UM10412

UBA2021 evaluation board

Rev. 1 — 2 November 2010 User manual

Document information

Info	Content
Keywords	UBA2021, evaluation board, TL, CFL
Abstract	This document is the user manual for the UBA2021 evaluation board.

Revision history

Rev	Date	Description
01	20101102	First issue

Contact information

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1. Introduction

This document describes the UBA2021 main board in combination with the UBA2021 daughter board. The main board is designed to be a flexible platform for demonstrating the functionality of the UBA2014 and UBA2021 fluorescent tube drivers in different applications. Please note that this board is not a complete ballast design for fluorescent tubes. The default setup permits a T5 HE 35 W fluorescent lamp to be demonstrated.

2. Safety warnings and cautions

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.

Remark: 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

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

CAUTIONS:

- 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.
- Do not use the UBA2021 daughter board in combination with the (old) V1.1 main board. The V1.1 board is blue instead of green.

3. Board description

The board consists of two separate PCBs. The main board with the resonance circuit and a small daughter board with the UBA2021 IC.

3.1 Daughter board

The daughter board contains the UBA2021 IC with the preheat, sweep and oscillator capacitors, the low voltage supply (V_{DD}) components and some other low voltage components.

The daughter PCB can easily be replaced if it becomes damaged. Care should be taken that the board is inserted properly and to assist this, pin 11 has been removed from the daughter board to prevent inserting the board incorrectly.

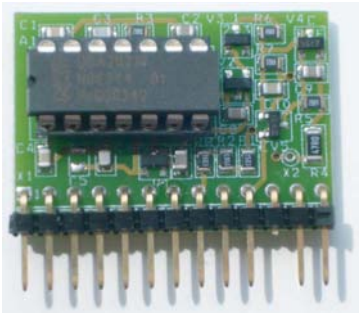

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Fig 2. Daughter board

3.2 Main board

The main board has been designed for both TL or CFL applications and comprises the following:

- DC and AC input connectors
- Dimming input
- Two sockets for FETs
- Two different transformers
- Area for experiments
- Connectors for up to four burners

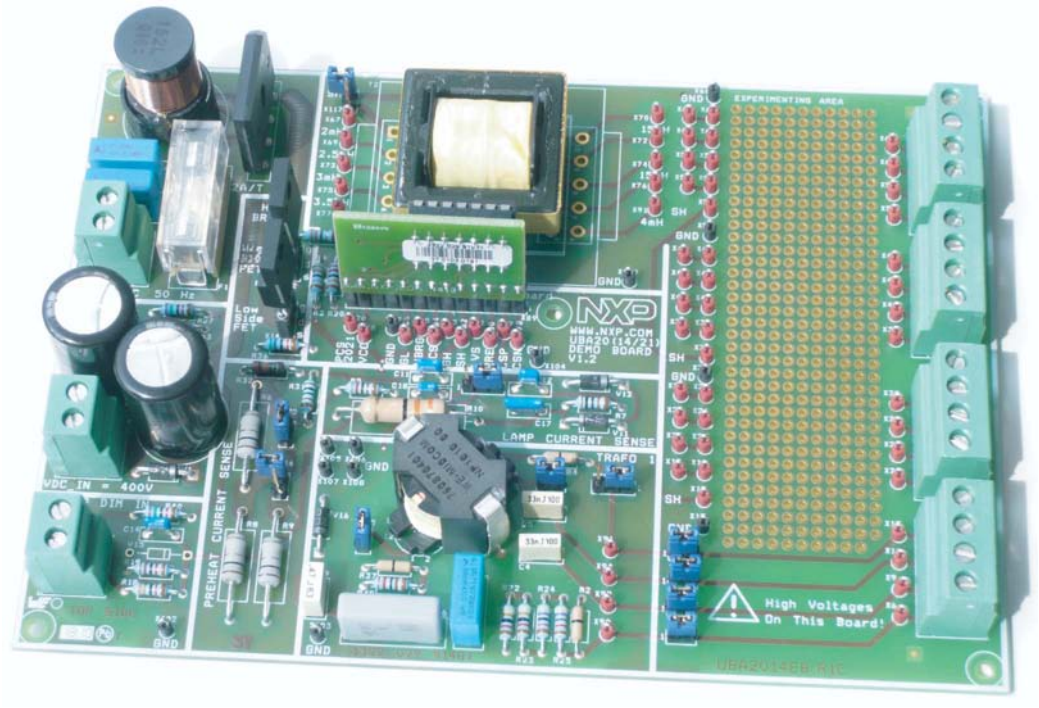

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Fig 3. UBA2014/21 Main board with UBA2021 daughter board inserted

4. Schematics

Figure 4 is a schematic of the daughter board with the UBA2021 IC. The component values for the oscillator and sweep are RREF = 30 kΩ, CF = 100 pF, CP = 330 nF. These values will give a minimum oscillator frequency of 39.5 kHz and a preheat time of 1.85 s.

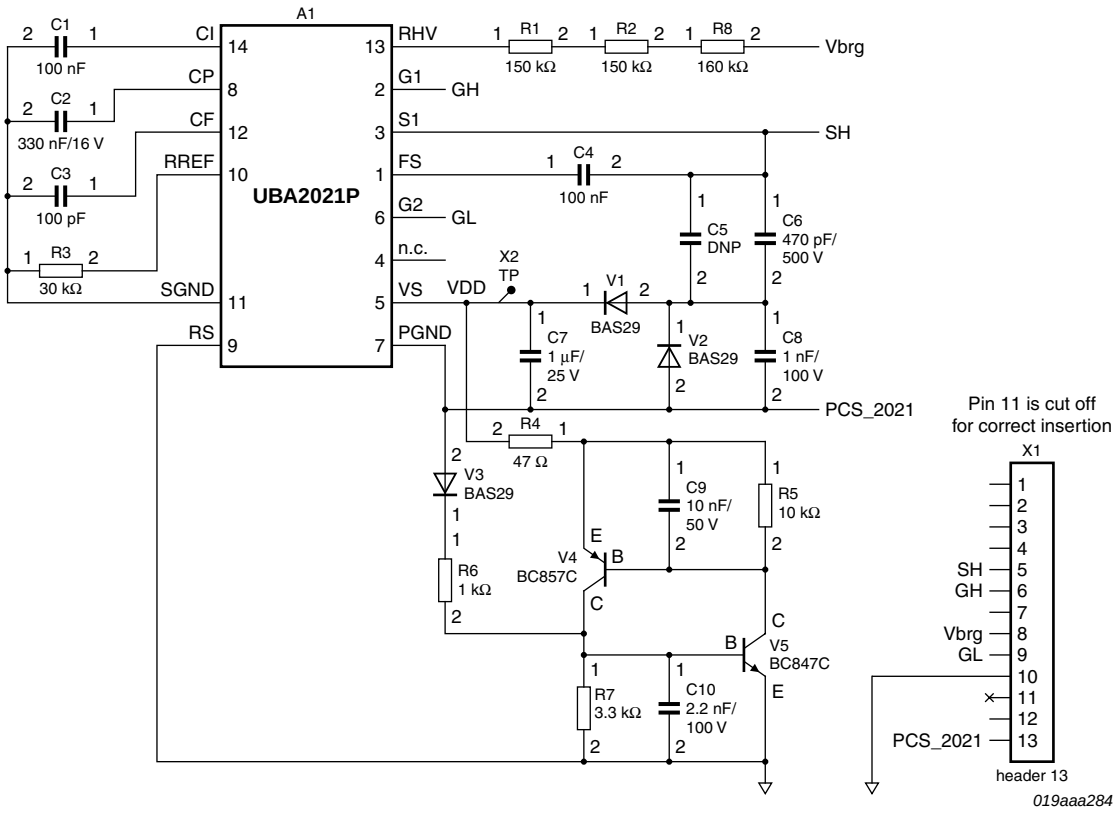


Fig 4. Daughter board with UBA2021 circuit

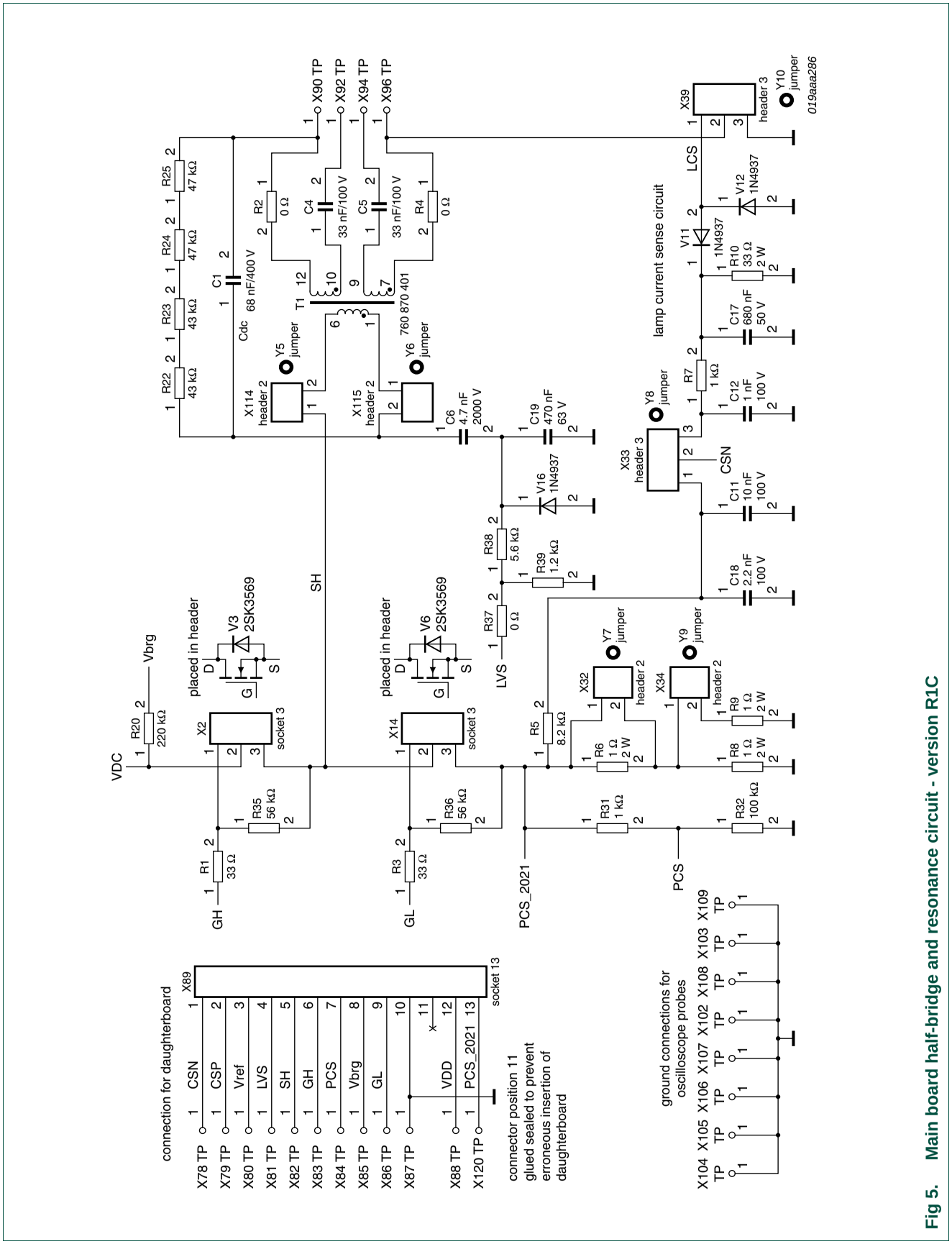


Fig 5. Main board half-bridge and resonance circuit - version R1C

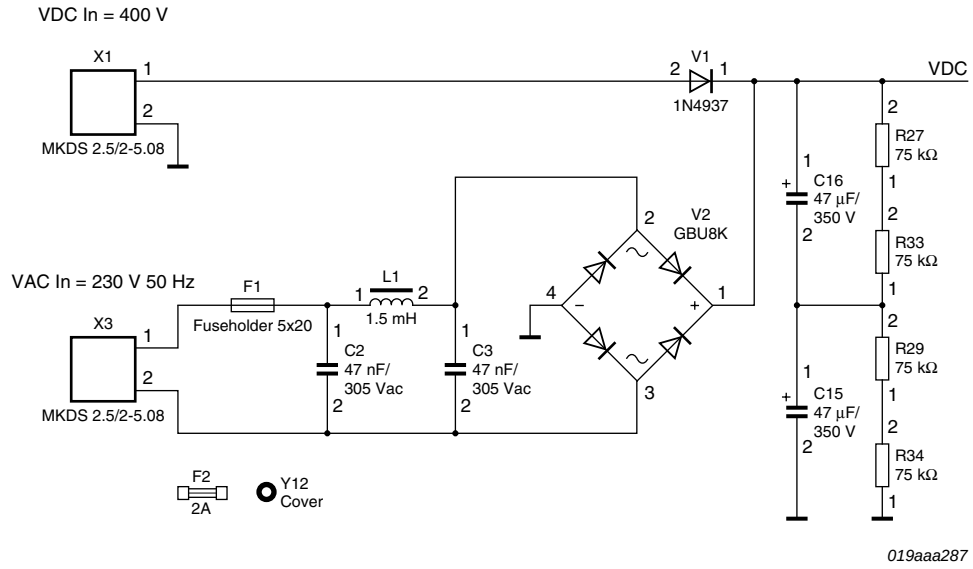


Fig 6. Main board input section

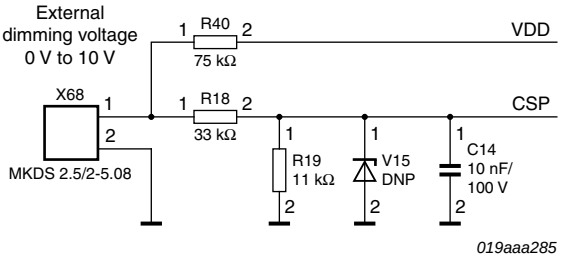


Fig 7. Main board dimming input (only in combination with UBA2014 daughter board)

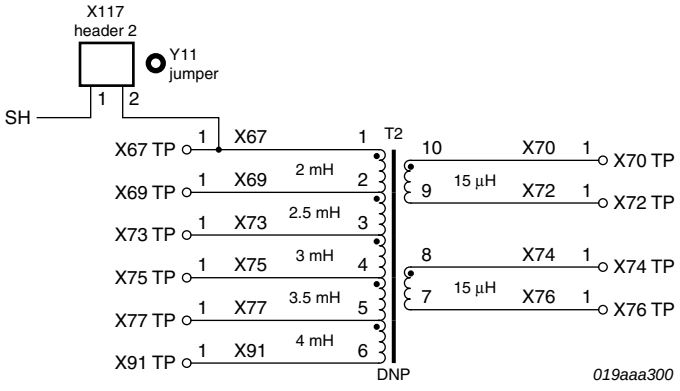


Fig 8. Main board transformer T2/T3

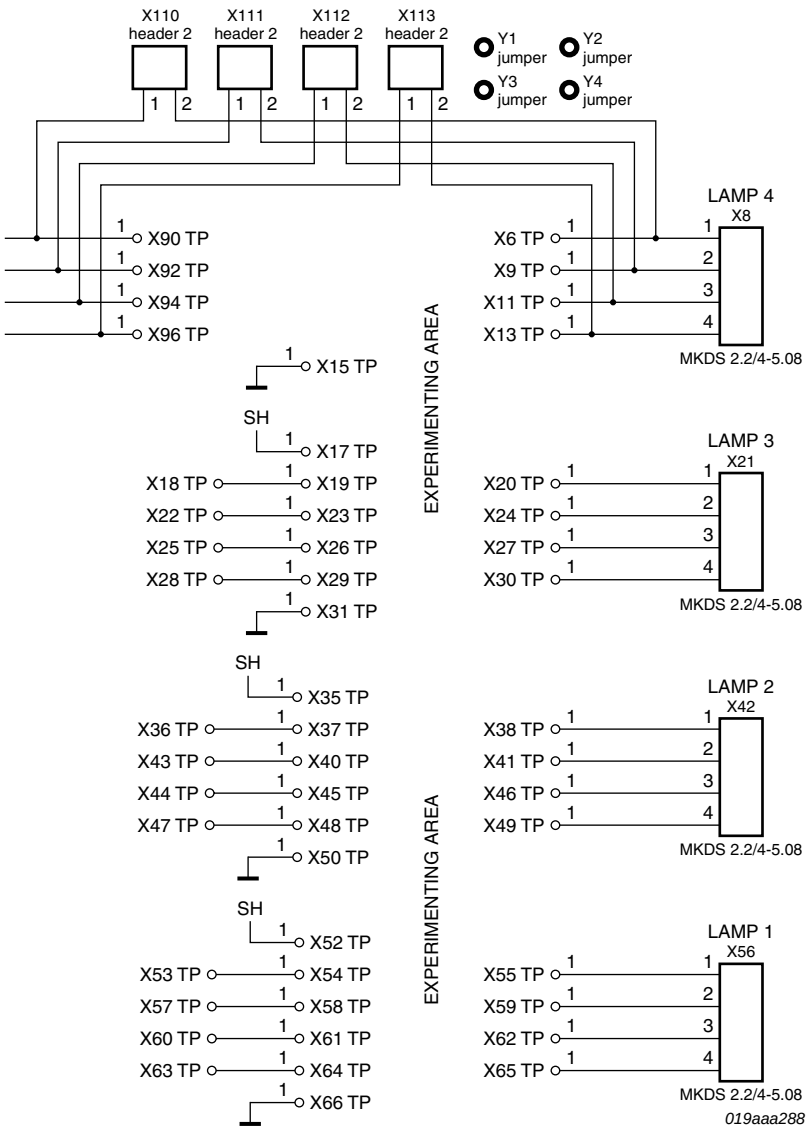


Fig 9. Main board lamp connectors and experimental area

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 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 UBA2021 does not have dimming functionality so this input is not used. If dimming is required, please use the UBA2014.

5.3 Lamp connectors

There are four lamp connectors on the board. The connectors are listed in Table 3, Table 4, Table 5 and Table 6, together with the names of the test points that are connected to them.

Table 3. 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 4. 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 5. 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 6. 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 black ground pins (X102 to X109) are distributed over the board so that (oscilloscope) probes can be grounded without the need for long grounding wires.

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

Table 7. Connections of the daughter board

Test Pin	Name	Comment
X78	CSN	negative input for the average current sensor for UBA2014 daughter board
X79	CSP	positive input for the average current sensor for UBA2014 daughter board
X80	V_{ref}	reference voltage output for UBA2014 daughter board
X81	LVS	lamp voltage sensor input for UBA2014 daughter board
X82	SH	source for the high-side switch
X83	GH	gate output for the high-side switch
X84	PCS	preheat current sensor input for UBA2014 daughter board
X85	V_{brg}	Connection to VDC via R20 (220 kΩ)
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

5.5 Transformer T1

In the default setup, transformer T1 will be used and is connected with jumpers to lamp connector 4 (X 8). The transformer specifications are listed in Section 6.

Table 8. 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 NMOST FETs should be placed in X2 and X14. The supplied NMOST's are Toshiba 2SK3569 (V_{DS} = 600 V; I_D = 10 A; R_{DSon} = 0.54 Ω). When using different NMOS types, the values of gate resistors R1 and R3 (default 33 Ω) maybe changed.

5.7 Current sense selection

A feed forward mechanism in the UBA2021 ensures that the lamp power will not increase above the maximum allowed value due to an increased mains voltage. This means that the operating frequency is controlled by the bus voltage rather than by the lamp current or the half-bridge current.

Table 9. Current sensing selection

X33	pins 1 and 2	pins 2 and 3
half-bridge	open	open
lamp current	open	open

5.7.1 Half-bridge current sensing

The half-bridge current is sensed for controlling the preheat current. Different values of the sense resistor can be selected using jumpers X32 and X34. To connect the lamp to ground, X39 should be shorted between pin 2 and pin 3.

Table 10. Current sensing selection

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

5.7.2 Lamp current sensing

The UBA2021 does not sense the lamp current, so X39 should be shorted between pin 2 and pin 3 in order to connect the lamp to ground.

5.8 Using transformer T3

The jumper X117 should be inserted to use the flexible transformer T3. This will connect SH to pin 1 of the transformer. Table 11 shows the different inductance values. The specifications of the transformer are listed in Section 6.

Table 11. Transformer T3 primary connections - Inductance to pin 1 (X67)

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

Table 12. Transformer T3 secondary connections

Connection	Inductance
X70-X72	15 μH
X74-X76	15 μH

Transformer T3 has a double footprint that enables the use of different types of transformers. The transformers are referred to as 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

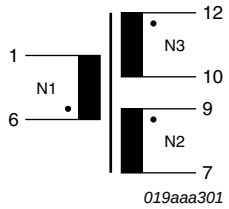


Fig 10. Transformer T1 schematic diagram

6.1.2 Winding specification

Table 13. Electrical characteristics for transformer T1

Properties	Test conditions		Value	Unit	Tolerance
Inductance N1	50 kHz/0.1 V	L_0	2.9	mH	± 5 %
Turns ratio N1 - N5	N1: N2: N3	TR	26.1 : 1 : 1		± 3 %
DC-resistance N1	at 20 °C	R_{DC1}	2.7	Ω	maximum
DC-resistance N2	at 20 °C	R_{DC2}	180	mΩ	maximum
DC-resistance N3	at 20 °C	R_{DC3}	180	mΩ	maximum
Saturation current N1	dL/L=20 %	I_{SAT}	1.6	A	typical
Leakage inductance N1	200 kHz/0.1 V rest 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 Dimensions

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

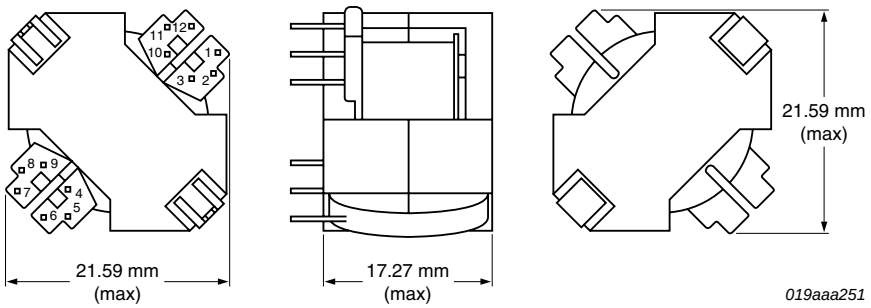


Fig 11. Transformer T1

6.2 Transformer T3

6.2.1 Schematic diagram

- Manufacturer: Würth Elektronik
- Part number: 760870402

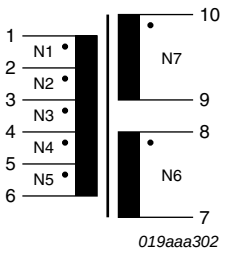


Fig 12. Transformer T3 schematic diagram

Table 14. Electrical characteristics for transformer T3

Properties	Test conditions		Value	Unit	Tolerance
InductanceN1-N5	50 kHz/0.1 V	L_0	4.0	mH	± 5 %
Turns ratio N1 - N5	N1: N2: N3: N4: N5: N6: N7	TR	12 : 1.33, 1.25 : 1.17, 1.17 : 1:1		± 3 %
DC-resistance N1-N5	at 20 °C	R_{DC1-5}	1.85	Ω	± 20 %
DC-resistanceN6	at 20 °C	R_{DC6}	135	mΩ	± 20 %
DC-resistance N7	at 20 °C	R_{DC7}	140	mΩ	± 20 %
Saturation current N1-N5	dL/L = 20 %	I_{SAT}	1.0	A	typical
Leakage inductance N1-N5	200 kHz/0.1 V rest shorted	L_S	275	µH	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 Dimensions

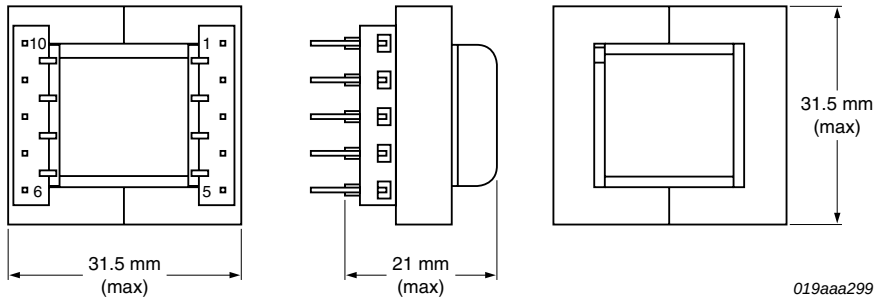


Fig 13. Transformer T3

- 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 15. Default settings

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

Table 16. External connections for T5 HE 35W

Jumper	Position	Comment
X1	VDC	400 V DC
X68	External dimming	the UBA2021 board has no dimming so this input can be left open.
X8	burner	T5 HE 35 W burner

8. Bill of Materials (BOM)

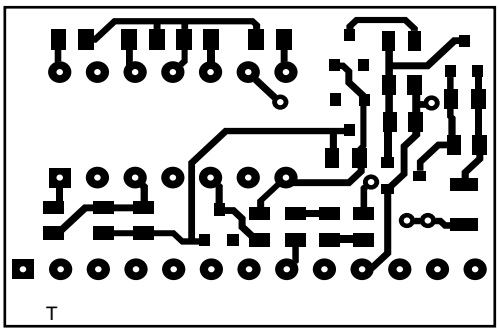
Table 17. BOM daughter board

Reference	Value or type no.	Component
A1	UBA2021P	NXP Semiconductors UBA2021P IC
C1, C4	100 nF/50 V	Capacitor ceramic X7R, 50 V, 10 %
C2	330 nF/16 V	Capacitor ceramic X7R, 16 V, 10 %
C3	100 pF/100 V	Capacitor ceramic C0G, 50 V, 1 %
C5	n.m.	-
C6	470 pF/500 V	Capacitor ceramic 500 V NP0 5 %
C7	1 μF/25 V	Capacitor ceramic X7R 25 V, 10 %
C8	1 nF/100 V	Capacitor ceramic X7R 100 V, 10 %
C9	10 n	Capacitor ceramic X7R, 50 V, 10 %
C10	2.2 n / 100 V	Capacitor ceramic X7R 100 V, 10 %
R1, R2	150 kΩ	Resistor 1 % 0.125 W 100 ppm RC12H
R3	30 kΩ	Resistor 1 % 0.125 W 100 ppm RC12H
R4	47 Ω	Resistor 1 % 0.125 W 0 to +500 ppm RC12H
R5	10 kΩ	Resistor 1 % 0.125 W 100 ppm RC12H
R6	1 kΩ	Resistor 1 % 0.125 W 100 ppm RC12H
R7	3.3 kΩ	Resistor 1 % 0.125 W 100 ppm RC12H
R8	160 kΩ	Resistor 1 % 0.125 W 100 ppm RC12H
V1, V2, V3	BAS29	NXP Semiconductors, Diode, 50 ns 90 V 250 mA
V4	BC857C	NXP Semiconductors, PNP transistor
V5	BC847C	NXP Semiconductors, NPN transistor

Table 18. BOM main board

Reference	Value or type no.	Component
C1	68 nF/400 V	Capacitor MKT 400 V DC 10 %
C2, C3	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	47 µF/350 V	Capacitor elco rad 350 V 105 °C 20 %
C17	680 nF/50 V	Capacitor ceramic disc X7R, 10 %
C18	2.2 nF/100 V	Capacitor ceramic disc X7R, 10 %
C19	470 n/63 V	Capacitor MKT 63 V DC 5 %
F1	Fuse holder 5 x 20	Fuse holder for 5 mm x 20 mm fuses
F2	2 A	Fuse 5 mm x 20 mm time lag
L1	1.5 mH	Inductor Choke Ir = 850 mA, R= 580 mΩ
R1, R3	33 Ω	Resistor 1 % 0.6 W 50 ppm MRS25
R2, R4	0 Ω	Zero Ohm Link I_m= 25 A at 25 °C
R5	8.2 KΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R6, R8, R9	1 Ω 2 W	Resistor Power 5 % 2 W 100 ppm/°C MFP
R7	1 KΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R10	33 Ω 2 W	Resistor Power 5 % 2 W 450 ppm/°C Carbon Film
R18	33 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R19	11 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R20	220 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R22, R23	43 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R24, R25	47 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R27, R29, R33, R34	75 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R31	1.0 kΩ	Resistor 1% 0.6 W 50 ppm MRS25
R32	100 kΩ	Resistor 1% 0.6 W 50 ppm MRS25
R35, R36	56 kΩ	Resistor 1% 0.6 W 50 ppm MRS25
R37	0 Ω	Zero Ohm Link I_m = 25 A at 25 °C
R38	5.6 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R39	1.2 kΩ	Resistor 1 % 0.6 W 50 ppm MRS25
R40	75 kΩ	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	MOSFET N-ch 600 V 10 A 0.54 Ω
V15	n.m.	-
X1, X3, X68	MKDS 2,5/2-5,08	Terminal block (screw) 2-pole, p = 2e, 2.5 mm^2
X2, X14	Socket 3	Socket straight p = 2.54, h = 7 mm
X8, X21, X42, X56	MKDS 2,5/4-5,08	Terminal block (screw) 4-pole, p = 2e, 2.5 mm^2

9. Layout



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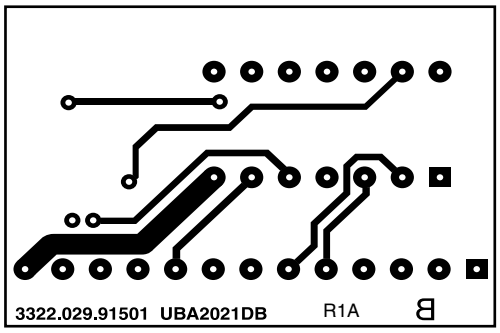
Top view



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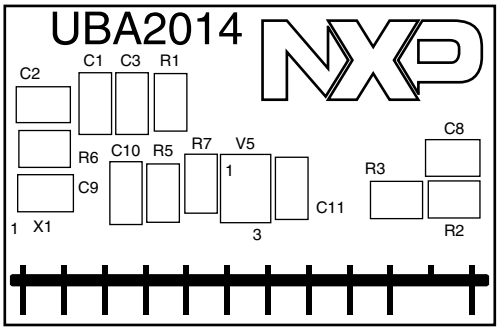
Bottom view

Fig 14. Daughter PCB layout



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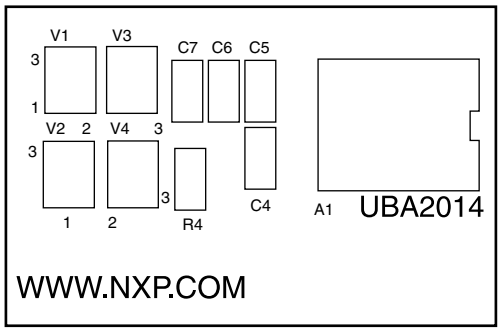
Top view



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Bottom view

Fig 15. Daughter board silk screen

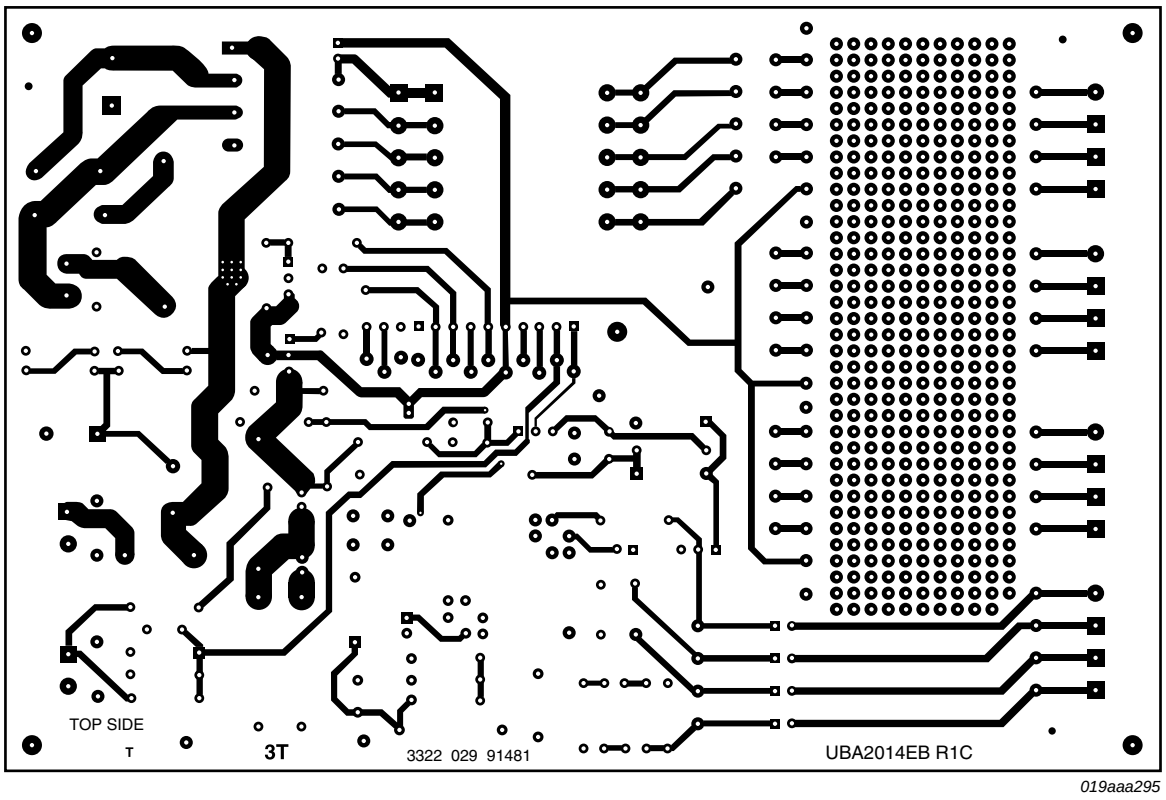

Fig 16. UBA2014/21 main board PCB layout top view

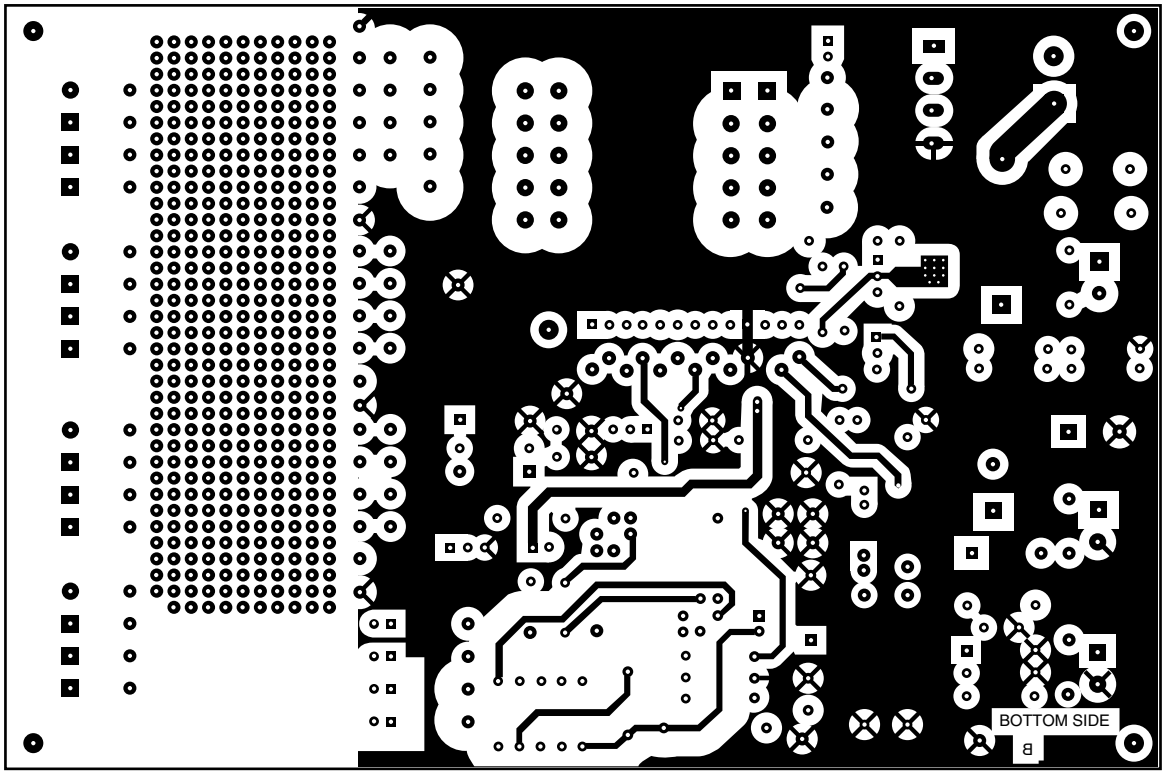

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Fig 17. UBA2014/21 main board PCB layout bottom view

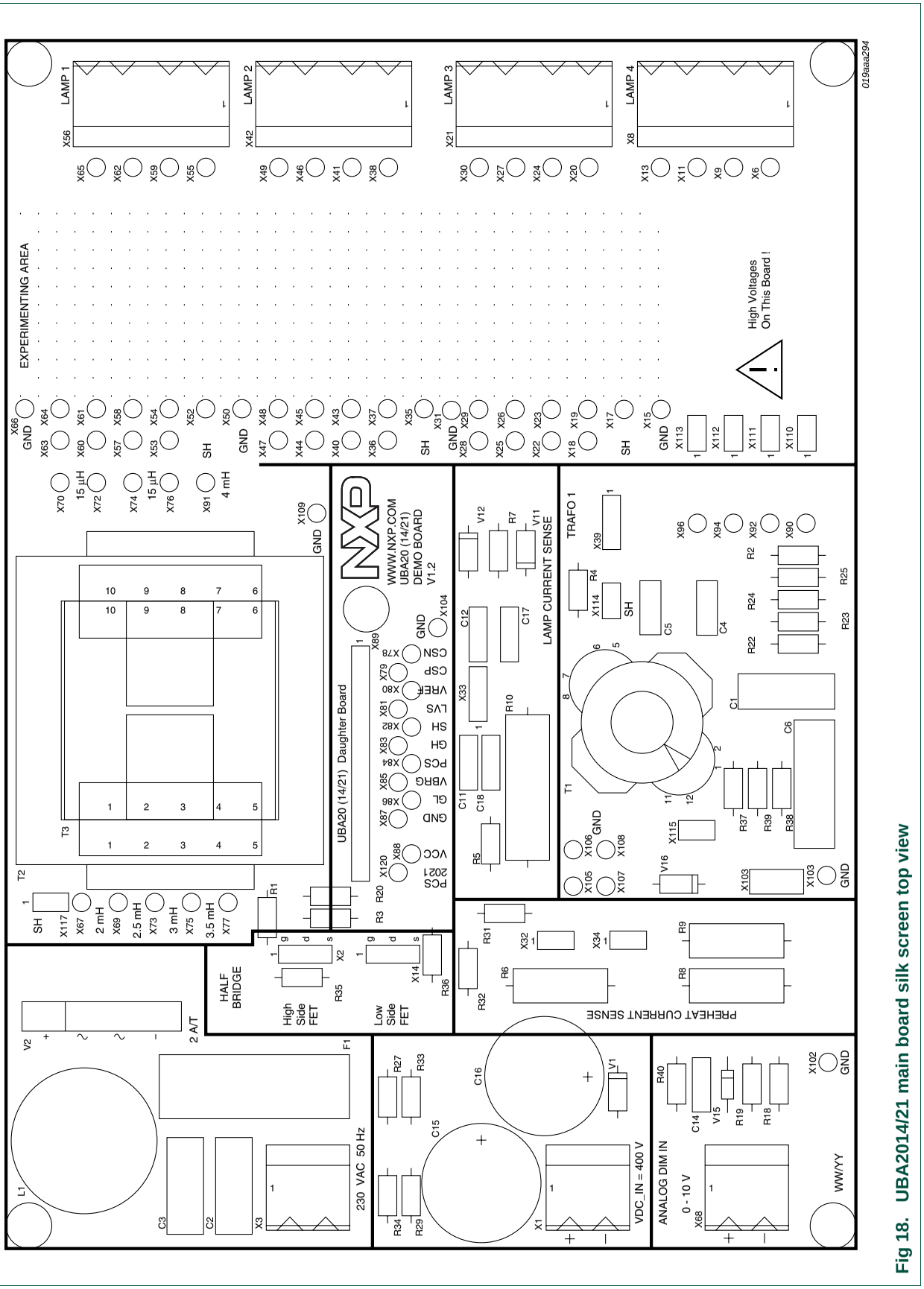

Fig 18. UBA2014/21 main board silk screen top view

10. Glossary

CFL — Compact Fluorescent Lamp

MOSFET — Metal–Oxide Semiconductor Field-Effect Transistor

NMOST — Negative channel Metal–Oxide Semiconductor Transistor

TL — Tubular Lamp

11. Legal information

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12. Contents

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

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