

UM10486

UBA2015P reference design 120 V (AC)

Rev. 1.1 — 8 September 2011

User manual

Document information

Info	Content
Keywords	UBA2015P, 2x TL5HE35W ballast
Abstract	This document describes the UBA2015P reference design for 120 V (AC).



Revision history

Rev	Date	Description
v.1.1	20110908	updated issue
v.1	20110624	first issue

Modifications:

- [Figure 11 “Schematic diagram”](#) has been updated.
- Bill of Materials ([Table 4](#)) has been updated.

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1. Introduction

WARNING

Lethal voltage and fire ignition hazard

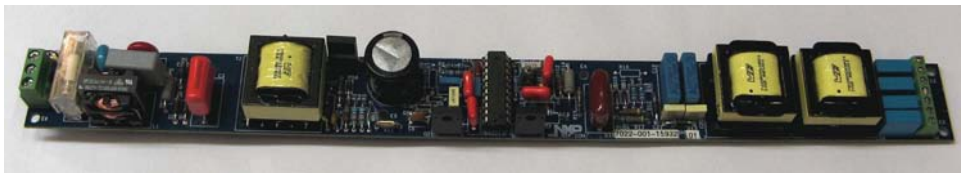


The non-insulated high voltages that are present when operating this product, constitute a risk of electric shock, personal injury, death and/or ignition of fire.

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 document describes the specification and use of the UBA2015P board. This reference ballast design is intended to drive two TL5HE35W lamps.

The Printed-Circuit Board Assembly (PCBA) has the 12NC 7022 001 15932.



019aac653

Fig 1. UBA2015P reference board

Do not power the board without IC. The VDD decoupling capacitor voltage exceeds the rated value when the IC does not limit the voltage to 13 V.

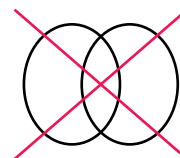
2. Safety warning

Connect the board to the mains voltage. Avoid touching the board at all times when it is connected to the mains voltage. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation of the mains phase using a variable transformer is always recommended.



019aab173

a. Isolated



019aab174

b. Non-isolated

Fig 2. Variac isolation symbols

3. Specifications

Table 1. Electrical board specification

Description	Product(s)
Ballast type	electronic
Starting method	programmed start with preheat
Starting time	< 1 s
Lamp terminals	7
Lamp connection	parallel
Line voltage	108 V (AC) to 132 V (AC)
Line frequency	50 Hz/60 Hz
Number of lamps	2
Dimming interface	none
Transient protection compatibility	IEC61547

Table 2. Supported lamps

Lamp type	Description
TL5HE35W	35 W TL5 high-efficiency fluorescent lamp
TL5HE28W	28 W TL5 high-efficiency fluorescent lamp

Table 3. Ballast performance

Lamp type	Number of lamps	Rated lamp power (W)	Maximum THD (%)	Maximum lamp current crest factor	Power factor	Nominal lamp current (A)
TL5HE35W	2	35	10	1.7	0.98	0.170
TL5HE28W	2	28	10	1.7	0.97	0.170

4. Board information

4.1 Block diagram

The input section includes:

- The fuse
- Surge protection against fast AC transients
- ElectroMagnetic Interference (EMI) filter
- Full-wave rectifier
- Pre-conditioner or Power Factor Correction (PFC)

The output of the PFC connects to an electrolytic buffer capacitor to supply the half-bridge circuit. The lamp connects to the half-bridge circuit. The UBA2015P controller IC controls the PFC and the half-bridge circuit.

The PFC is implemented as an up converter in boundary conduction mode. The resonant circuit is voltage fed by the half-bridge which consists of two N-channel MOSFETs. The resonant circuit includes a transformer for electrode preheating and heating.

This type of topology with inductive heating is used in many commercial ballasts whose power exceeds 25 W, making it a cost-effective application.

The lamps are connected in parallel.

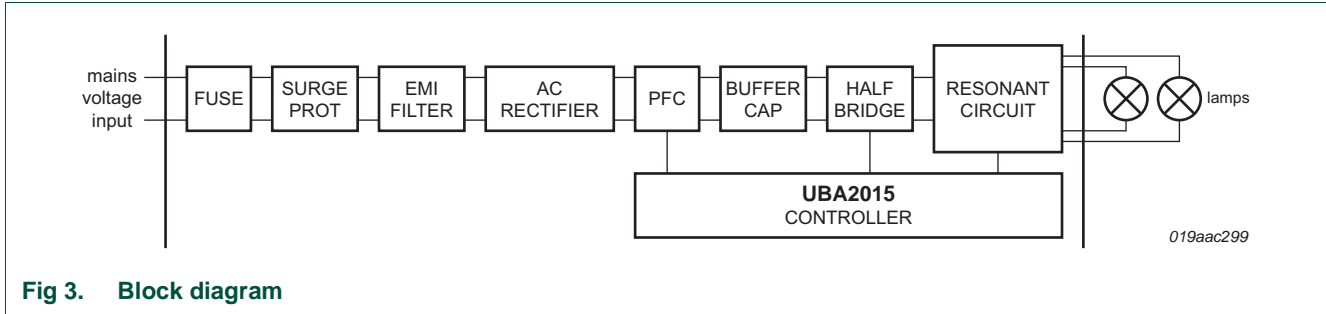


Fig 3. Block diagram

4.2 Performance indicators

4.2.1 Input power, power factor and Total Harmonic Distortion (THD)

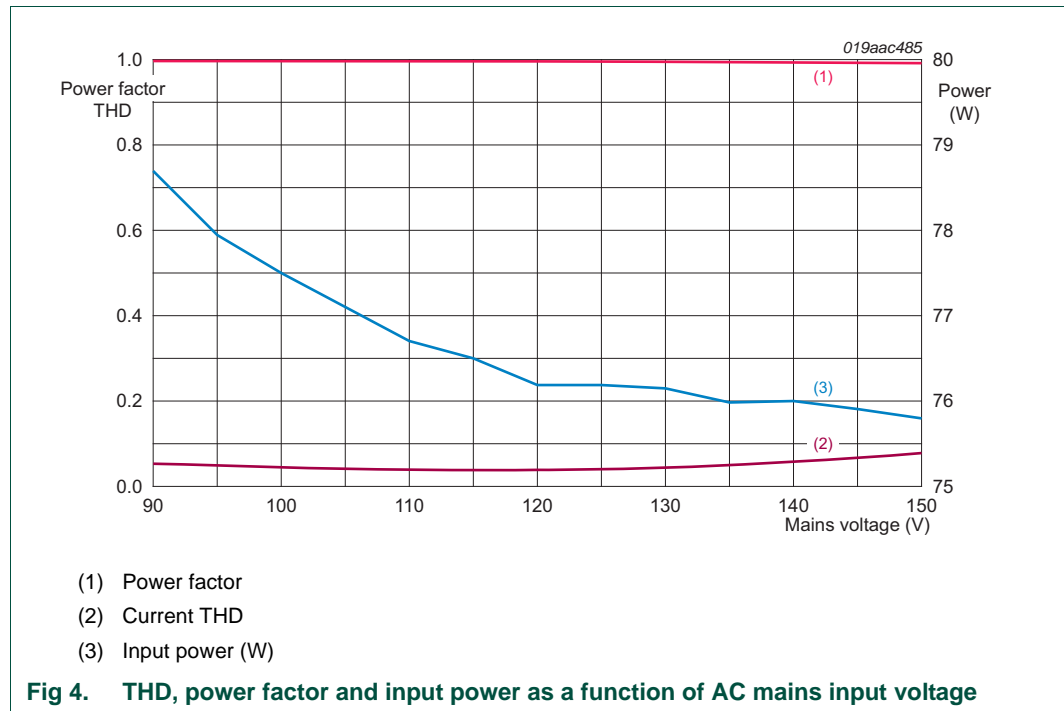
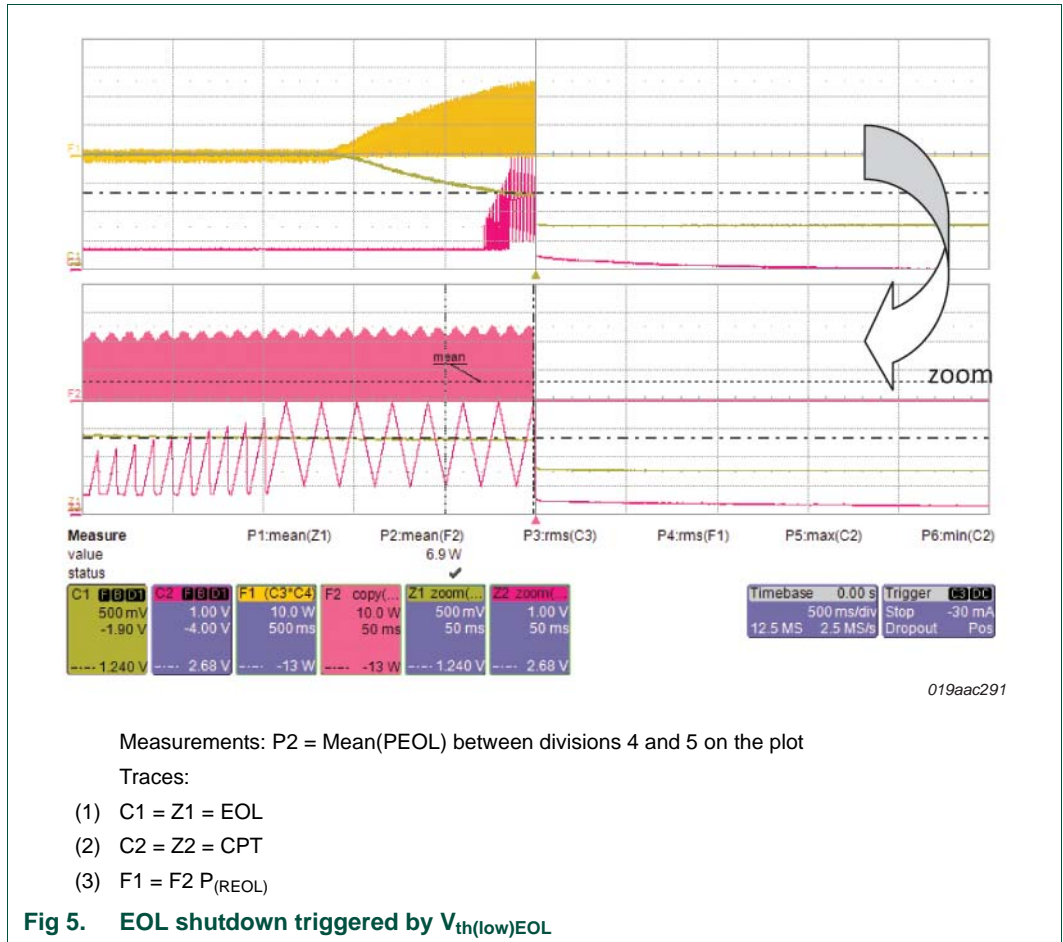
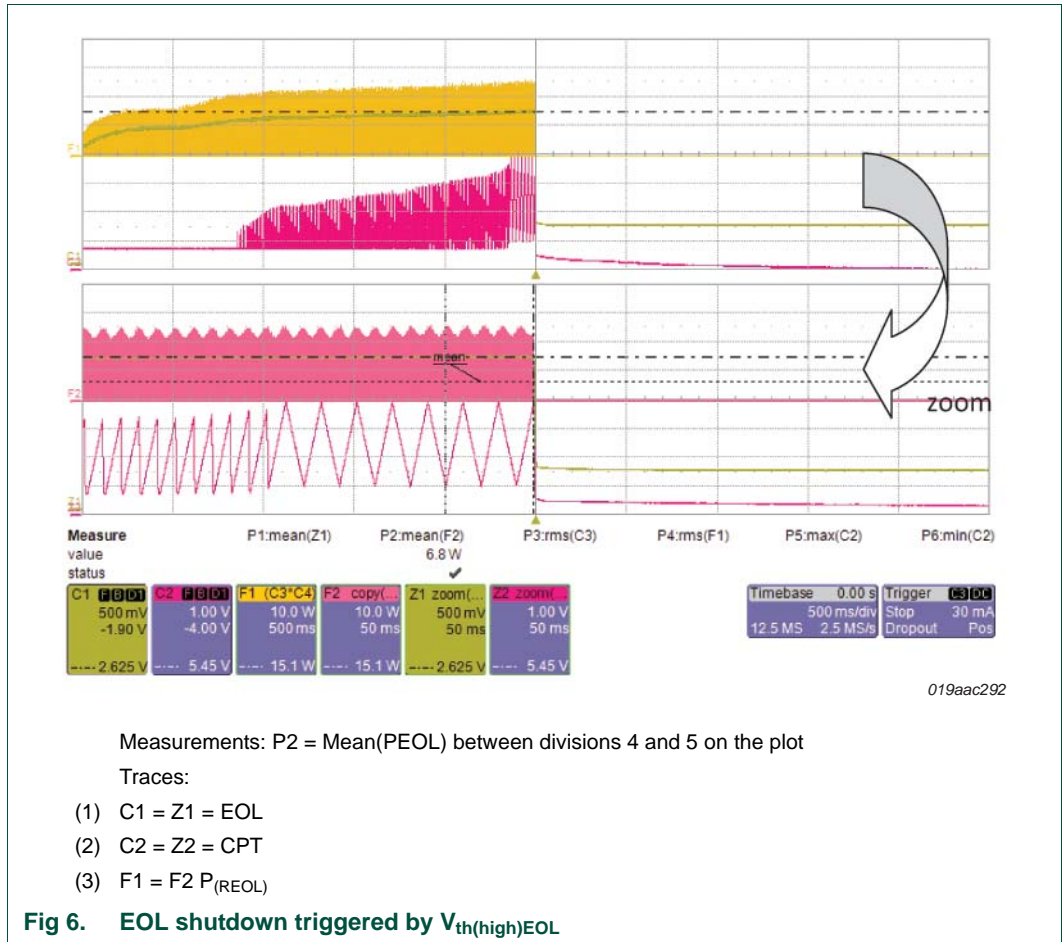


Fig 4. THD, power factor and input power as a function of AC mains input voltage

4.2.2 Lamp end of life detection

IEC asymmetrical power test: The End-Of-Life (EOL) resistor R_{EOL} is increased (manually controlled rheostat of 1 k Ω) until the ballast shuts down. A rheostat is a two-terminal variable resistor. See IEC-61347-2-3 Section 17.3 where this test is described. When the EOL voltage exceeds the thresholds of the internal window comparator, the slow fault timer (CPT pin) starts.





4.2.3 Lamp removal detection

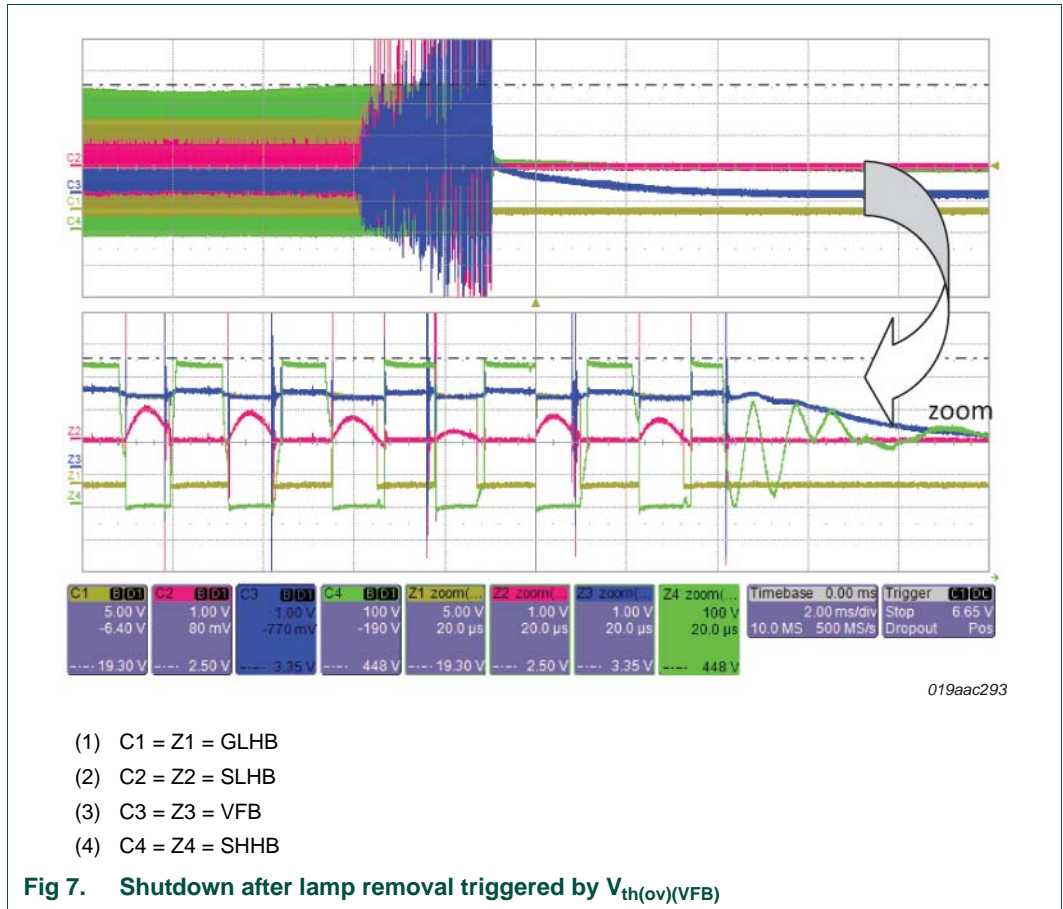
The UBA2015/UBA2016 family has several fast protection features for lamp removal detection:

- Capacitive Mode Protection (CMP)
- Saturation protection
- OverVoltage Protection (OVP)

In this application, overvoltage protection is triggered during lamp removal. Other applications with a different operating frequency with respect to the resonance frequency can be triggered differently. The main function of the IC is to shut down as fast as possible when a lamp is removed.

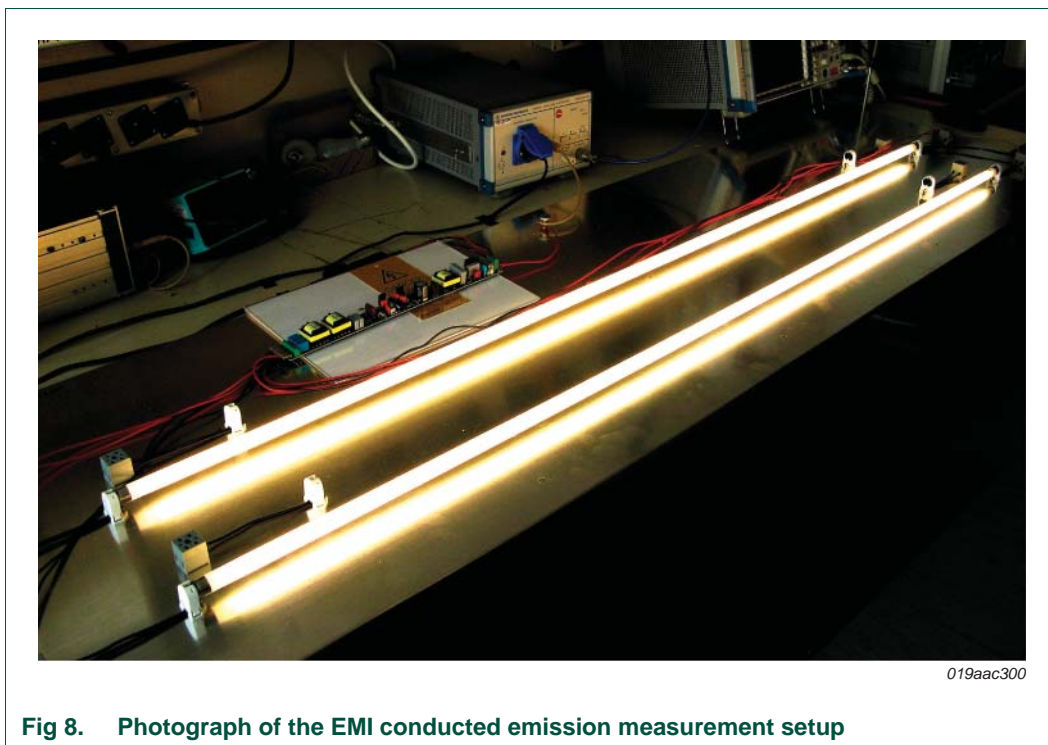
The fast protection on the VFB pin is repeatedly triggered ($V_{VFB} > 3.35$ V (typical)) during the lamp removal process. As a result the fast fault detection timer $t_{det(fault)}$ ends.

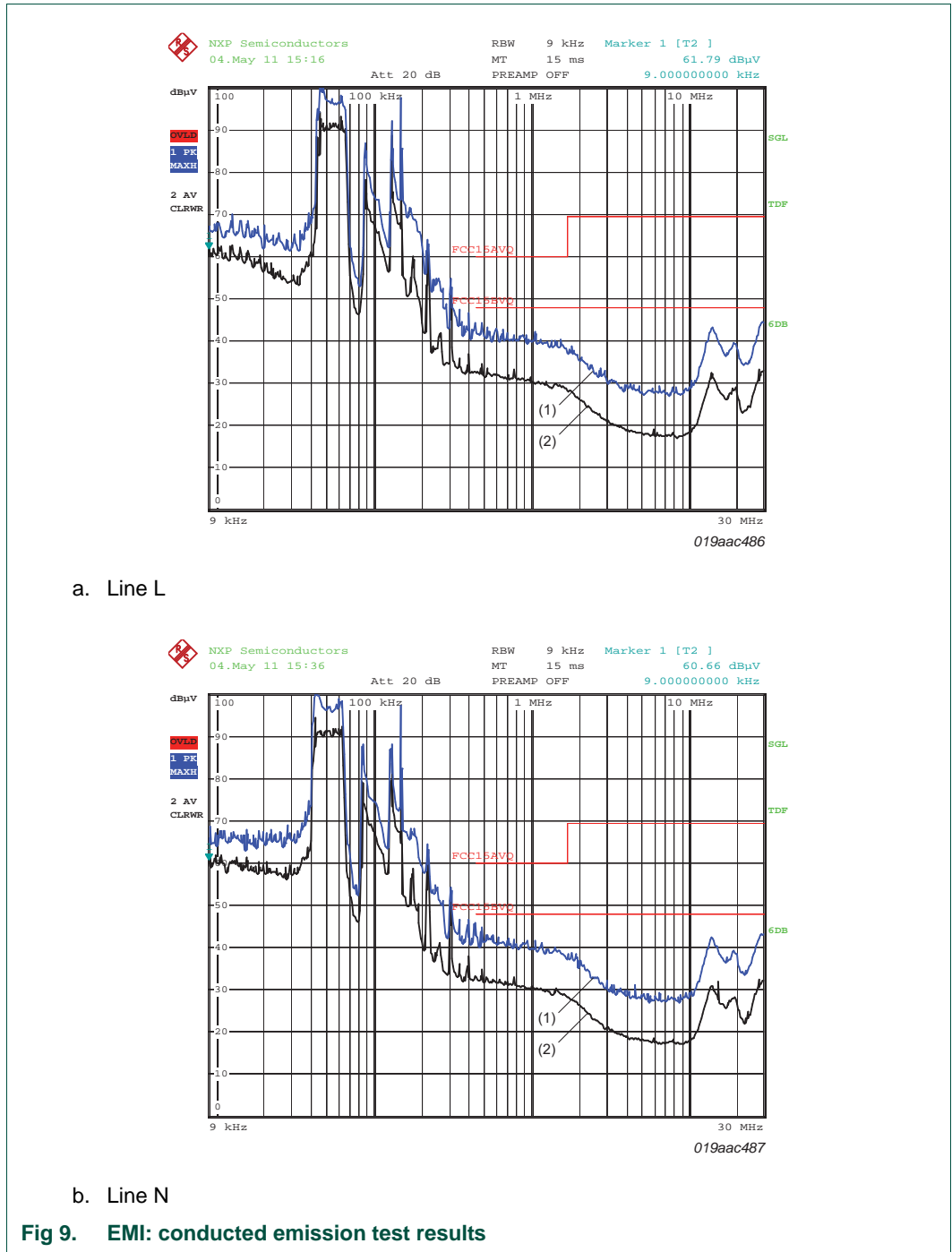
In this application, the shutdown is not triggered by pin SLHB because of the 340 ns leading edge blanking time on this pin.



4.2.4 ElectroMagnetic Interference (EMI) - conducted emission tests

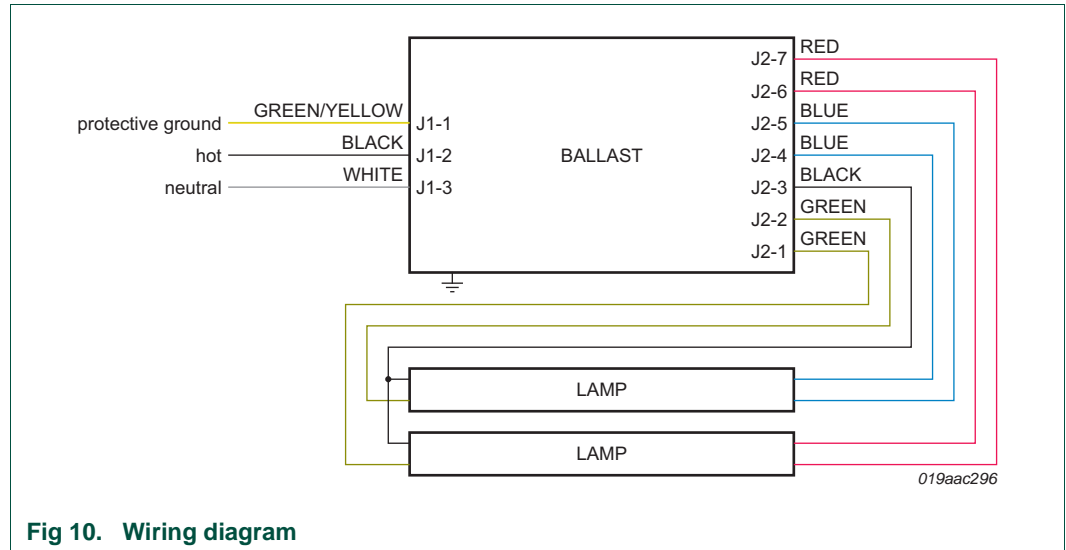
The board with lamp complies with FCC-15 quasi-peak and average measurements, no metal shielding required for acceptable EMI performance. The ballast was tested on a reference luminaire with two TL5HE35W lamps.





5. Wiring diagram

Connect the ballast as shown in [Figure 10](#).



Connect the chassis to ground using mounting hole E1.

Keep the hot wires to the lamps as short as possible (red and blue wires), so parasitic capacitance remains as low as possible.

6. Schematic

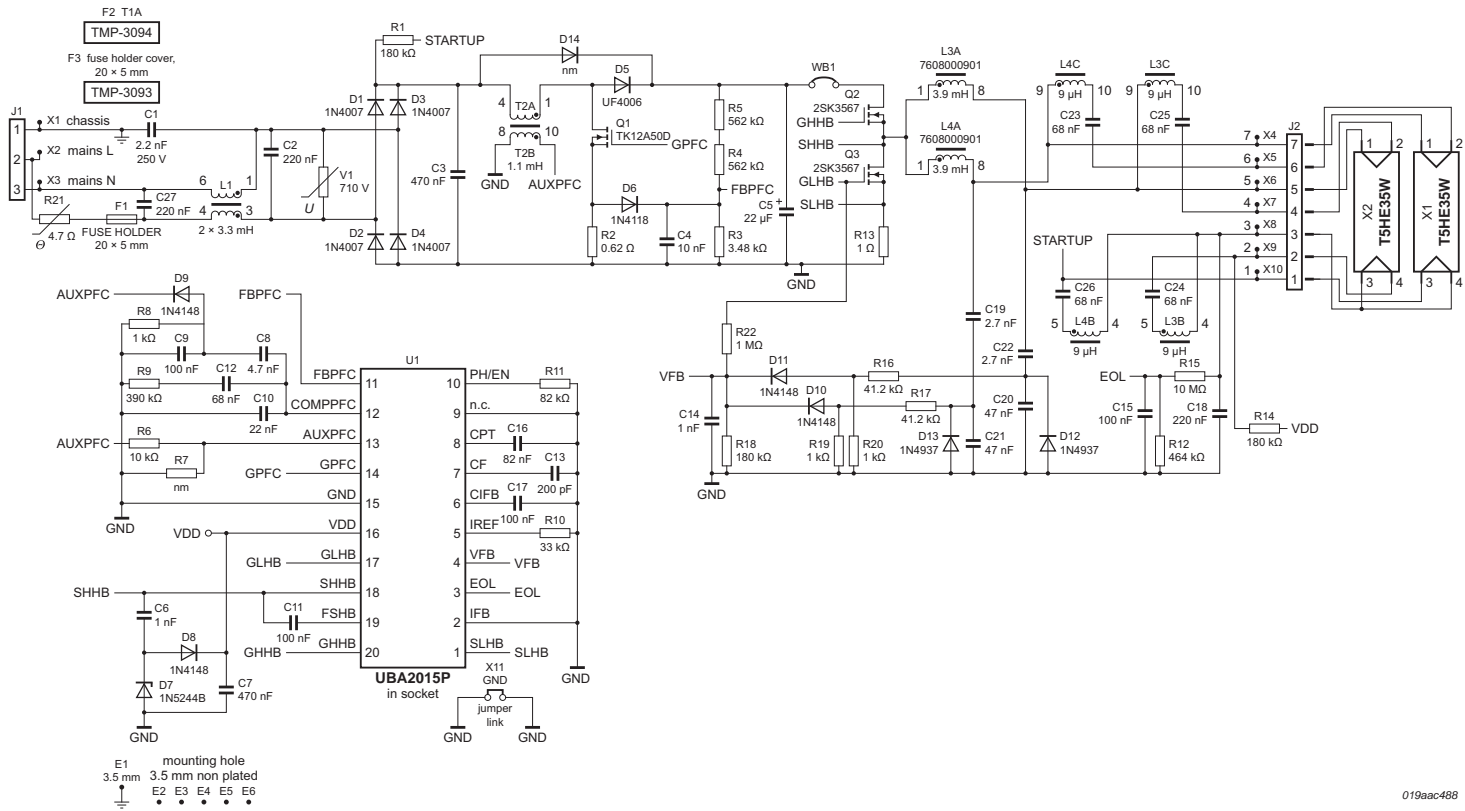


Fig 11. Schematic diagram

7. PCB layout

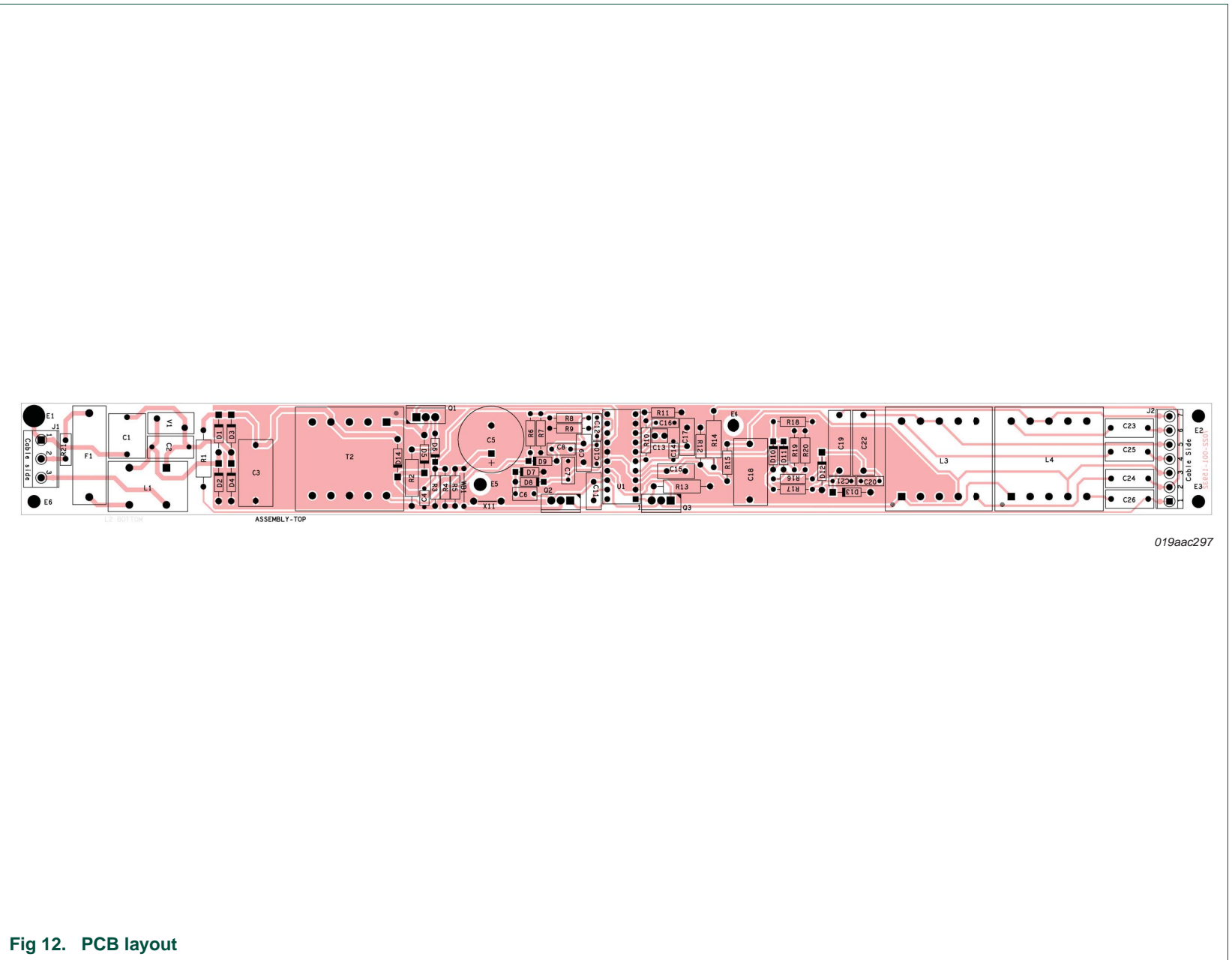


Fig 12. PCB layout

8. Bill of materials

Table 4. Bill of materials

Item number	Part reference	Description/value	Manufacturer	Part number
1	C1	2.2 nF; 20 %; 250 V	Murata	DE1E3KX222MA5B
2	C2	220 nF; 20 %; 310 V	Vishay	BFC233922224
3	C3	470 nF; 20 %; 400 V	Vishay	MKP1840447404M
4	C4	10 nF; -20 %, +80 %; 50 V	Vishay	K103Z15Y5VF5TH5
5	C5	22 μ F; 20 %; 450 V	Panasonic	EEU-EB2W220S
6	C6	1 nF; 10 %; 500 V	Vishay	H102K25X7RL63J5R
7	C7	470 nF; 5 %; 63 V	Kemet	R82DC3470DQ60J
8	C8	4.7 nF; 10 %; 100 V	Kemet	SR211C472KAR
9	C9	100 nF; 10 %; 100 V	Vishay	BFC236525104
10	C10	22 nF; 10 %; 100 V	BC components	2222 370 21223
11	C11	100 nF; 10 %; 100 V	Vishay	BFC236525104
12	C12	68 nF; 5 %; 63 V	Kemet	MMK5683K63J01L16.5TA182
13	C13	200 pF; 5 %; 100 V	Multicomp	MC0805N201J101A2.54MM
14	C14	1 nF; 10 %; 50 V	Vishay	K102K15X7RF5TH5
15	C15	100 nF; 10 %; 100 V	Vishay	BFC236525104
16	C16	82 nF; 5 %; 63 V	Kemet	MMK5823M63J01L4BULK
17	C17	100 nF; 10 %; 100 V	Vishay	BFC236525104
18	C18	220 nF; 10 %; 400 V	Xicon	146-MEF2G224K
19	C19	2.7 nF; 5 %; 2000 V	Vishay	BFC238361272
20	C20	47 nF; 5 %; 100 V	Kemet	R82EC2470AA60J
21	C21	47 nF; 5 %; 100 V	Kemet	R82EC2470AA60J
22	C22	2.7 nF; 5 %; 2000 V	Vishay	BFC238361272
23	C23	68 nF; 10 %; 400 V	Epcos	B32521C6683K
24	C24	68 nF; 10 %; 400 V	Epcos	B32521C6683K
25	C25	68 nF; 10 %; 400 V	Epcos	B32521C6683K
26	C26	68 nF; 10 %; 400 V	Epcos	B32521C6683K
27	C27	220 nF; 20 %; 310 V	Vishay	MKP1840447404M
28	D1	1N4007-E3/51	Vishay	1N4007-E3/51
29	D2	1N4007-E3/51	Vishay	1N4007-E3/51
30	D3	1N4007-E3/51	Vishay	1N4007-E3/51
31	D4	1N4007-E3/51	Vishay	1N4007-E3/51
32	D5	UF4006-E3/73	Vishay	UF4006-E3/73
33	D6	1N4148	NXP Semiconductors	1N4148,133
34	D7	1N5244B	Fairchild Semiconductor	1N5244B
35	D8	1N4148	NXP Semiconductors	1N4148,133
36	D9	1N4148	NXP Semiconductors	1N4148,133
37	D10	1N4148	NXP Semiconductors	1N4148,133
38	D11	1N4148	NXP Semiconductors	1N4148,133

Table 4. Bill of materials ...continued

Item number	Part reference	Description/value	Manufacturer	Part number
39	D12	1N4937/54; 600 V; 1 A	Vishay	1N4937-E3/54
40	D13	1N4937/54; 600 V; 1 A	Vishay	1N4937-E3/54
41	D14	1N4007-E3/51	Vishay	1N4007-E3/51
42	F1	fuse holder; 20 × 5 mm	Multicomp	MCHTC-15M
43	F2	fuse T1A	Schurter	34.3117
44	F3	fuse holder cover; 20 × 5 mm	Multicomp	MCHTC-150M
45	J1	PCB mounted screw terminal MKDSN2,5/3-5.08	Phoenix Contact	1888690
46	J2	PCB mounted screw terminal MKDS 1/7-3,81	Phoenix Contact	1727065
47	L1	B82731T2182A020; 2 × 3.3 mH	Epcos	B82731T2182A020
48	L3	Transformer; 3.9 mH; 9 μH; 9 μH	Würth Elektronik	7608000901
49	L4	Transformer; 3.9 mH; 9 μH; 9 μH	Würth Elektronik	7608000901
50	Q1	TK12A50D	Toshiba	TK12A50D
51	Q2	2SK3567	Toshiba	2SK3567
52	Q3	2SK3567	Toshiba	2SK3567
53	R1	180 kΩ; 5 %; 2 W	Welwyn	MFP2-180KJI
54	R2	0.62 Ω; 5 %; 1 W; 500 V	KOA Speer	MOSX1CT52RR62J
55	R3	3.48 kΩ; 1 %; 0.6 W	Vishay	MRS25000C3481FCT00
56	R4	562 kΩ; 1 %; 0.6 W	Vishay	MRS25000C5623FCT00
57	R5	562 kΩ; 1 %; 0.6 W	Vishay	MRS25000C5623FCT00
58	R6	10 kΩ; 1 %; 0.25 W	Xicon	271-10K-RC
59	R7	1 kΩ; 1 %; 0.25 W	Xicon	271-1K-RC
60	R8	1 kΩ; 1 %; 0.25 W	Xicon	271-1K-RC
61	R9	390 kΩ; 1 %; 0.25 W	Xicon	271-390K-RC
62	R10	33 kΩ; 1 %; 0.25 W	Xicon	271-33K-RC
63	R11	82 kΩ; 1 %; 0.6 W	Vishay	MRS25000C8202FCT00
64	R12	464 kΩ; 1 %; 0.6 W	Vishay	MRS25000C4643FCT00
65	R13	1 Ω; 5 %; 1 W; 400 V	KOA Speer	MOSX1/2CT52R1R0J
66	R14	180 kΩ; 5 %; 2 W	Welwyn	MFP2-180KJI
67	R15	10 MΩ; 1 %; 0.6 W	Vishay	MRS25000C1005FRP00
68	R16	41.2 kΩ; 1 %; 0.25 W	Xicon	271-41.2K-RC
69	R17	41.2 kΩ; 1 %; 0.25 W	Xicon1	271-41.2K-RC
70	R18	180 kΩ; 1 %; 0.25 W	Xicon	271-180K-RC
71	R19	1 kΩ; 1 %; 0.25 W	Xicon	271-1K-RC
72	R20	1 kΩ; 1 %; 0.25 W	Xicon	271-1K-RC
73	R21	4.7 Ω; 20 %; 1.4 W	Epcos	B57153S479M
74	R22	1 MΩ; 1 %; 0.6 W	Vishay	MRS25000C1004FCT00

Table 4. Bill of materials ...continued

Item number	Part reference	Description/value	Manufacturer	Part number
75	T2	Transformer; $L_p = 1.1$ mH; 2.7 A; $N_p/N_s = 57$	Würth Elektronik	750312407
76	U1	UBA2015P	NXP Semiconductors	UBA2015P
77	V1	275 V (AC); 85 °C; 3.5 kA; 710 V _{clamp}	Littelfuse	V10E275P
78	WB1	wire-bridge-4E	3M	923345-04
79	X11	jumper link	Fischer Elektro	LB 03 G

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