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Team Nexperia

UM10395

UBA2014 evaluation board

Rev. 2 — 16 September 2010

User manual

Document information

Info	Content
Keywords	UBA2014, evaluation board, TL, CFL
Abstract	This user manual describes the UBA2014 evaluation board, which is designed to be a flexible tool for demonstrating the many UBA2014 fluorescent tube driver applications.



Revision history

Rev	Date	Description
v.2	20100916	<ul style="list-style-type: none">• Illustrations amended to new standard• Section 11 "Legal information" amended to include new items
01	20091014	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 document describes the UBA2014 evaluation board. The board is designed to be a flexible tool that demonstrates the many different applications that are possible with the UBA2014 fluorescent tube driver. Please note that this board is not a complete ballast design for fluorescent tubes. The default setup is made such that a T5 HE 35W fluorescent lamp can be demonstrated.

2. Safety warnings

The board is intended as an evaluation board to build different TL and or CFL applications. To optimize flexibility, almost no protection is built in (except for IC internal protection). The board does not conform with any safety norm.

WARNINGS:

- Do not supply voltages to the board without a daughter board correctly inserted. Failing to do so may damage the board.
- Always operate with burner (lamp) connected to the board and connected to the resonant circuit. Failing to do so may damage the board.
- Many parts contain dangerous high voltages. It is necessary to take relevant safety precautions before using this board.
- Do not touch any part of the board during or shortly after operation of the board.

3. Board description

The board consists of two separate Printed-Circuit Boards (PCBs). The main board with the resonant circuit and a small daughter board with the UBA2014 IC.

3.1 Daughter board

The daughter board contains the UBA2014 IC with the preheat, sweep and oscillator capacitor, the V_{DD} generation and some other low voltage components.

The daughter PCB can be easily replaced in case of damage. Care should be taken that the board is inserted properly. Pin 11 has been removed from the daughter board to prevent the board being inserted incorrectly.

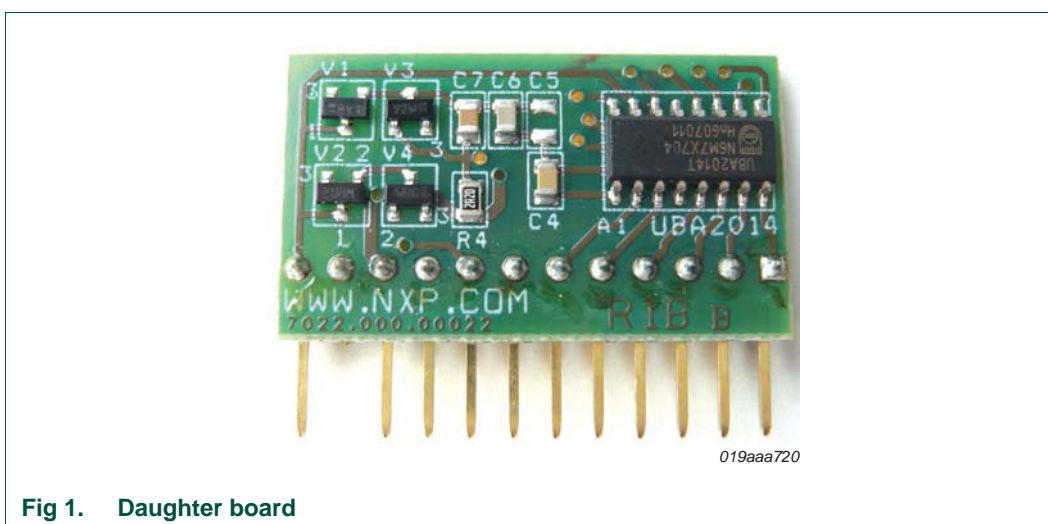


Fig 1. Daughter board

3.2 Main board

The main board has all the other necessary circuit to make a Tubular Lamp (TL) or Compact Fluorescent Lamp (CFL) application. The board consists of the following:

- DC and AC input connector
- Dimming input
- 2 sockets for FETs
- 2 different transformers
- Area for experiments
- Connections for up to 4 burners.

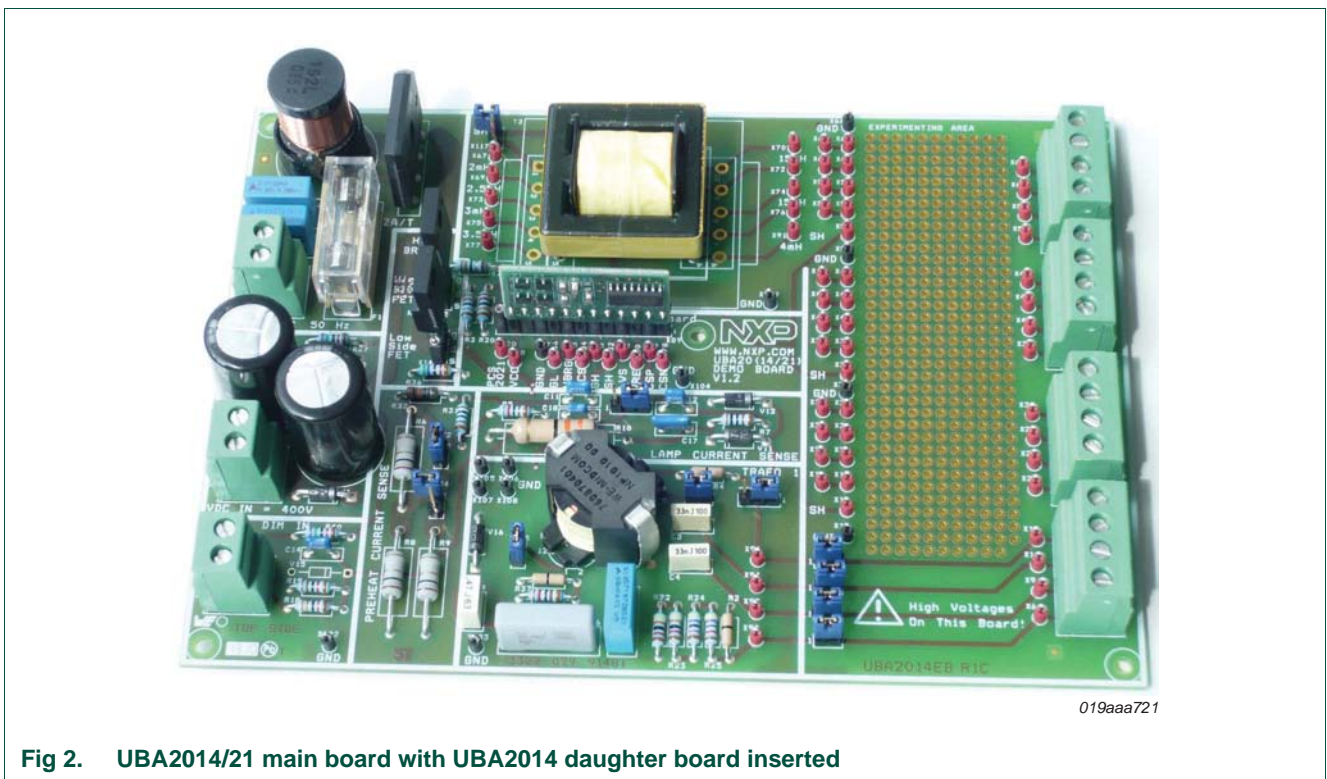


Fig 2. UBA2014/21 main board with UBA2014 daughter board inserted

4. Schematics

The schematics of the daughter board with the UBA2014 IC can be found in [Figure 3](#). The settings for the oscillator and sweep are R1 = 33 kΩ (to pin IREF), C3 = 100 pF (to pin CF) and C1 = 330 nF (to pin CT). This will provide a minimum oscillator frequency of 40.5 kHz and a preheat time of 1.8 s.

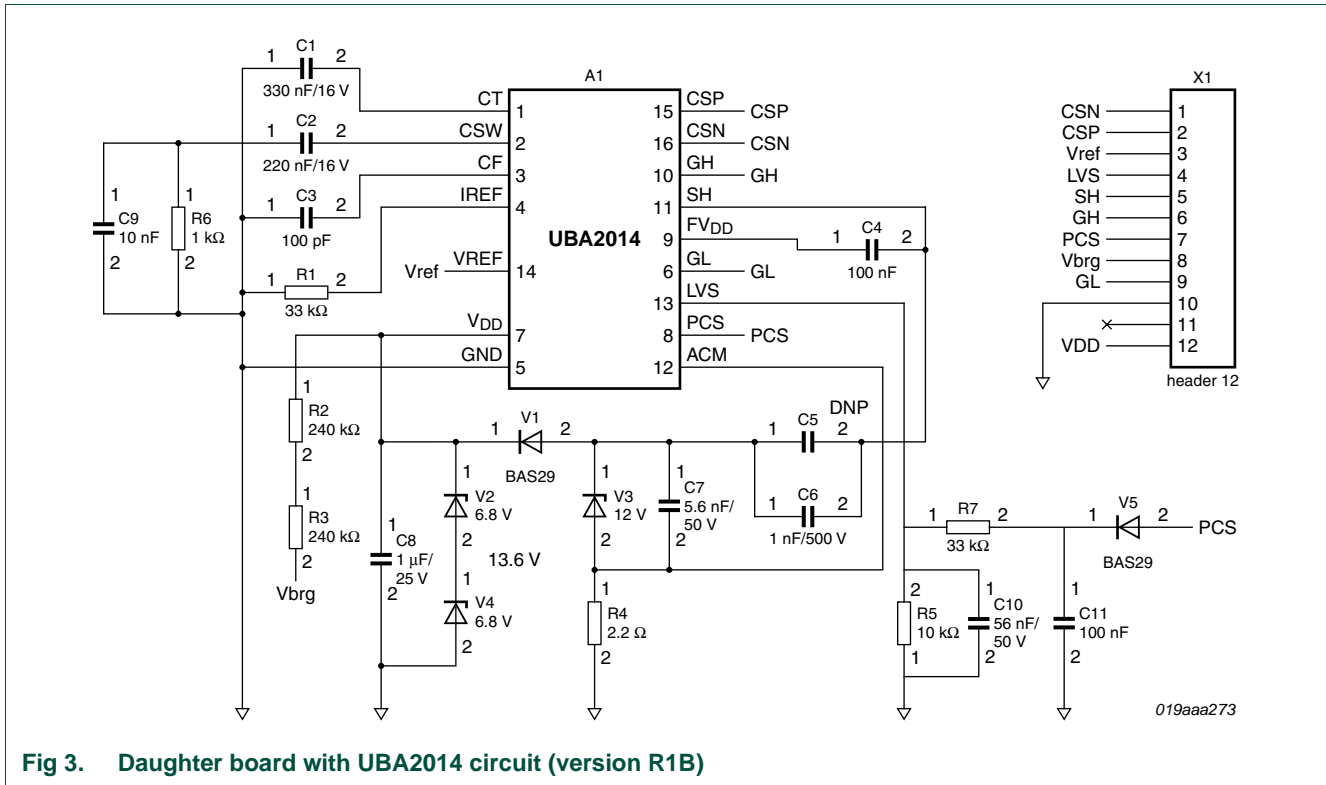


Fig 3. Daughter board with UBA2014 circuit (version R1B)

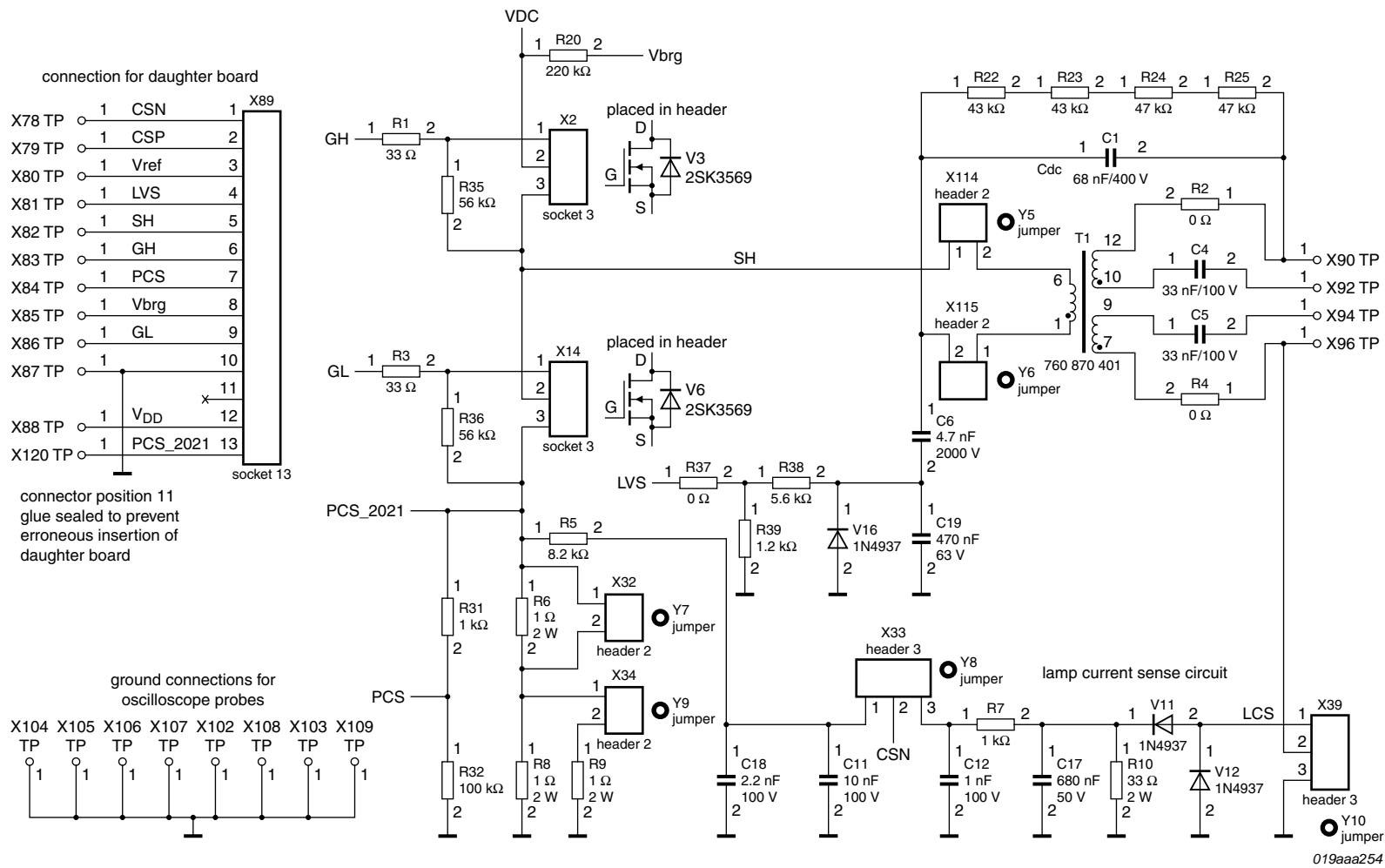


Fig 4. Main board half-bridge and resonant circuit - (version R1C)

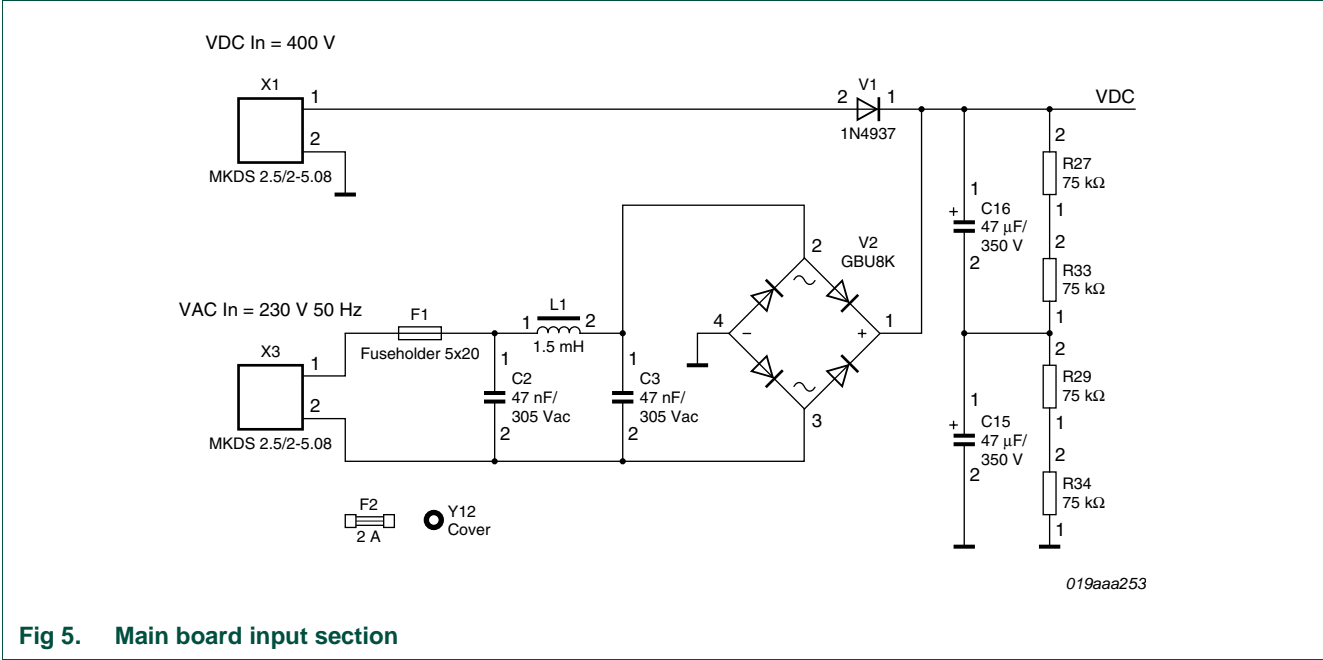


Fig 5. Main board input section

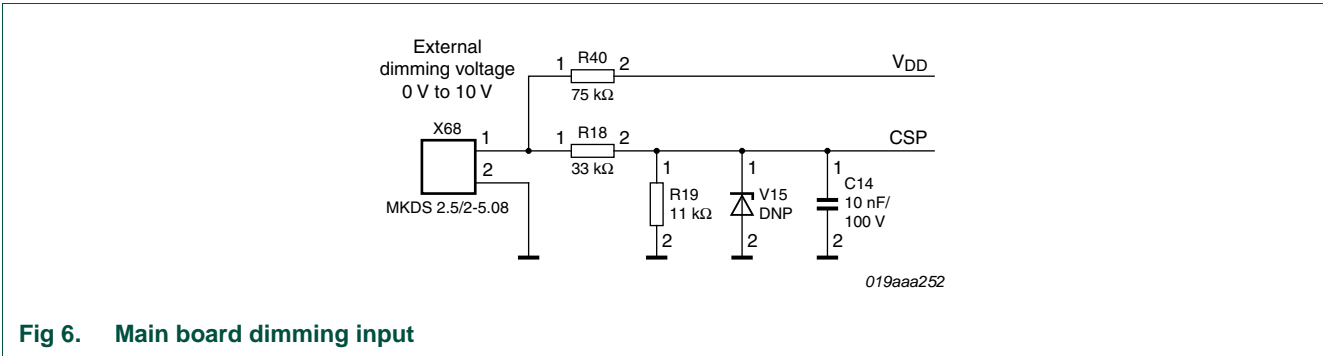


Fig 6. Main board dimming input

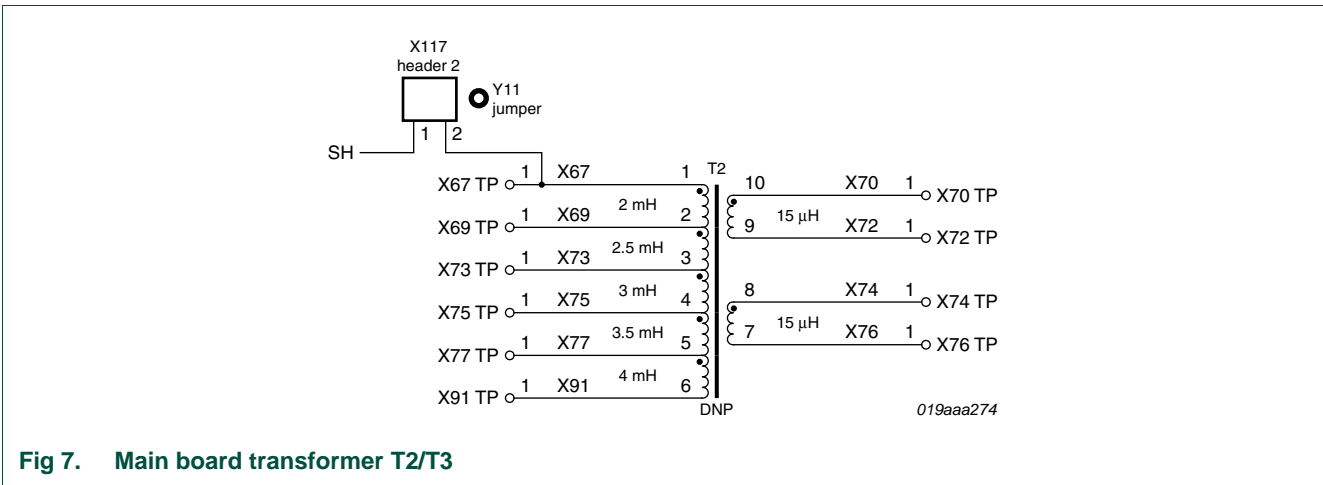


Fig 7. Main board transformer T2/T3

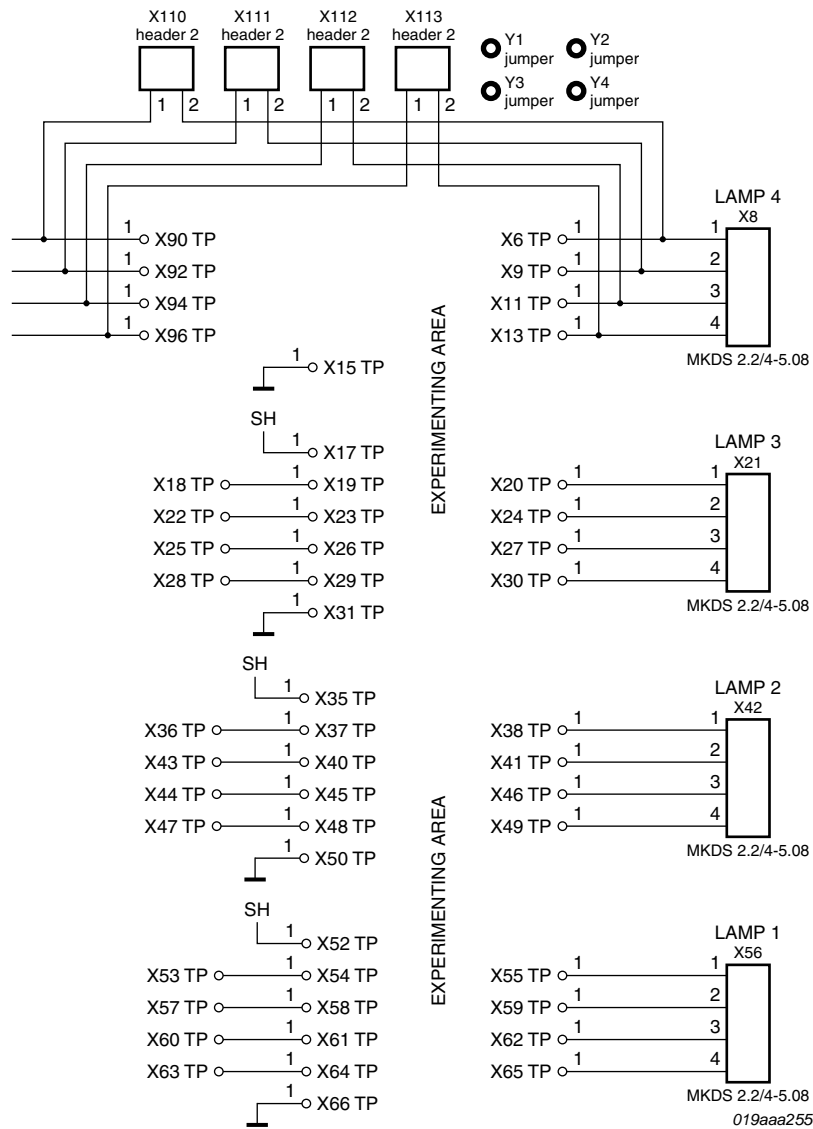


Fig 8. Main board lamp connectors and experimenting area

5. Connectors

5.1 Power supply connectors

The board can be supplied by either a high voltage DC or a mains AC input. For most applications the high voltage DC input should be used. In the final product, a Power Factor Correction (PFC) of choice may be used to replace the high voltage DC supply.

For some applications (such as CFL applications) the rectified mains is sufficient. In these cases a mains input of 230 V AC may be used.

Table 1. DC high voltage input connector X1

Connector	Signal	Comment
X1-1	+	+ 400 V (DC) in
X1-2	GND	ground

Table 2. AC input connector X3

Connector	Signal	Comment
X3-1	~	mains 230 V (AC)
X3-2	~	mains 230 V (AC)

5.2 Dimming input

The UBA2014 has dimming functionality. An input with a voltage divider has been provided so that a 0 V to 10 V signal can be used. If no voltage is supplied to the dimming input, the lamp operates at approximately 50 % of its nominal power.

Please note that there is no galvanic isolation between the dimming input and the rest of the circuit, it is therefore advisable to use a mains isolation transformer to separate the board ground from the mains. If required, a Zener diode (V15) can be used as protection against input voltages that are too high.

Table 3. Dimming input connector X68

Connector	Signal	Comment
X68-1	+	0 V to 10 V dimming input (max 10 V)
X68-2	GND	ground

5.3 Lamp connectors

There are connections for four lamps on the board. In the following tables, the connectors are listed together with the names of the test points connected to them.

Table 4. Lamp 1 (X56)

TP	Comment
X55	connection for filament 1
X59	connection for filament 1
X62	connection for filament 2
X65	connection for filament 2

Table 5. Lamp 2 (X42)

TP	Comment
X38	connection for filament 1
X41	connection for filament 1
X46	connection for filament 2
X49	connection for filament 2

Table 6. Lamp 3 (X21)

TP	Comment
X20	connection for filament 1
X24	connection for filament 1
X27	connection for filament 2
X30	connection for filament 2

Table 7. Lamp 4 (X8)

TP	Comment
X6	connection for filament 1
X9	connection for filament 1
X11	connection for filament 2
X13	connection for filament 2

5.4 Test points

Eight ground pins are distributed over the board so that (oscilloscope) probes can be grounded without the need for long grounding wires.

Table 8. Ground test points

TP	Color	Signal
X102	black	GND
X103	black	GND
X104	black	GND
X105	black	GND
X106	black	GND
X107	black	GND
X108	black	GND
X109	black	GND

Remark: A test pin is available for each pin of the daughter board.

Table 9. Daughter board connections

TP	Name	Comment
X78	CSN	negative input for the average current sensor [1]
X79	CSP	positive input for the average current sensor [1]
X80	Vref	reference voltage output [2]
X81	LVS	lamp voltage sensor input [1]
X82	SH	source for the high-side switch

Table 9. Daughter board connections ...continued

TP	Name	Comment
X83	GH	gate output for the high-side switch
X84	PCS	preheat current sensor input [1] (also connected to LVS via V5, R7/C11, R5/C10)
X85	Vbrg	connection to VDC via R20 (220 k Ω)
X86	GL	gate output for the low-side switch
X87	GND	ground
X88	V _{DD}	low voltage supply
X120	PCS_2021	preheat current sense for the UBA2021 daughter board

[1] For UBA2014 daughter board.

[2] From UBA2014 daughter board.

5.5 Transformer T1

Transformer T1 is used in the default setup, and it is connected with jumpers to lamp connector 4 (X8). The transformer specifications are listed in [Section 6.1](#).

Table 10. Default connection transformer T1

Header	Comment
X110	insert to connect T1 to filament 1, lamp 4
X111	insert to connect T1 to filament 1, lamp 4
X112	insert to connect T1 to filament 2, lamp 4
X113	insert to connect T1 to filament 2, lamp 4
X114	insert to connect SH to transformer T1
X115	insert to connect T1 to resonant capacitor C6 (4.7 nF; 2000 V)

5.6 FET

Two NMOS FETs should be placed in X2 and X14. The supplied NMOSs are Toshiba 2SK3569 ($V_{DS} = 600$ V; $I_D = 10$ A; $R_{DS(on)} = 0.54$ Ω). When using different NMOS types, the values of gate resistors R1 and R3 (default 33 Ω) can be changed.

5.7 Current sense selection

There are two ways to use current sensing. Sensing of the half-bridge current or sensing of the lamp current.

Table 11. Current sensing selection

X33	Pins 1 to 2	Pins 2 to 3
half-bridge	shorted	open
lamp current	open	shorted

5.7.1 Half-bridge current sensing

Pins 1 and 2 of jumper X33 should be shorted in order to connect the sense resistor network in the half-bridge to the CSN pin of the UBA2014. With jumpers X32 and X34, different values of the sense resistor can be selected. In this case, X39 should be shorted between pins 2 and 3 in order to connect the lamp to ground.

Table 12. Current sensing selection

X32	X34	Resistance (Ω)
short	short	0.5
short	open	1.0
open	short	1.5
open	open	2.0

5.7.2 Lamp current sensing

Pins 2 and 3 of jumper X33 should be shorted to connect the lamp current sense network to the CSN pin. X39 should be shorted between pins 1 and 2 to connect the lamp to the sensing circuit.

5.8 Using transformer T3

To use the flexible transformer T3, jumper X117 should be inserted. This connects SH to pin 1 of the transformer. [Table 13](#) shows the different inductance values that can be made with this transformer. The specifications of the transformer are listed in [Section 6.2](#).

Table 13. Transformer T3 primary connections

Connection	Inductance
X69	2.0 mH
X73	2.5 mH
X75	3.0 mH
X77	3.5 mH
X91	4.0 mH

Two secondary connections are available for filament (pre-)heating, as shown in [Table 14](#)

Table 14. Transformer T3 secondary connections

Connection	Inductance
X70 to X72	15 μ H
X74 to X76	15 μ H

Transformer T3 has a double footprint that enables the use of different types of transformers. The transformers are named "T2" and "T3" on the schematic drawings.

6. Transformer specifications

6.1 Transformer T1

6.1.1 Schematic diagram

- Manufacturer: Würth Elektronik
- Part number: 760870401

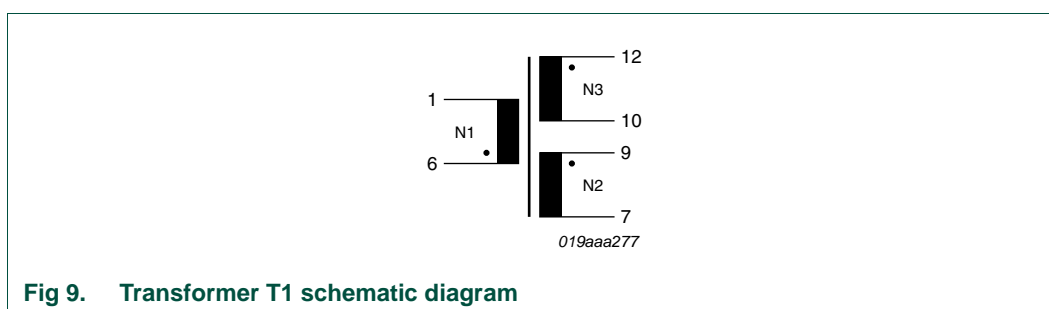


Fig 9. Transformer T1 schematic diagram

6.1.2 Electrical properties

Table 15. Electrical characteristics of transformer T1

Properties	Test conditions		Value	Unit	Tolerance
Inductance N1	50 kHz/0.1 V	L_0	2.9	mH	±5 %
Turns ratio N1 to N3	N1: N2: N3	TR	26.1 : 1 : 1		±3 %
DC-resistance N1	at 20 °C	R_{DC1}	2.7	?	maximum
DC-resistance N2	at 20 °C	R_{DC2}	180	m?	maximum
DC-resistance N3	at 20 °C	R_{DC3}	180	m?	maximum
Saturation current N1	$dL / L = 20 \%$	I_{SAT}	1.6	A	typical
Leakage inductance N1	200 kHz/0.1 V other windings shorted	L_S	350	μH	maximum
Coupling capacitance	20 kHz/1 V all windings	C_{WW}	11.0	pF	typical
Hipot test	3 mA, 1s all windings	HV	1.2	kV	

6.1.3 Core and bobbin T1

- Core: RM-8 (Ferroxcube RM/I or equivalent)
- Core material: 3F3, N87 or equivalent
- Bobbin: RM-8 (12 pin, vertical type)

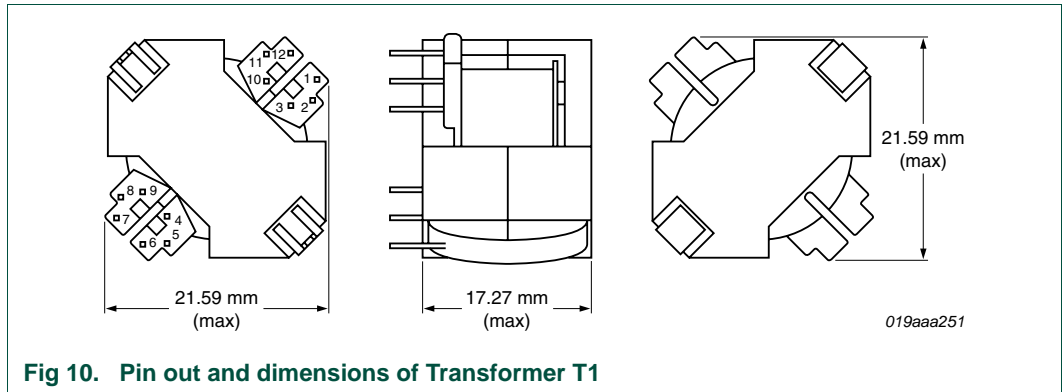


Fig 10. Pin out and dimensions of Transformer T1

6.2 Transformer T3

6.2.1 Schematic diagram

- Manufacturer: Würth Elektronik
- Part number: 760870402

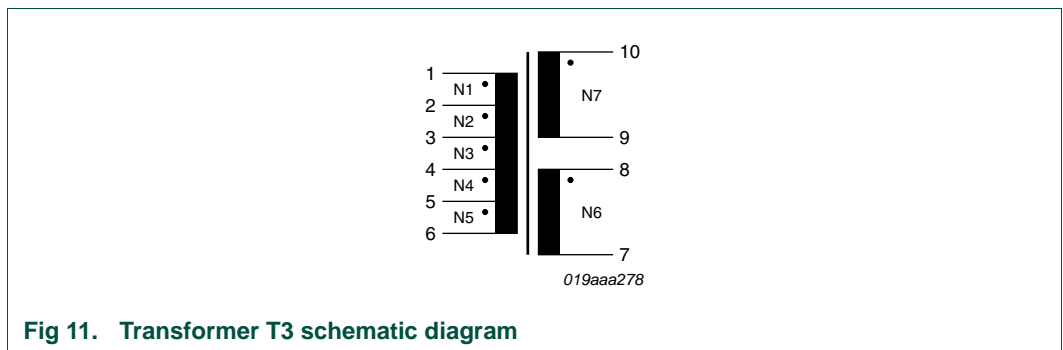


Fig 11. Transformer T3 schematic diagram

Table 16. Electrical characteristics for transformer T3

Properties	Test conditions		Value	Unit	Tolerance
Inductance N1 to N5	50 kHz/0.1 V	L_0	4.0	mH	$\pm 5\%$
Turns ratio N1 to N5	N1: N2: N3: N4: N5: N6: N7	TR	12 : 1.33 : 1.25 : 1.17 : 1.17 : 1 : 1		$\pm 3\%$
DC-resistance N1 to N5	at 20 °C	R_{DC1-5}	1.85	?	$\pm 20\%$
DC-resistance N6	at 20 °C	R_{DC6}	135	m?	$\pm 20\%$
DC-resistance N7	at 20 °C	R_{DC7}	140	m?	$\pm 20\%$
Saturation current N1 to N5	dL / L = 20 %	I_{SAT}	1.0	A	typical
Leakage inductance N1 to N5	200 kHz/0.1 V other windings shorted	L_S	275	μ H	typical
Coupling capacitance	20 kHz/1 V all windings	C_{WW}	30.0	pF	typical
Hipot test	3 mA, 1 s all windings	HV	3.0	kV	

6.2.2 Core and bobbin T3

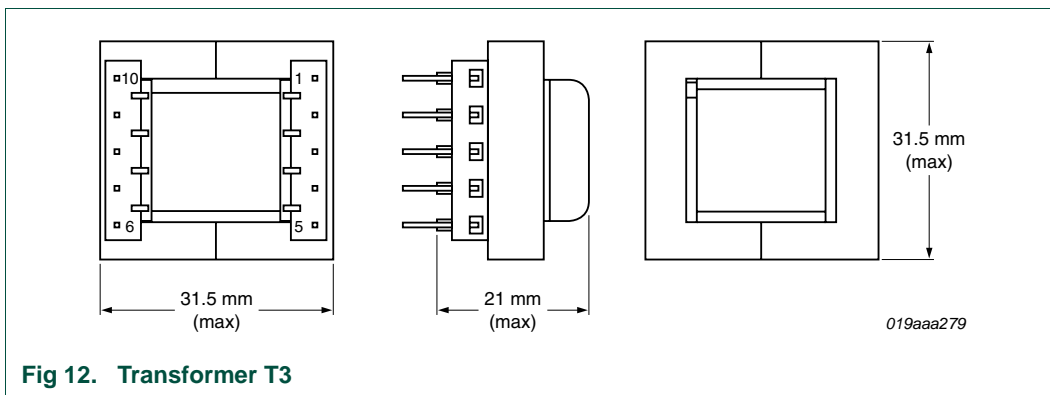


Fig 12. Transformer T3

- Core: E30/15/7
- Core material: ferrite
- Air gap in center leg: 1100 μm
- Bobbin: CSH-E30/7-1S-10P

7. Application example

7.1 Default application T5 HE 35 W

The default settings of the board are for a T5 HE 35 W burner.

Table 17. Default settings

Jumper	Position	Comment
X32	shorted	half-bridge sense resistor 1 Ω (used for PCS)
X34	open	-
X33	1 to 2 open, 2 to 3 shorted	use lamp current sensing
X114	shorted	connect transformer T1
X115	shorted	-
X39	1 to 2 shorted, 2 to 3 open	connect lamp to lamp current sense circuit
X110, X111, X112, X113	shorted	connect to lamp 4
X117	open	do not connect transformer T3

Table 18. External connections for T5 HE 35 W

Jumper	Position	Comment
X1	VDC	400 V (DC)
X68	external dimming	10 V for full power
X8	burner	T5 HE 35 W burner

When no external dimming voltage is supplied, the lamp power is 20 W.

8. Bill of Materials (BOM)

Table 19. BOM daughter board

Reference	Value	Component
A1	UBA2014T	NXP
C1	330 n /16 V	capacitor ceramic X7R, 16 V, 10 %
C2	220 nF/16 V	capacitor ceramic X7R, 16 V, 10 %
C3	100 pF	capacitor ceramic C0G, 50 V, 5 %
C4, C11	100 nF	capacitor ceramic X7R, 50 V, 10 %
C5	not mounted	
C6	1 nF/500 V	capacitor ceramic 500 V NP0 5 %
C7	5.6 nF/50 V	capacitor ceramic 50 V X7R 10 %
C8	1 μ F/25 V	capacitor ceramic X7R 25 V 10 %
C9	10 nF	capacitor ceramic X7R, 50 V, 10 %
C10	56 nF/50 V	capacitor ceramic 50 V X7R 10 %
R1, R7	33 k Ω	resistor 1 % 0.125 W 100 ppm RC12H
R2, R3	240 k Ω	resistor 1 % 0.125 W 100 ppm RC12H
R4	2.2 Ω	resistor 1 % 0.125 W 0 to + 500 ppm RC12H
R5	10 k Ω	resistor 1 % 0.125 W 100 ppm RC12H
R6	1 k Ω	resistor 1 % 0.125 W 100 ppm RC12H
V1, V5	BAS29	NXP, diode, 50 ns 90 V 250 mA
V3	BZX84C12V	NXP, Zener, 250 mW, 5 % [Y2t/Y2p/Y2W]
V2, V4	BZX84-B6V8	NXP, Zener, 250 mW, 2 % [Z61 or R6]

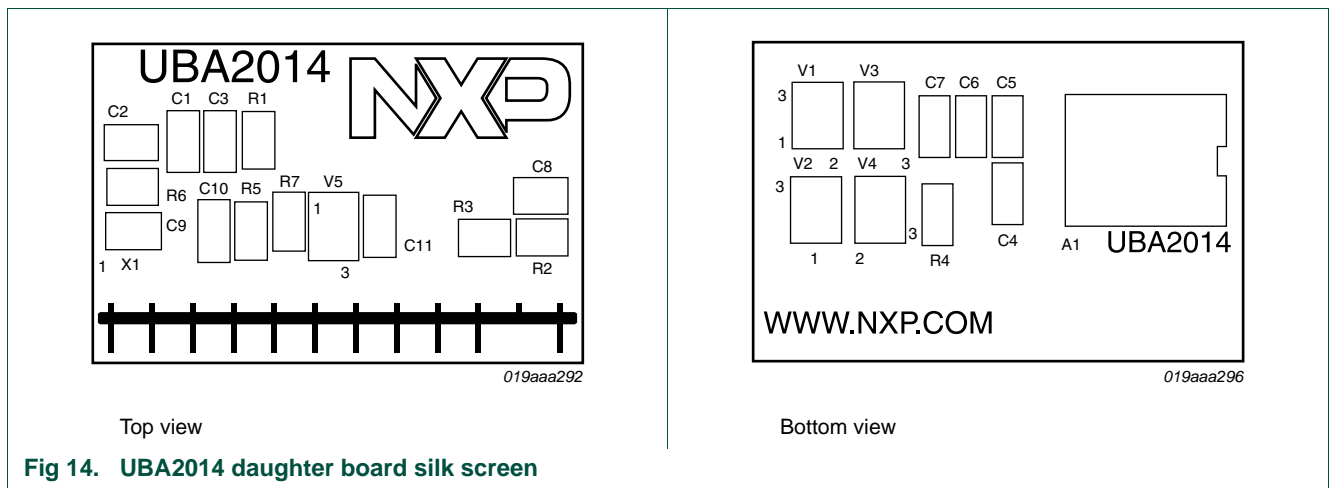
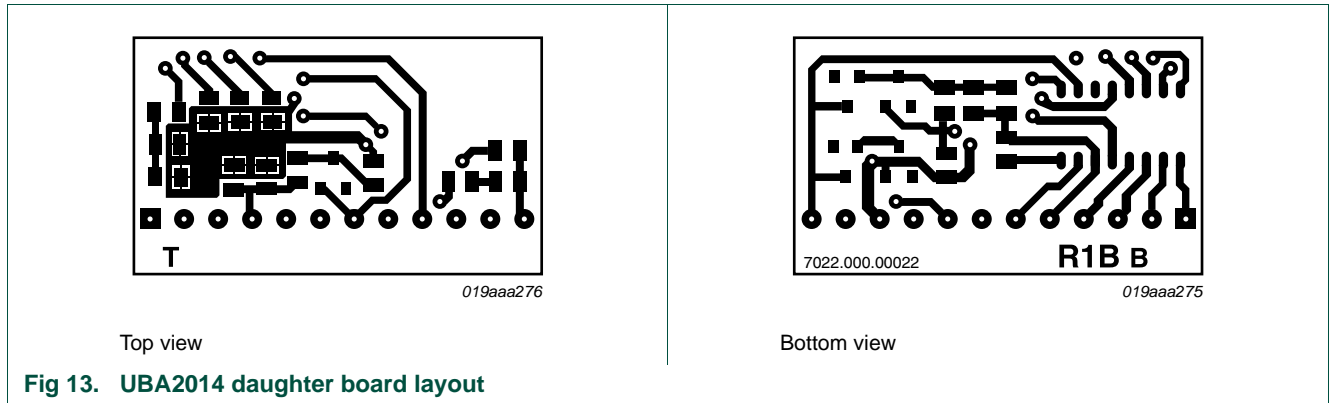
Table 20. BOM Main board

Reference	Value	Component
C1	68 nF/400 V	capacitor, MKP Class X2, 20 %
C2, C3, C4, C5	47 nF/305 V (AC)	capacitor, MKP Class X2, 20 %
C4, C5	33 nF/100 V	capacitor, MKT 100 V (DC), 5 %
C6	4.7 nF/2000 V	capacitor MKP radial potted, 5 %
C11, C14	10 nF/100 V	capacitor ceramic disc X7R, 10 %
C12	1 nF/100 V	capacitor ceramic disc X7R, 10 %
C15, C16	4.7 μ F/450 V	cap. elco rad 450 V 105C 20 %
C17	680 nF/50 V	capacitor ceramic disc X7R, 10 %
C18	2.2 nF/100 V	capacitor ceramic disc X7R, 10 %
C19	470 nF/63 V	capacitor, MKT 63 V (DC), 5 %
F1	fuse holder 5 mm x 20 mm	fuse holder for 5 mm x 20 mm
F2	2 A	fuse 5 mm x 20 mm time lag
L1	1.5 mH	inductor choke current rating = 850 mA, R = 580 m Ω
R1, R3	33 Ω	resistor 1 % 0.6 W 50 ppm MRS25
R2, R4	0 Ω	zero ohm link, current rating = 25 A at 25 $^{\circ}$ C
R5	8.2 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R6, R8, R9	1.2 Ω	resistor power 5 % 2 W 100 ppm/ $^{\circ}$ C MFP

Table 20. BOM Main board ...continued

Reference	Value	Component
R7	1 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R10	33.2 Ω	resistor Power 5 % 2 W 450 ppm/ $^{\circ}$ C Carbon Film
R18	33 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R19	11 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R20	220 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R22, R23	43 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R24, R25	47 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R27, R29, R33, R34	75 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R31	1 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R32	100 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R35, R36	56 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R37	0 Ω	Zero ohm link $I_m = 25$ A at 25 $^{\circ}$ C
R38	5.6 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R39	1.2 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
R40	75 k Ω	resistor 1 % 0.6 W 50 ppm MRS25
T1	760870401	Würth Elektronik: part number 760870401
T3	760870402	Würth Elektronik: part number 760870402
V1, V11, V12, V16	1N4937	diode, fast-recovery, 600 V, 1 A
V2	GBU8K	bridge 800 V 8 A TH
V3, V6	2SK3569	FET MOS N-ch 600 V, 10 A 0,54E
V15	not mounted	
X1, X3, X68	MKDS 2,5/2-5,08	terminal block (screw) 2-p, p = 2e, 2.5 mm ²
X2, X14	Socket 3	socket straight p = 2.54 mm, h = 7 mm
X8, X21, X42, X56	MKDS 2,5/4-5,08	terminal block (screw) 4-p, p = 2e, 2.5 mm ²

9. Layout



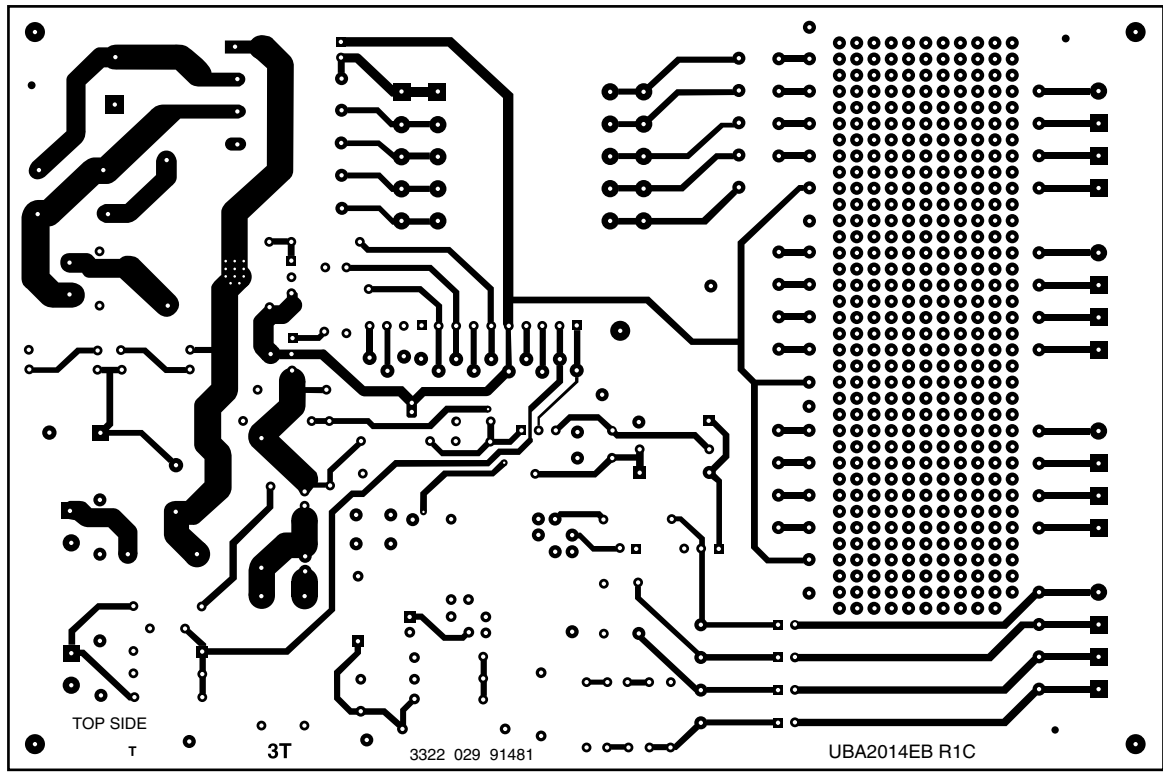
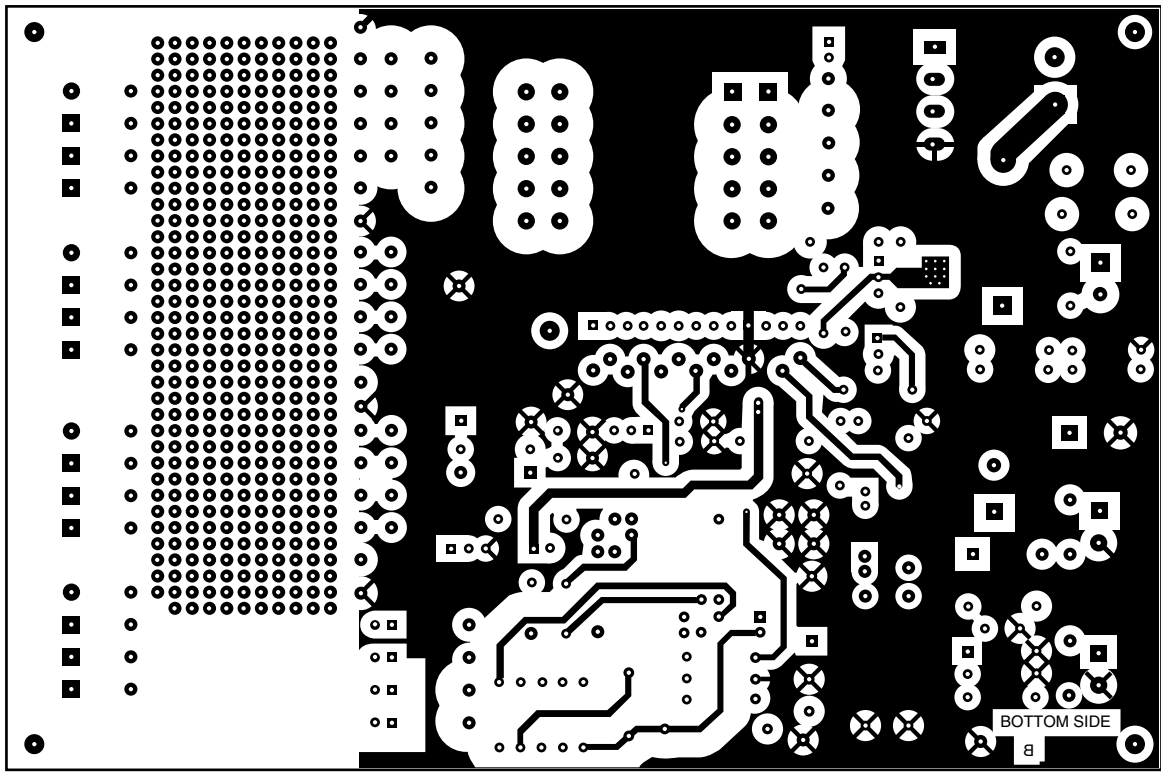
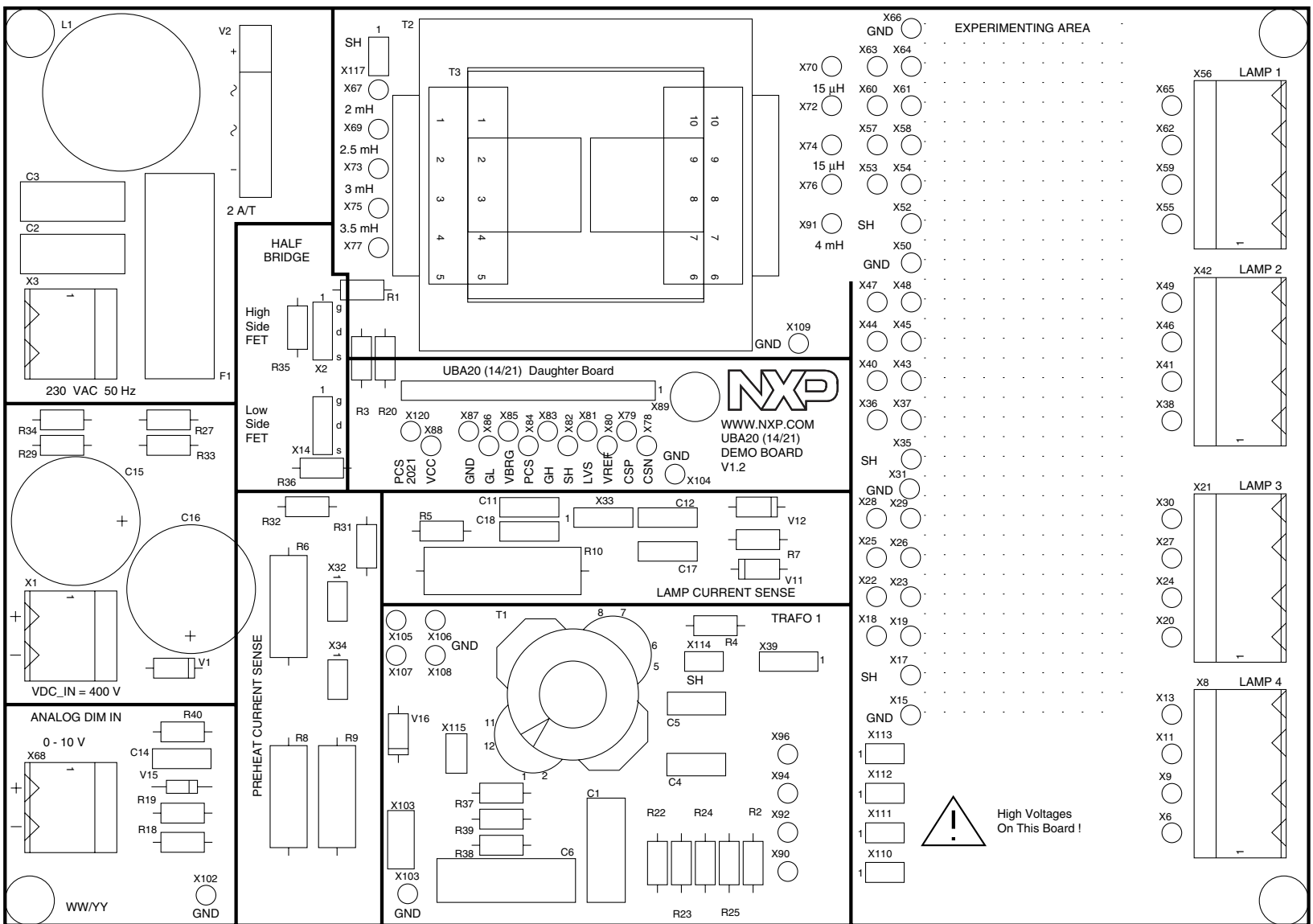


Fig 15. UBA2014/21 main board PCB layout top



019aaa293

Fig 16. UBA2014/21 main board PCB layout bottom



019aaa294

Fig 17. UBA2014/21 main board silk screen top

10. Glossary

CFL — Compact Fluorescent Lamp

FET — Field-Effect Transistor

NMOST — Negative channel Metal–Oxide–Semiconductor Transistor

TL — Tubular Lamp

11. Legal information

11.1 Definitions

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