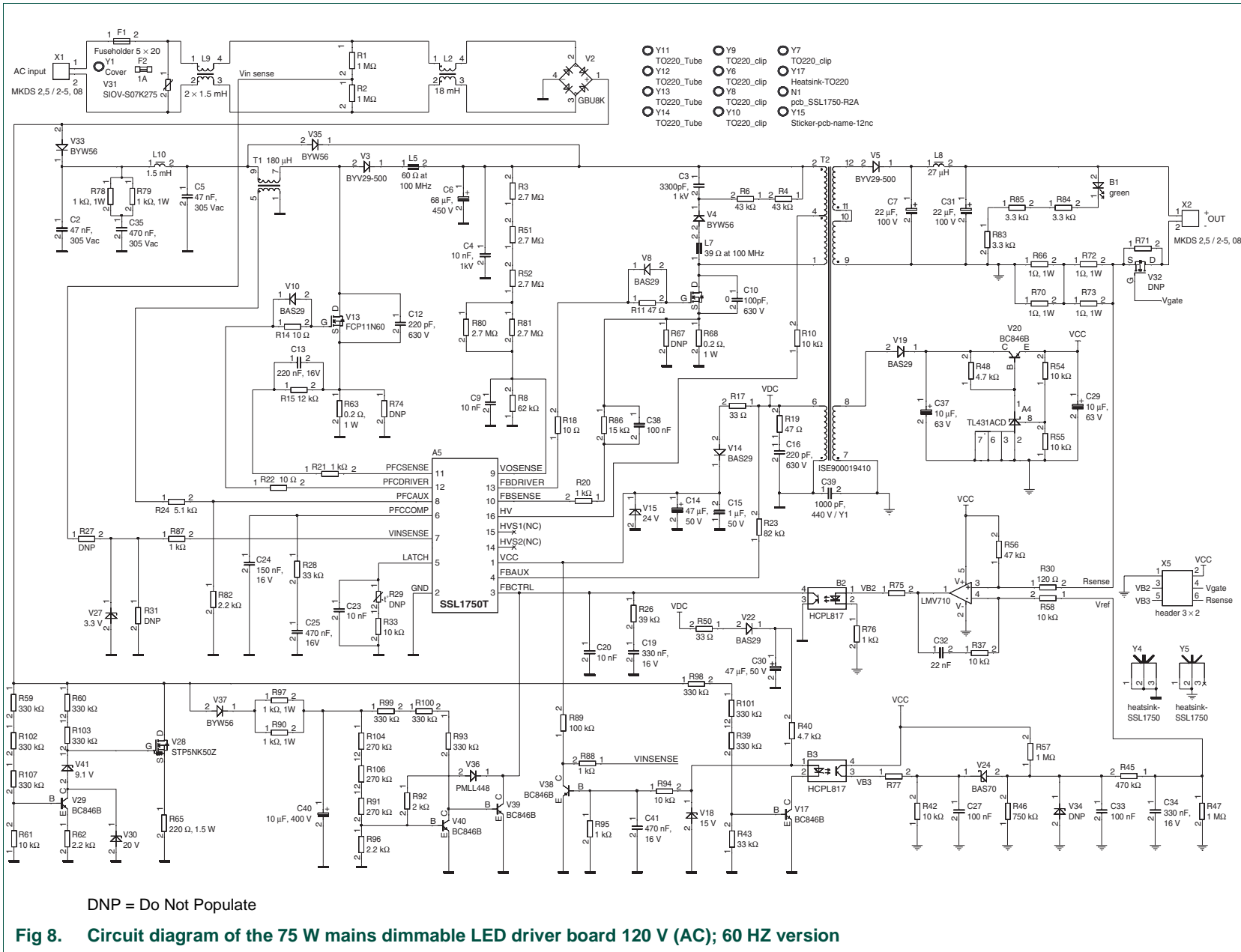
5.3.1 Dimming curve

Measurement data of the dimming curve, as described in [Section 4.2](#), is shown in [Figure 7](#).



When the dimming level is getting below a certain point ($t_{on} \sim 2$ ms), the input voltage seen by the board, will be too low and the board will switch off the flyback.

6. Circuit diagram



7. PCB silk screen and layout

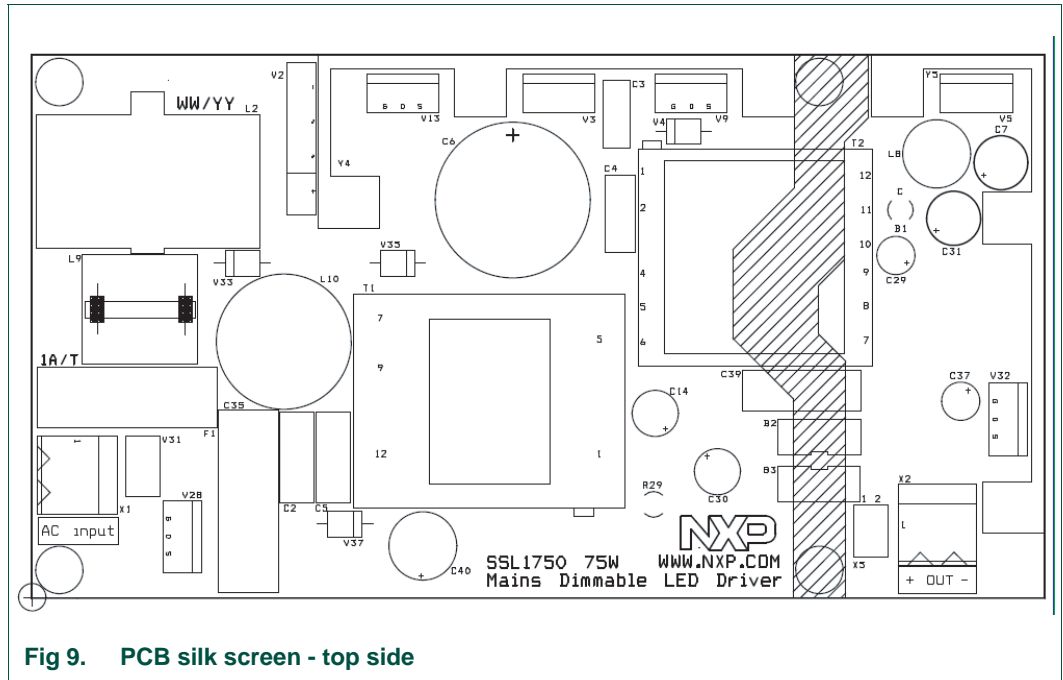


Fig 9. PCB silk screen - top side

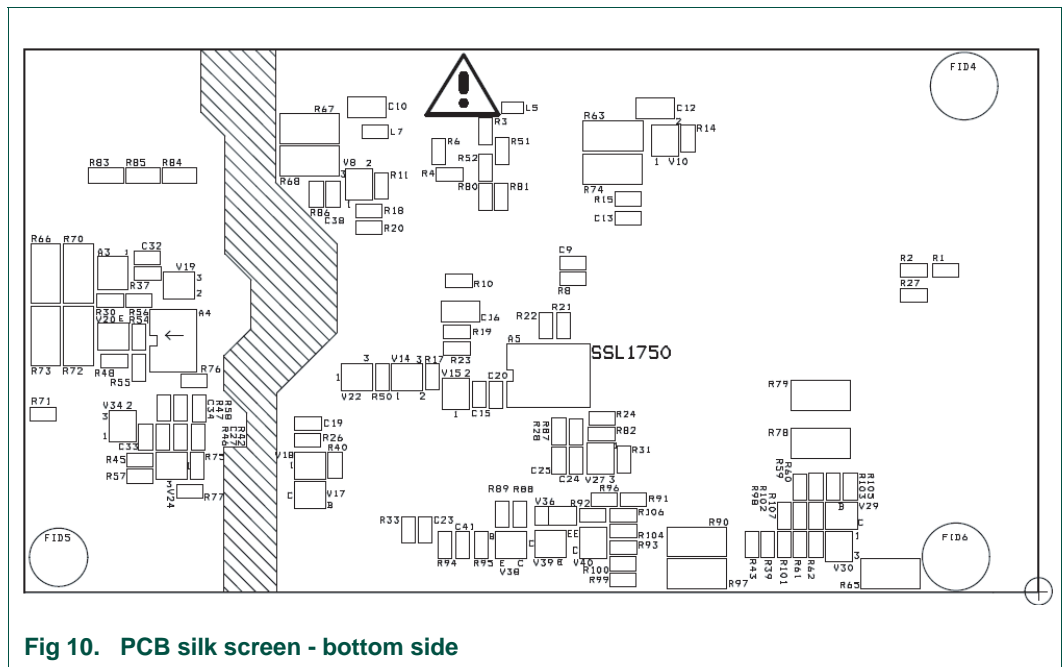


Fig 10. PCB silk screen - bottom side

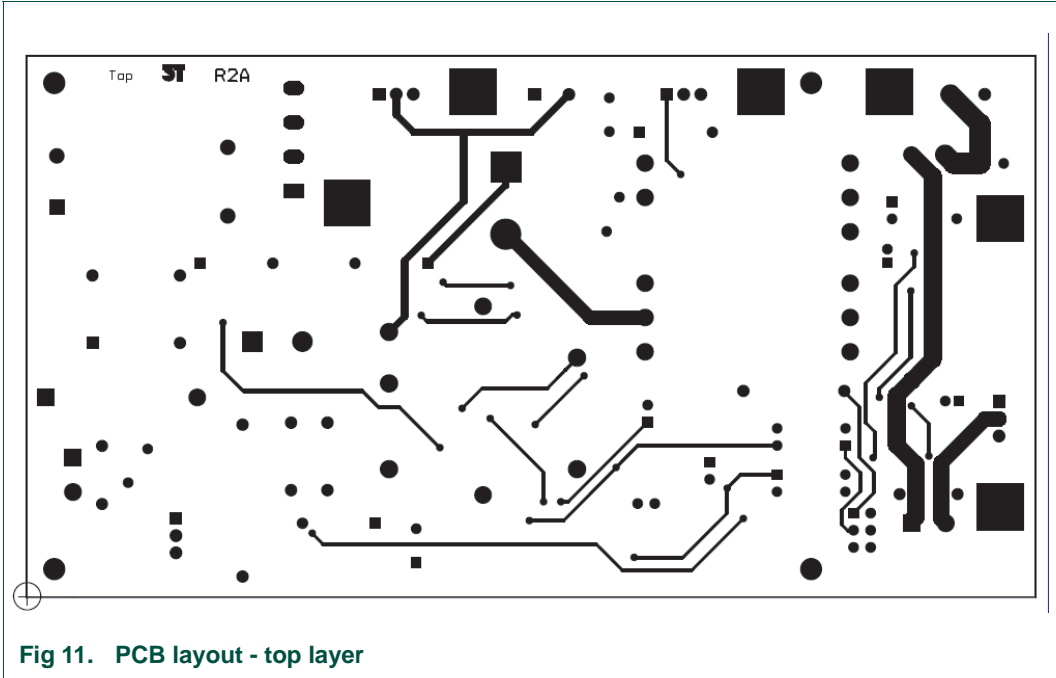


Fig 11. PCB layout - top layer

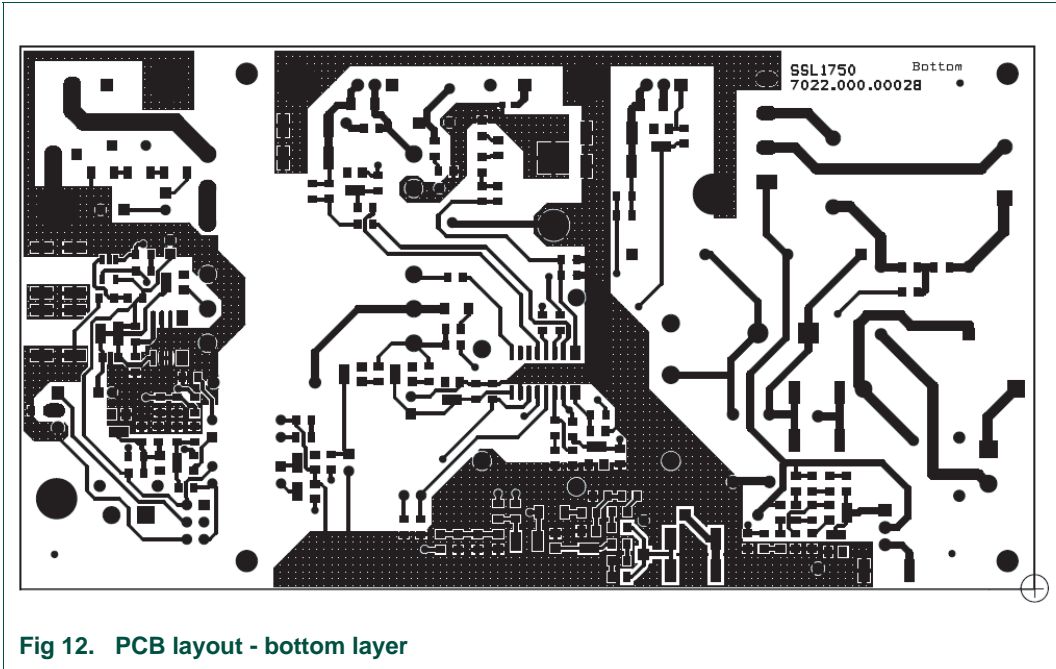


Fig 12. PCB layout - bottom layer

8. Transformer specification

8.1 PFC

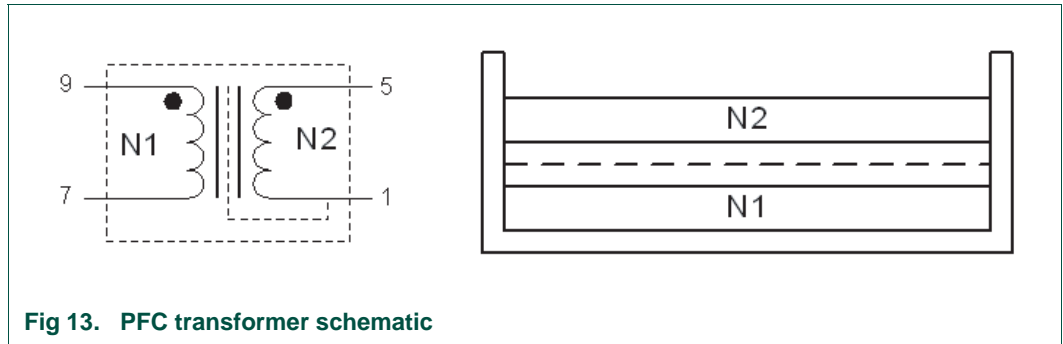


Fig 13. PFC transformer schematic

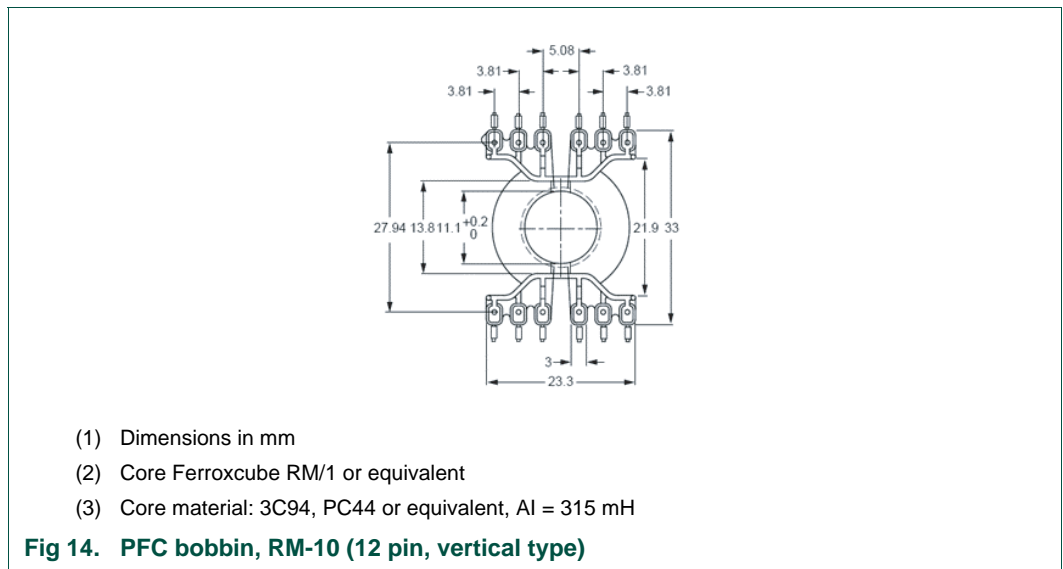


Fig 14. PFC bobbin, RM-10 (12 pin, vertical type)

Table 4. PFC transformer winding specifications 120 V version

No.	Pin ^[1]		Wire	Turns	Winding method	Ignition Turns	Width
	Start	Finish					
N1	9	7	0.1Φ*30	23	center		
I1						1	10 mm
N2	5	1	0.22Φ*2	2	center		
I2						1	10 mm
S1		1	0.05t*10 mm	1	center		
I3						1	10 mm

[1] Pins 2, 3, 4, 6, 8, 10 & 11 cut off

Table 5. PFC transformer electrical characteristics 120 V version

	Pin	Specification	Remark
Inductance	9-7	180 μ H \pm 10 %	60 kHz, 1 V
Leakage inductance	9-7	N/A	-

8.2 Flyback

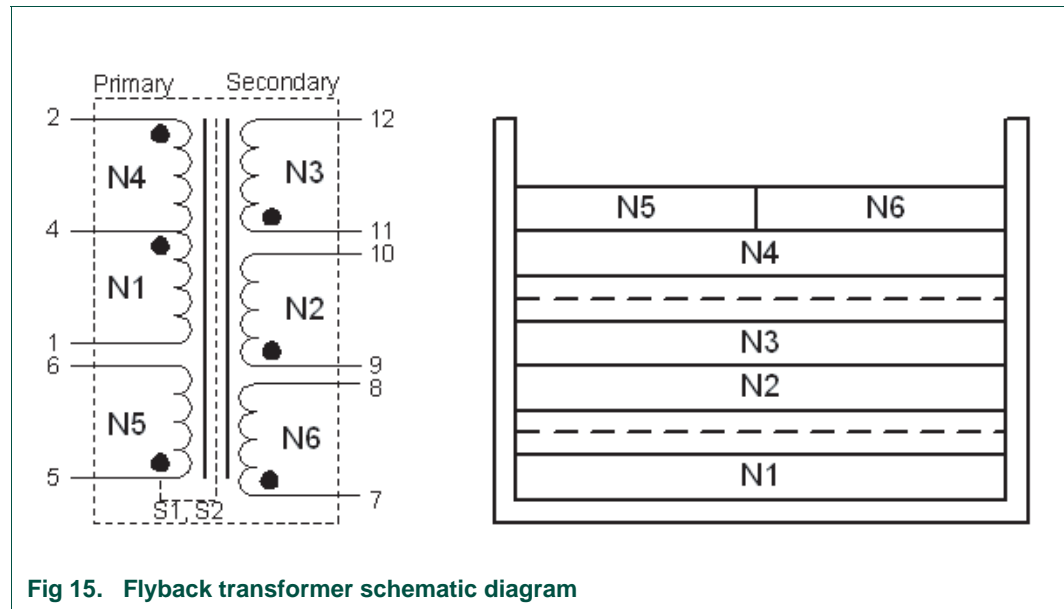


Fig 15. Flyback transformer schematic diagram

Table 6. Flyback winding specification

No.	Pin ^[1]		Wire ^[2]	Turns	Winding method	Insulation	
	Start	Finish				Ignition turns	Width
N1	4	1	-	20	center	-	-
I1	-	-	-	-	-	1	10 mm
S1	-	5	0.025t*10mm	1	center	-	-
I2	-	-	-	-	-	1	10 mm
N2	9	10	[3]	14	center	-	-
N3	11	12	[3]	14	center	-	-
I3	-	-	-	-	-	1	10 mm
S2	-	5	0.025t*10mm	1	center	-	-
I4	-	-	-	-	-	1	10 mm
N4	2	4	-	20	center	-	-
I5	-	-	-	-	-	1	10 mm
N5	5	6	0.25 Φ *2	8	center	-	-
N6	7	8	0.25 Φ *2	8	center	-	-
I6	-	-	-	-	-	2	10 mm

[1] Pin 3 cut off

[2] N2, N3 and N6, and N6, use triple insulated wire

[3] wire diameters, Use maximum diameter or parallel wires for maximal fill

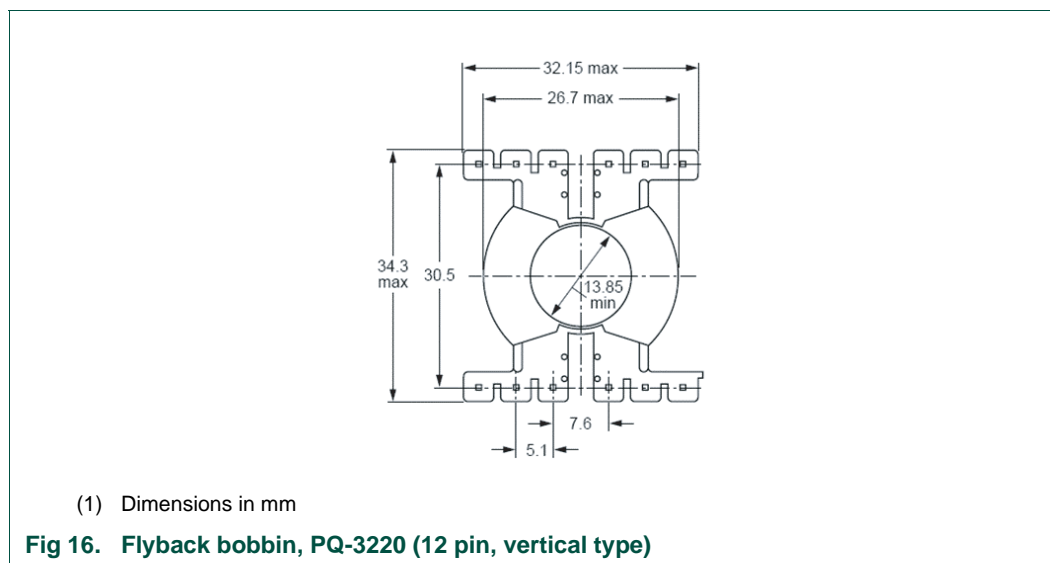
Table 7. Electrical characteristics

	Pin	Specification	Remark
Inductance	1-2	650 μ H \pm 10 %	60 kHz, 1 V
Leakage inductance	1-2	< 5 μ H	2 nd all short

Flyback core and bobbin

Core: PQ-3220

Core material: 3C94, PC44 or equivalent (Al = 400 nH)



9. Bill Of Materials (BOM)

Table 8. Bill of material SSL1750 75 W mains dimmable board 120 V version

Reference	Manuf.	Value	Description	Pkg. type
A3	-	LMV710	operational amplifier; single; 2.7 V to 5.5 V SS, RR-i/o, 3mVos [A48A]	SOT23-5
A4	-	TL431ACD	voltage reference programmable shunt 2.5 V to 36 V SO8	SO8
A5	NXP	SSL1750T	SMPS control IC for LED drivers	SO16
B1	-	green	LED 3 mm green diffused tinted 6 mcd at 10 mA	LED3_V
B2, B3	-	HCPL817	single opto-coupler; 5000 V; CTR = 50..600 %	DIP4W
C2, C5	-	47 nF; 305 V ac	capacitor; MKP Class X2; pitch = 10 mm 20 %	CFILM10MMx5
C3	-	3300 pF; 1 kV	capacitor ceramic high voltage; Class2	CDISC
C4	-	10 nF; 1 kV	capacitor ceramic high voltage	-
C6	-	68 μ F; 450 V	capacitor electrolytic; radial; 450 V 85 c 20 %	CPRAD
C7, C31	-	22 μ F; 100 V	capacitor electrolytic; radial; 8 mm x 11.5 mm x 3.5 mm; 105 °C, 0.68ESR 20 %	CPRAD
C9, C20, C23	-	10 nF	capacitor ceramic X7R, 50 V, 10 %	C0805
C10	-	100 pF; 630 V	capacitor ceramic C0G, 630 V, 5 %	C1206
C12, C16	-	220 pF; 630 V	capacitor ceramic C0G, 630 V, 5 %	C1206

Table 8. Bill of material SSL1750 75 W mains dimmable board 120 V version

Reference	Manuf.	Value	Description	Pkg. type
C13	-	220 nF; 16 V	capacitor ceramic X7R, 16 V: 10 %	C0805
C14, C30	-	47 μ F; 50 V	capacitor electrolytic; radial; 50 V; esr = 0.65 Ω 105 $^{\circ}$ C 20 % d = 6.3 h = 11 p2.5	CPRAD
C15	-	1 μ F; 50 V	capacitor ceramic X5R, 50 V, 20 %	C0805
C19, C34	-	330 nF; 16 V	capacitor ceramic X7R, 16 V, 10 %	C0805
C24	-	150 nF; 16 V	capacitor ceramic X7R, 16 V, 10 %	C0805
C25, C41	-	470 nF; 16 V	capacitor ceramic X7R 16 V 10 %	C0805
C27, C33, C38	-	100 nF	capacitor ceramic X7R, 50 V, 10 %	C0805
C29, C37	-	10 μ F; 63 V	capacitor electrolytic; radial, 63 V 20 %; 5 mm x 11 mm x 2mm	CPRAD
C32	-	22 nF	capacitor ceramic X7R, 50 V, 10 %	C0805
C35	-	470 nF; 305 V (AC)	capacitor, MKP, Class X2, pitch = 22 mm 5 20 %	CFILM2 2.5MMx8.5
C39	-	1000 pF; 440 V/Y1	capacitor ceramic high voltage Y1	CDISC
C40	-	3.3 μ F; 450 V	capacitor electrolytic; radial; 450 V 105 $^{\circ}$ C 20 %; d = 10 h = 16 p=5	CPRAD
F1	-	fuseholder 5 mm x 20 mm	fuse holder for 5 mm x 20 mm fuse	FUSE_H_20x5
F2	-	1 A	fuse, time lag; 5 mm x 20 mm	5mm x 20 mm
L2	-	18 mH	inductor choke common; I _r =1 A; R = 640 m Ω	TH_CM_IND
L5	-	60 Ω at 100 MHz	inductor solid chip ferrite HF smd	L0603
L7	-	39 Ω at 100 MHz	inductor solid chip ferrite HF smd	L0805
L8	-	27 μ H	inductor choke; I _r = 1.6 A R = 58 m Ω	LRAD5 mm10
L9	-	2 x 1.5 mH	inductor choke CM; I _r = 2 A, R = 150 m Ω	L_CM-TH
L10	-	1.5 mH	inductor choke I _r = 850 mA R = 580 m Ω	LRAD7.5 mm 20
N1	-	pcb_SSL1750-R2A	PCB unassembled SSL1750 R2A	150x80x1.6
R1, R2, R47, R57	-	1 M Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R3, R51, R52, R80, R81	-	2.70 M Ω	resistor 1 % 0.125 W; 100 ppm RC12H	R0805
R4, R6	-	43 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R8	-	62 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R10, R33, R37, R54, R55, R58, R61, R94	-	10 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R11, R19	-	47 Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R14, R18, R22	-	10 Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R15	-	12 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R17, R50	-	33 Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R20, R21, R76, R87, R88, R95	-	1 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R23	-	82 k Ω	resistor 1 % 0.125 W; 100 ppm RC12H	R0805
R24	-	5.1 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805

Table 8. Bill of material SSL1750 75 W mains dimmable board 120 V version

Reference	Manuf.	Value	Description	Pkg. type
R26	-	39 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R27	-	DNP	-	-
R28, R43	-	33 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R29	-	DNP	-	-
R30	-	120 Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R31	-	DNP	-	-
R39, R59 R60, R93 R98, R99 R100 R101 R102 R103 R107	-	330 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R40, R48, R56	-	4.7 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R42	-	8.2 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R45	-	470 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R46	-	750 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R62, R82	-	2.2 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R63	-	0.10 Ω ; 1 %	resistor 1 %; 2 W; 100 ppm/C	R2512
R65	-	220 Ω ; 1.5 W	resistor pulse withstanding 5 %; 1.5 W; 500 V	R2512
R66, R70 R72, R73	-	1 Ω ; 1 W	resistor thick film 1 %; 1 W; 200 V	R2512
R67	-	DNP	-	-
R68	-	0.2 Ω ; 1 W	resistor metal Strip 1 %; 1 W	R2512
R71, R75, R77	-	0 Ω	resistor R0805 0 Ω jumper	R0805
R74	-	DNP	-	-
R78, R79, R90, R97	-	1 k Ω ; 1 W	resistor thick film 1 %; 1 W	R2512
R83, R84, R85	-	3.3 k Ω	resistor 1 %; 0.250 W; 100 ppm RC02H	R1206
R86	-	15 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R89	-	100 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R91, R104, R106	-	270 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R92	-	2.0 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
R96	-	4.3 k Ω	resistor 1 %; 0.125 W; 100 ppm RC12H	R0805
T1	-	180 μ H	coil PFC RM 10 custom-made	RM10
T2	-	ISE900019410	transformer PQ-32/20 custom-made	PQ-3220
V2	-	GBU8K	bridge; 800 V; 8 A TH	SIL_BRIDGE
V3, V5	NXP	BYV29-500	ultra fast diode; 500 V; 9 A	TO220AC
V4, V33, V35, V37	-	BYW56	avalanch diode, ; 1000 V; 2 A	SOD57
V8, V10, V14, V19, V22	NXP	BAS29	diode; 50 ns; 90 V; 250 mA	SOT23
V9, V13	-	FCP11N60	FET MOS N-ch; 650 V; 11 A; 0,32 Ω	TO220
V15	NXP	24 V	Zener diode; 250 mW; 5 % [Y9t/Y9p/Y9W]	SOT23

Table 8. Bill of material SSL1750 75 W mains dimmable board 120 V version

Reference	Manuf.	Value	Description	Pkg. type
V17, V20, V29, V39, V40	NXP	BC846B	NPN transistor; 65 V; 250 mW; smd [1Bp/1Bt]	SOT23
V18	NXP	15 V	Zener diode; 250 mW; 5 % [Y4t/Y4p/Y4W]	SOT23
V24	NXP	BAS70	Schottky diode; 70 mA; 70 V; $V_f < 410$ mV at 1 mA	SOT23
V27	NXP	3.3 V	Zener diode; 250 mW; 5 % [z14/pB1/tB1/WB1]	SOT23
V28	-	STP5NK50Z	FET N-ch; 500 V; 4.4 A 1.22E, Zener protected	TO220
V30	NXP	20 V	Zener diode; 250 mW; 5 % [Y7%]	SOT23
V31	-	SIOV-S07K275	disk varistor; 275 V; d = 9, p = 5 mm	Rdisc9mm
V32	-	DNP	-	-

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