UM10387

UBA2024AT SO14 18 W demo board

Rev. 3 — 25 January 2011 **User manual**

Document information

Info	Content
Keywords	UBA2024AT, half-bridge CFL driver, non-dimmable
Abstract	This document describes the correct use of the UBA2024AT half-bridge CFL driver demo boards for both 120 V and 230 V mains voltages and some circuit examples for up to 18 W

Revision history

Rev	Date	Description
v.3	20110125	third issue
v.2	20100406	second issue
v.1	20091001	first issue

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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.

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

1.1 General description

The UBA2024AT circuit is a half-bridge driver IC which has been set up to drive a standard PLC-18W, G24q-2 socket based lamp or similar lamp types with a nominal lamp power of 16.5 W. The total power drawn from the mains is about 18 W at a nominal mains voltage of 230 V (RMS); 50 Hz or 120 V (RMS); 60 Hz. The board can easily be configured to drive different Compact Fluorescent Lamps (CFL) of different power ratings as some design examples will show by changing the inductor tap and applying a different lamp capacitor.

The UBA2024AT demo board is not recommended for driving lower voltage linear lighting lamps like the T5 or the T8. The UBA2021 is the optimal option for these type of lamps.

The IC is able to drive lamps up to 22 W provided the maximum junction temperature of the IC is not exceeded. There are no THD requirements for mains powers lower than 25 W so that a preconditioning function is obsolete.

The circuit is set up to perform a quasi preheat so the lamp will turn on approximately 0.7 s after the mains voltage has been applied to the board. For detailed design steps on the 18 W lamp solution or how to set-up lamps with other power ratings please consult the application note *AN10713 “18 W CFL lamp design using UBA2024 application development tool and application examples”*.

Depending on the ordered board the mains voltage operating range is either set for 90 V to 130 V (RMS) or 200 V to 250 V (RMS). Both voltage range strappings have been incorporated in one layout of the board. This makes easier to set-up the same board with a different voltage range.

Since the IC was intended as a cost-effective solution to drive CFLs with an integrated ballast (CFLi), the IC is not equipped with a thermal protection or open lamp detection. As the demo board has been set up around a detachable lamp, a protection circuit has been added to it to set the IC to a safe mode of operation when no lamp is attached to the circuit. This circuit is not needed in a typical CFL application.

Remark: If the UBA2024AT is used in a non-integrated ballast or a 'matchbox' type of ballast, the protection circuit is a requirement.

2. Schematic diagram

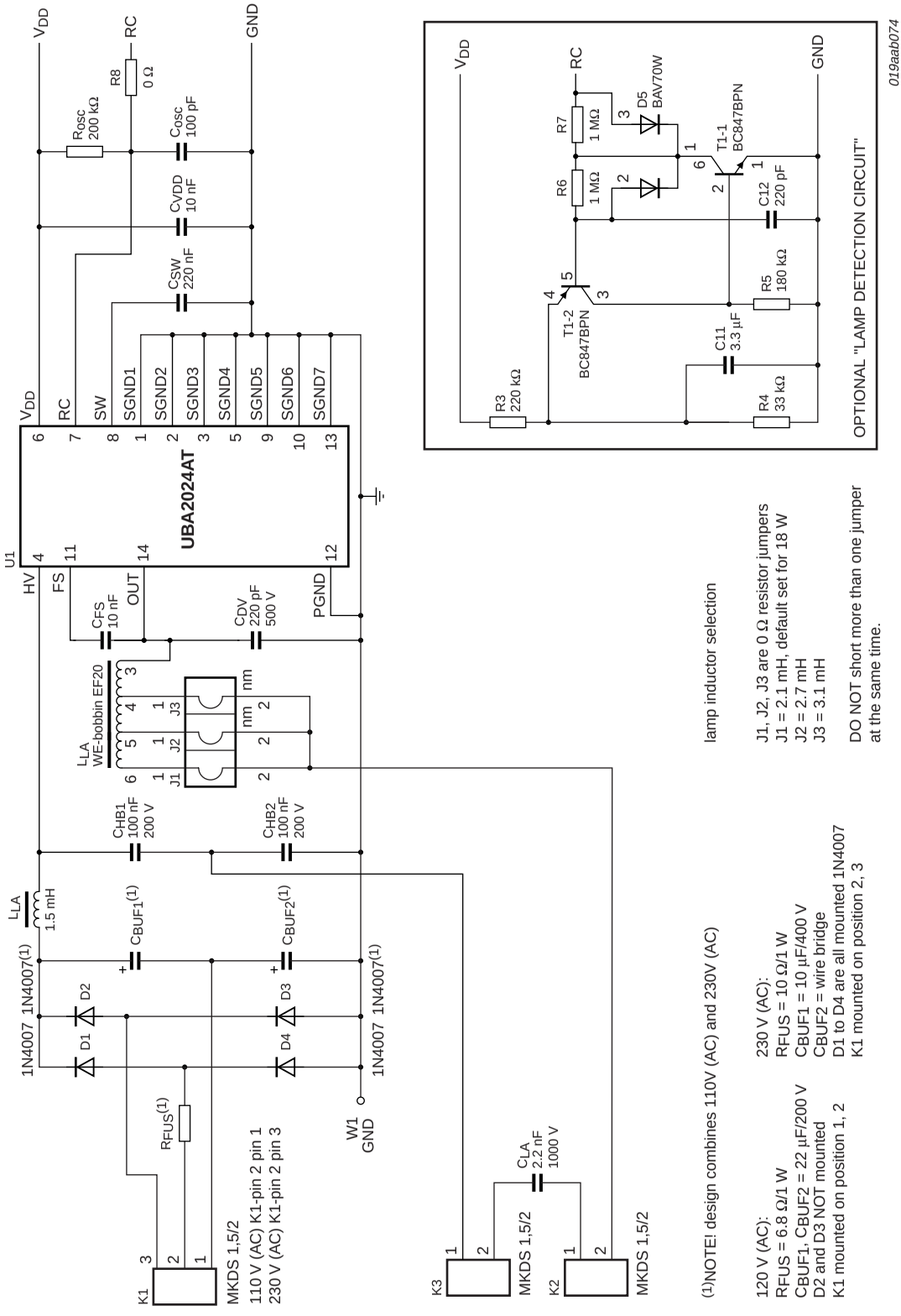

Fig 2. Schematic diagram

3. Specification

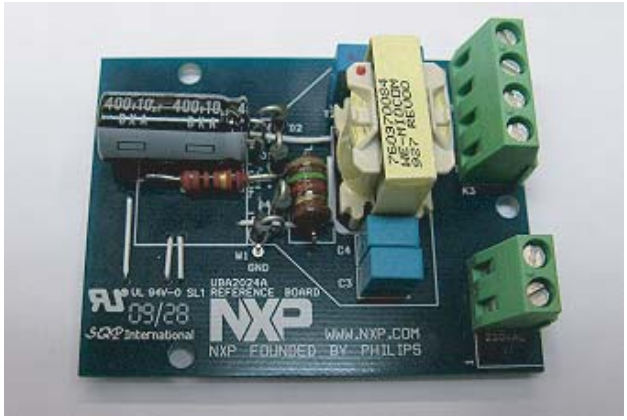

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Fig 3. UBA2024AT 230 V (AC) mains demo board

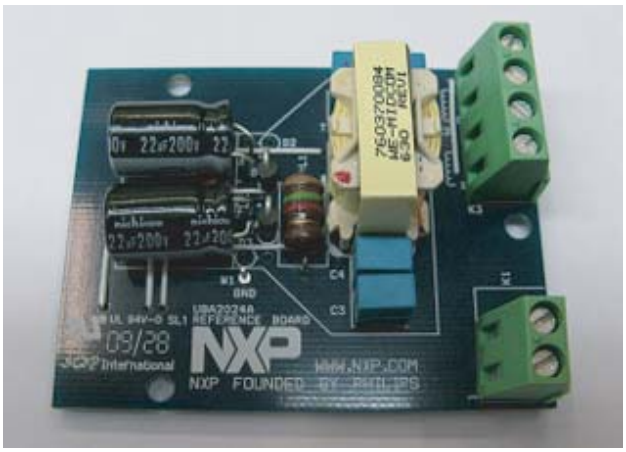

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Fig 4. UBA2024AT 120 V (AC) mains demo board

The UBA2024AT demo board is set up to drive an 18 W burner with a G24q-2 type of socket. The specifications for this setup are:

230 V (AC):

- Input voltage range: 230 V (AC); ± 15 %; 50 Hz
- Input power: 18 W at 230 V (AC)
- Input current: 145 mA at 230 V (AC)
- Power factor: 0.54
- Running frequency 44 kHz; start frequency 110 kHz
- 700 ms quasi-preheat

120 V (AC):

- Input voltage range: 120 V (AC); ± 15 %; 60 Hz
- Input power: 18 W at 120 V (AC)
- Input current: 255 mA at 120 V (AC)
- Power factor: 0.59
- Running frequency 44 kHz; start frequency 110 kHz
- 700 ms quasi-preheat

Protective functions:

- No load and lamp removal protection by means of external protection circuit

Burners:

- Osram Dulux D/E 18 W; 4-pin; G24q-2
- Philips PL-C 18 W; 4-pin; G24q-2

- General Electric F18DBX ECO 4P; G24q-2

Other burners that are electrically possible and safe to use:

- Osram Dulux T/E 18 W; 4-pin; Gx24q-2
- Philips PL-T 18 W; 4-pin; Gx24q-2
- General Electric F18TBX ECO 4P; GX24q-2
- All T2 or T3 16.5 W burners with 80 V lamp voltage and 210 mA lamp current

3.1 Board connections

The connection to the lamp is very straight forward as the Figure 5 and Figure 6 show. The board has been designed to accommodate layouts for 120 V (AC) or 230 V (AC) line voltages. An ordered board is preset for a certain line voltage. The labeling on the board for the mains voltage connector has been designed in such a way that the correct line voltage label becomes visible when the two way screw terminal block for the mains voltage is soldered to the proper position.

When a board for a specific line voltage is ordered, the customer is free to set it up for a different line voltage. Ensure that the position of the two way screw terminal block is changed accordingly, so the correct mains voltage label is visible.

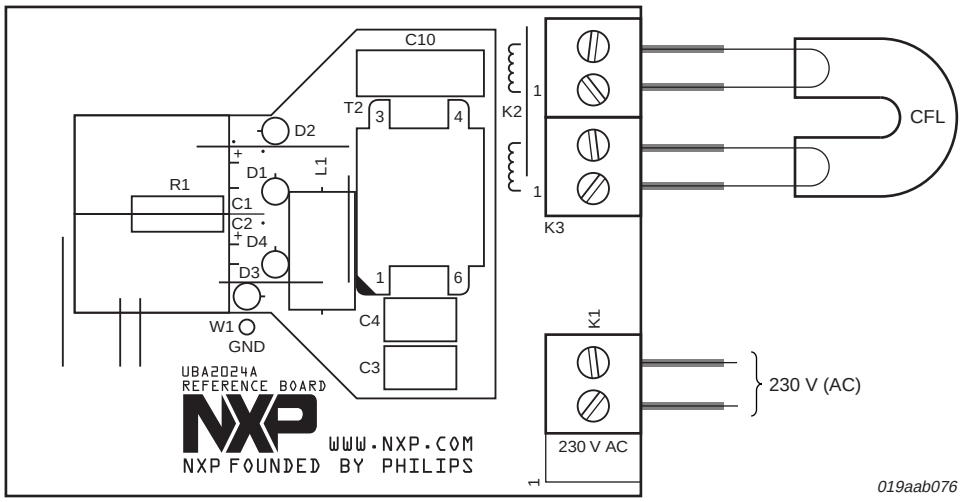

Fig 5. Connecting the 230 V (AC) mains demo board

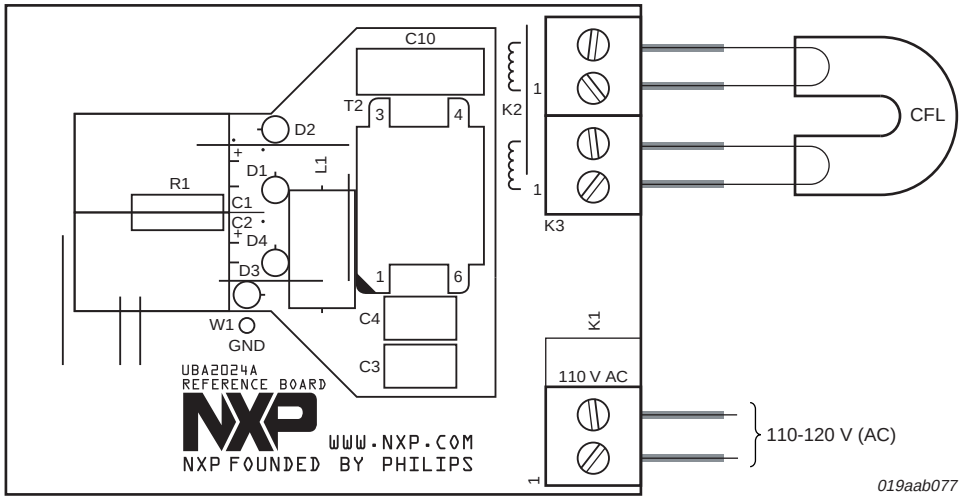

Fig 6. Connecting the 120 V (AC) mains demo board

3.2 Lamp inductor selection

The inductor supplied with this board has been made to accommodate three inductors in one. This makes setting up the board for different lamp powers easier, since it is much easier to change the lamp capacitor than the lamp inductor. It also speeds up the design time (see Section 5 and the application note *AN10713 "18 W CFL lamp design using UBA2024 application development tool and application examples"*.

Figure 5 shows how to select a different lamp inductor. The inductor can be set for 2.1 mH (default setting on delivery for the 18 W lamp), 2.7 mH, and 3.1 mH, The saturation current for the 2.1 mH inductor setting is 1.1 A at 125 °C ambient.

Remark: Only short one jumper, otherwise the inductor windings become shorted.

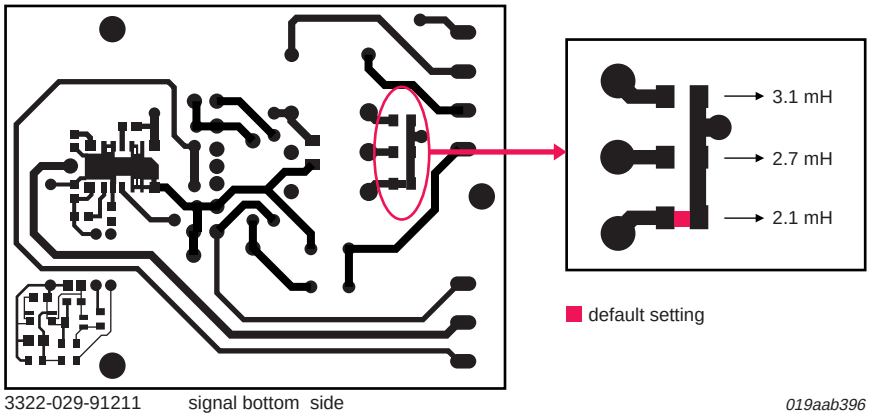

Fig 7. Selecting the lamp inductor by resistor programming on the bottom side of the board

3.3 Bill of materials 18 W lamp

Table 1. 18 W lamp (16.5 W; 145 mA burner; requiring warm ignition; f_O = 45 kHz)

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R_{FUS}	fusible inrush current limiter resistor	special type, fusible, high peak power	6.8 Ω	10 Ω
D1, D2	voltage doubler diodes	-	1N4007	-
D1, D4	bridge rectifier diodes	-	-	1N4007
C_{BUF1}, C_{BUF2}	buffer capacitors	high temperature electrolytic type	22 μF; 200 V	-
C_{BUF1}	buffer capacitor	high temperature electrolytic type	-	10 μF; 400 V
L_{FILT}	filter inductor	axial type	1.5 mH; 300 mA	1.5 mH; 300 mA
C_{HB1}, C_{HB1}	half-bridge capacitors	-	100 nF; 400 V	100 nF; 400 V
C_{LA}	lamp capacitor	high voltage polypropylene film type capable of withstanding peak voltages	2.2 nF; 800 V	2.2 nF; 800 V
L_{LA}	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see Section 6); J1 = closed; J2 = open; J3 = open	2.1 mH	2.1 mH
C_{DV}	dV/dt limiting capacitor	-	220 pF; 500 V	220 pF; 500 V
C_{FS}	floating supply buffer capacitor	SMD: X7R type; leaded; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{VDD}	low voltage supply buffer capacitor	SMD: X7R type; leaded; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{OSC}	oscillator capacitor	SMD: NP0 type; leaded: C0G type, preferably high accuracy value type	100 pF; 50 V; 2 %	100 pF; 50 V; 2 %
R_{OSC}	oscillator resistor	preferably E96 series high accuracy value type	200 kΩ; 1/8 W; 1 %	200 kΩ; 1/8 W; 1 %
C_{SW}	sweep time capacitor	SMD: X7R type; leaded; PET type; high temperature	220 nF; 50 V	220 nF; 50 V
U1	CFL half-bridge driver IC	NXP ordering code: 9352 895 91518	UBA2024AT	UBA2024AT

Table 2. Components values for the optional lamp detection circuit

Reference	Description	Remarks	Value
R3	resistor	preferably E24 series high accuracy value type	220 kΩ; 0.125 W; 1 %
R4	resistor	preferably E24 high accuracy value type	33 kΩ; 0.125 W; 1 %
R5	resistor	-	180 kΩ; 0.125 W
R6, R7	resistor	-	1 MΩ; 0.125 W
C11	ignition time-out capacitor	MLCC X7R type with a voltage rating ≥10 V	3.3 μF; 10 V
C12	capacitor	ceramic or MLCC NP0 or leaded C0G type	220 pF; 16 V
D5	double diode common cathode	-	-
Q1-1, Q2-2	PNP/NPN transistor in one package or use separate transistors.	h_{fe} > 100 at 10 μA	BC847BNP
	Q1-1	h_{fe} > 100 at 10 μA	BC847B
	Q2-2	h_{fe} > 100 at 10 μA	BC857B

4. Thermal considerations for the SO14 package

As can be seen on Figure 3 and Figure 4 the board outline for the UBA2024AT in the SO14 package drawn on the demo board is T shaped. The reason for this shape is that an actual board with a similar shape is intended to be mounted vertically into a CFL lamp base. In this way distance is created between lamp filaments and the IC.

In most situations, the PCB is mounted horizontally into a lamp base, but since the UBA2024AT is a SMD component this would mean the IC is very close to the lamp filaments. The lamp filaments would directly radiate heat onto the IC. This would limit the IC drive capabilities. It is recommended to either mount some form of heat shield in between the lamp filaments and the PCB or to mount the PCB in vertically into the lamp socket. This increases the distance between IC and Lamp filaments.

Another solution is to mount the SMD components: C_{FS}, C_{VDD}, C_{OSC}, R_{OSC}, C_{SW} and the UBA2024AT onto a separate PCB and mount this PCB perpendicular onto a horizontal PCB under the lamp that contains all the leaded components. In this way the horizontal PCB serves as a shield between the lamp filaments and the heat sensitive components on the vertical PCB.

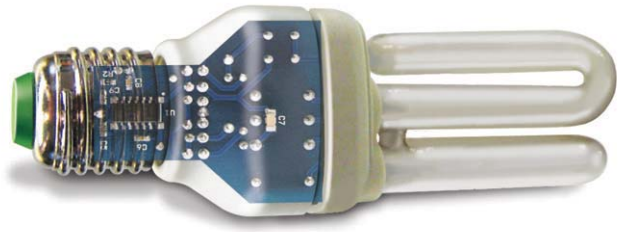

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Fig 8. Proposed board placement in a lamp for the UBA2024AT to reduce radiated heat to the IC

5. Examples of different lamp powers

5.1 8 W lamp

Table 3. 8 W lamp (7 W; 150 mA burner; suited for cold ignition; f_O = 46 kHz)

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R_{FUS}	fusible inrush current limiter resistor	special type, fusible, high peak power	10 Ω	39 Ω
D1, D2	voltage doubler diodes		1N4007	-
D1, D4	bridge rectifier diodes		-	1N4007
C_{BUF1},C_{BUF2}	buffer capacitors	high temperature electrolytic type	10 μF; 200 V	-
C_{BUF1}	buffer capacitor	high temperature electrolytic type		3.3 μF; 400 V
L_{FILT}	filter inductor	axial type	2.7 mH; 200 mA	2.7 mH; 200 mA
C_{HB1}, C_{HB1}	half -bridge capacitors		47 nF; 400 V	47 nF; 400 V
C_{LA}	lamp capacitor	high voltage polypropylene film type capable of withstanding peak voltages	1.5 nF; 800 V	1.5 nF; 800 V
L_{LA}	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see Section 6); J1 = open; J2 = open; J3 = short	3.1 mH	3.1 mH
C_{DV}	dV/dt limiting capacitor		220 pF; 500 V	220 pF; 500 V
C_{FS}	floating supply buffer capacitor	SMD: X7R type; leaded; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{VDD}	low voltage supply buffer capacitor	SMD: X7R type; leaded; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{OSC}	oscillator capacitor	SMD: NP0 type; leaded: C0G type, preferably high accuracy value type	180 pF; 50 V; 2 %	180 pF; 50 V; 2 %
R_{OSC}	oscillator resistor	preferably E24 series high accuracy value type	110 kΩ; 1/8 W; 1 %	110 kΩ; 1/8 W; 1 %
C_{SW}	sweep time capacitor	SMD: X7R type; leaded; PET type; high temperature	68 nF; 50 V	68 nF; 50 V

5.2 11 W lamp

Table 4. 11 W lamp (9.5 W; 150 mA burner; suited for cold ignition; f_O = 42.5 kHz)

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R_{FUS}	fusible inrush current limiter resistor	special type, fusible, high peak power	8.2 Ω	33 Ω
D1, D2	voltage doubler diodes		1N4007	-
D1, D4	bridge rectifier diodes		-	1N4007
C_{BUF1},C_{BUF2}	buffer capacitors	high temperature electrolytic type	15 μF; 200 V	-
C_{BUF1}	buffer capacitor	high temperature electrolytic type	-	4.7 μF; 400 V
L_{FILT}	filter inductor	axial type	2.7 mH; 200 mA	2.7 mH; 200 mA
C_{HB1}, C_{HB1}	half-bridge capacitors		47 nF; 400 V	47 nF; 400 V
C_{LA}	lamp capacitor	high voltage polypropylene film type capable of withstanding peak voltages	1.5 nF; 800 V	1.5 nF; 800 V

Table 4. 11 W lamp (9.5 W; 150 mA burner; suited for cold ignition; f_O = 42.5 kHz) *...continued*

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
L_{LA}	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see Section 6); J1 = open; J2 = open; J3 = short	3.1 mH	3.1 mH
C_{DV}	dV/dt limiting capacitor		220 pF; 500 V	220 pF; 500 V
C_{FS}	floating supply buffer capacitor	SMD: X7R type; leaded:; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{VDD}	low voltage supply buffer capacitor	SMD: X7R type; leaded:; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{OSC}	oscillator capacitor	SMD: NP0 type; leaded: C0G type, preferably high accuracy value type	180 pF; 50 V; 2 %	180 pF; 50 V; 2 %
R_{OSC}	oscillator resistor	preferably E24 series high accuracy value type	120 kΩ; 1/8 W; 1 %	120 kΩ; 1/8 W; 1 %
C_{SW}	sweep time capacitor	SMD: X7R type; leaded:; PET type; high temperature	68 nF; 50 V	68 nF; 50 V

5.3 13 W lamp

Table 5. 13 W lamp (12 W; 150 mA burner; suited for warm ignition; f_O = 44 kHz)

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R_{FUS}	fusible inrush current limiter resistor	special type, fusible, high peak power	6.8 Ω	10 Ω
D1, D2	voltage doubler diodes		1N4007	-
D1, D4	bridge rectifier diodes		-	1N4007
C_{BUF1},C_{BUF2}	buffer capacitors	high temperature electrolytic type	10 μF; 200 V	-
C_{BUF1}	buffer capacitor	high temperature electrolytic type	-	6.8 μF; 400 V
L_{FILT}	filter inductor	axial type	2.2 mH; 200 mA	2.2 mH; 200 mA
C_{HB1}, C_{HB1}	half-bridge capacitors		100 nF; 400 V	100 nF; 400 V
C_{LA}	lamp capacitor	high voltage polypropylene film type capable of withstanding peak voltages	1.5 nF; 800 V	1.5 nF; 800 V
L_{LA}	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see Section 6); J1 = open; J2 = open; J3 = short	3.1 mH	3.1 mH
C_{DV}	dV/dt limiting capacitor		220 pF; 500 V	220 pF; 500 V
C_{FS}	floating supply buffer capacitor	SMD: X7R type; leaded; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{VDD}	low voltage supply buffer capacitor	SMD: X7R type; leaded; PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C_{OSC}	oscillator capacitor	SMD: NP0 type; leaded: C0G type, preferably high accuracy value type	100 pF; 50 V; 5 %	100 pF; 50 V; 5 %
R_{OSC}	oscillator resistor	preferably E24 series high accuracy value type	200 kΩ; 1/8 W; 1 %	200 kΩ; 1/8 W; 1 %
C_{SW}	sweep time capacitor	SMD: X7R type; leaded; PET type; high temperature	220 nF; 50 V	220 nF; 50 V

6. Inductor specification

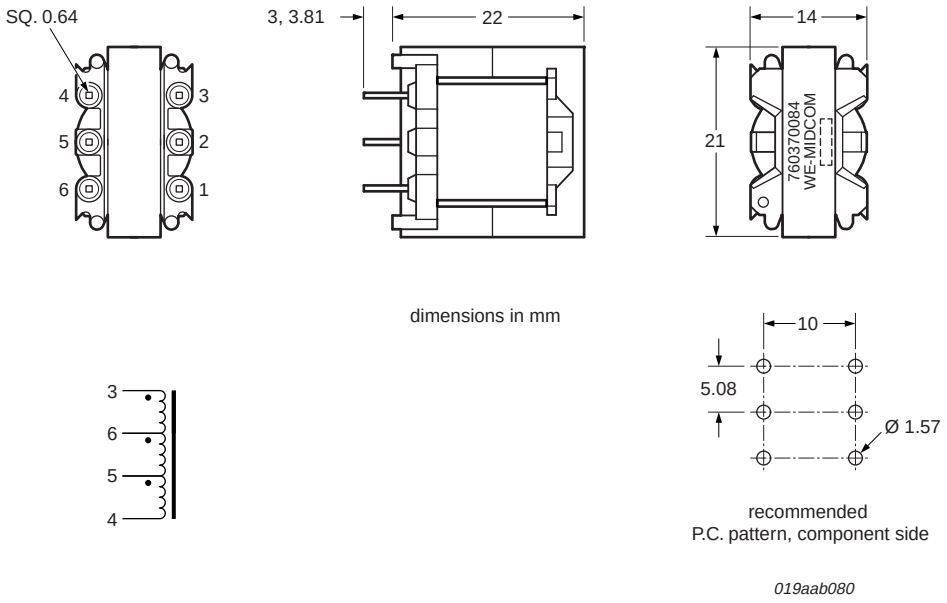

Fig 9. Inductor specification

Remark: The following electrical specifications are at 25 °C unless otherwise specified.

6.1 D.C. RESISTANCE (at 20 °C)

- 3 to 6: 4.75 Ω ± 20 %
- 6 to 5: 0.630 Ω ± 20 %
- 5 to 4: 0.465 Ω ± 20 %

6.2 INDUCTANCE

- 2.20 mH ± 10 %, 10 kHz, 100 m V (AC), 0 mA DC, 3 to 6, Ls
- 2.70 mH ± 15 %, 10 kHz, 100 m V (AC), 0 mA DC, 3 to 5, Ls
- 3.10 mH ± 15 %, 10 kHz, 100 m V (AC), 0 mA DC, 3 to 4, Ls

6.3 OPERATING TEMPERATURE RANGE

- –40 °C to +125 °C including temp rise

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