UM10388

UBA2024AP DIP8 18 W demo board

Rev. 3 — 27 January 2011 **User manual**

Document information

Info	Content
Keywords	UBA2024AP, half-bridge CFL driver, non-dimmable
Abstract	This document describes the correct use of the UBA2024AP 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	20110127	third issue
v.2	20100407	second issue
v.1	20091001	first issue

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 UBA2024AP 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 There are no THD requirements for mains power lower than 25 W, so a pre-conditioning function is obsolete.

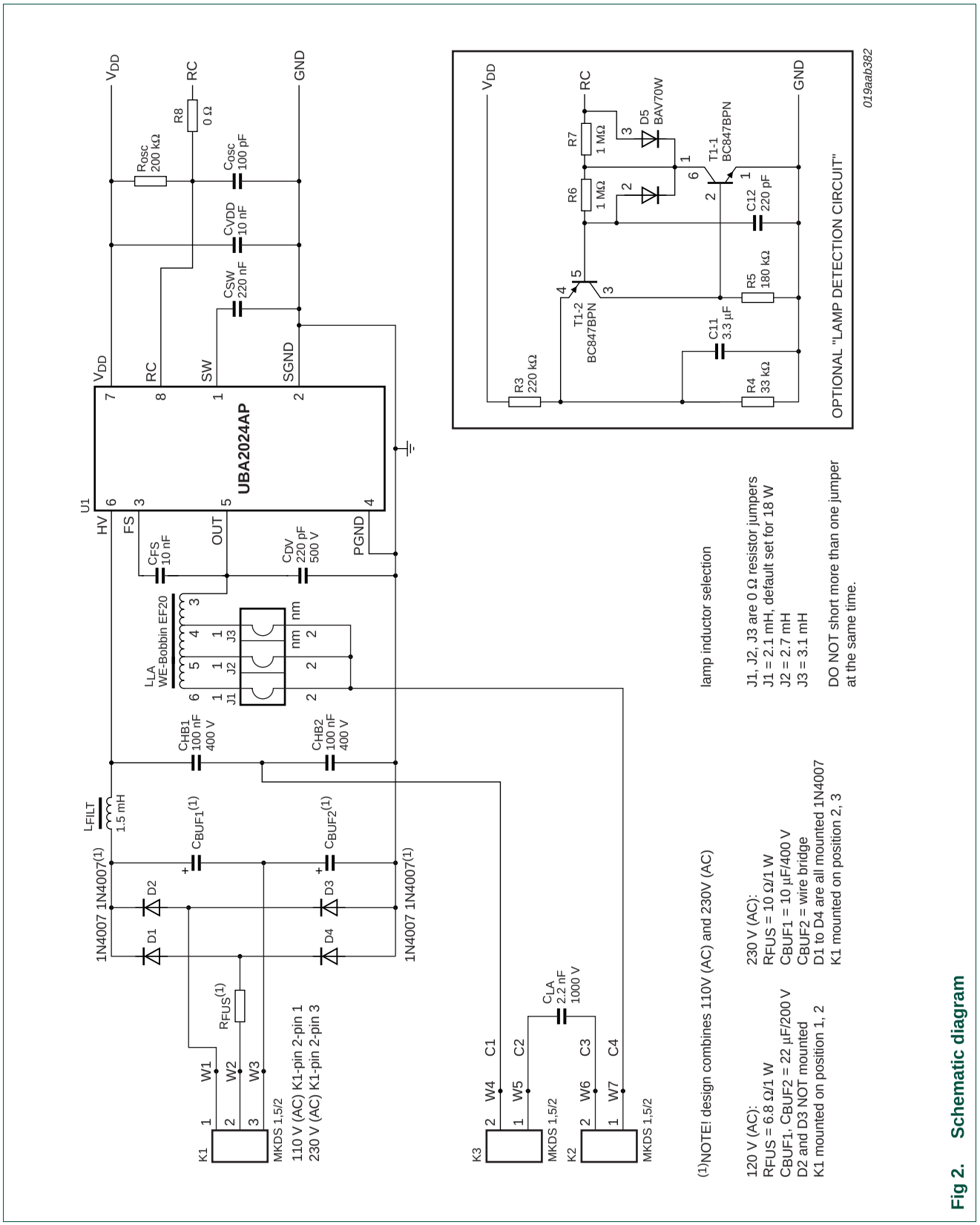
The circuit is set-up to perform a quasi preheat so the lamp will turn on approximately 0.7 s after the mains voltage has been applied to the board. For detailed design steps on the 18 W lamp solution or how to set-up lamps with other power ratings please consult the application note *AN10713 “18 W CFL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

The mains voltage operating range is either set for 90 V to 130 V (RMS) or 200 V to 250 V (RMS), depending on the ordered board. 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.

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

Remark: If the UBA2024AP is used in a non-integrated ballast or a 'matchbox' type of ballast, the protection circuit is required.

2. Schematic diagram



(1)NOTE! design combines 110V (AC) and 230V (AC)

120 V (AC):
RFUS = 6.8 Ω/1 W
CBUF1, CBUF2 = 22 µF/200 V
D2 and D3 NOT mounted
K1 mounted on position 1, 2

230 V (AC):
RFUS = 10 Ω/1 W
CBUF1 = 10 µF/400 V
CBUF2 = wire bridge
D1 to D4 are all mounted 1N4007
K1 mounted on position 2, 3

lamp inductor selection

J1, J2, J3 are 0 Ω resistor jumpers
J1 = 2.1 mH, default set for 18 W
J2 = 2.7 mH
J3 = 3.1 mH

DO NOT short more than one jumper at the same time.

Fig 2. Schematic diagram

3. Specification

019aab383

Fig 3. UBA2024AP 230 V (AC) mains demo board

019aab384

Fig 4. UBA2024AP 120 V (AC) mains demo board

The UBA2024AP 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

Protections:

- 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 suitable and safe to use are the following:

- 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. Make sure that the position of the two way screw terminal block is changed accordingly, so the correct mains voltage label becomes visible.

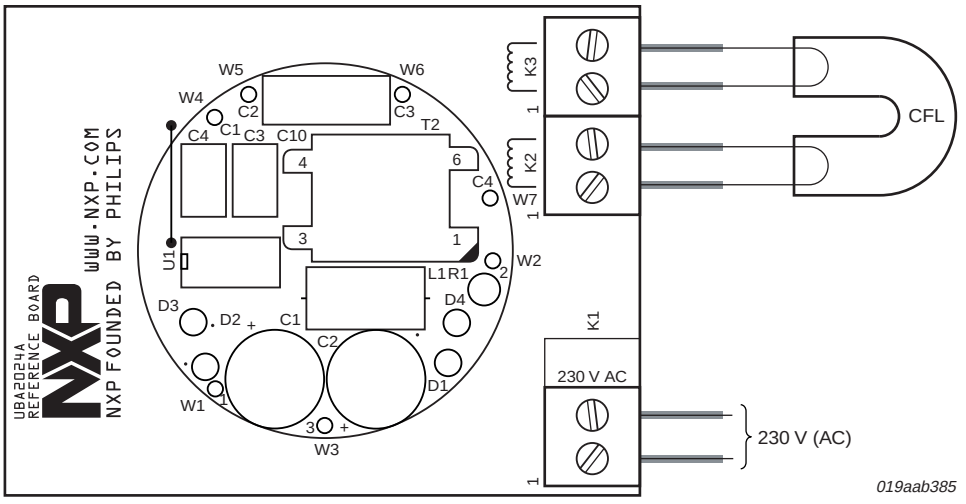


Fig 5. Connecting the 230 V (AC) mains demo board

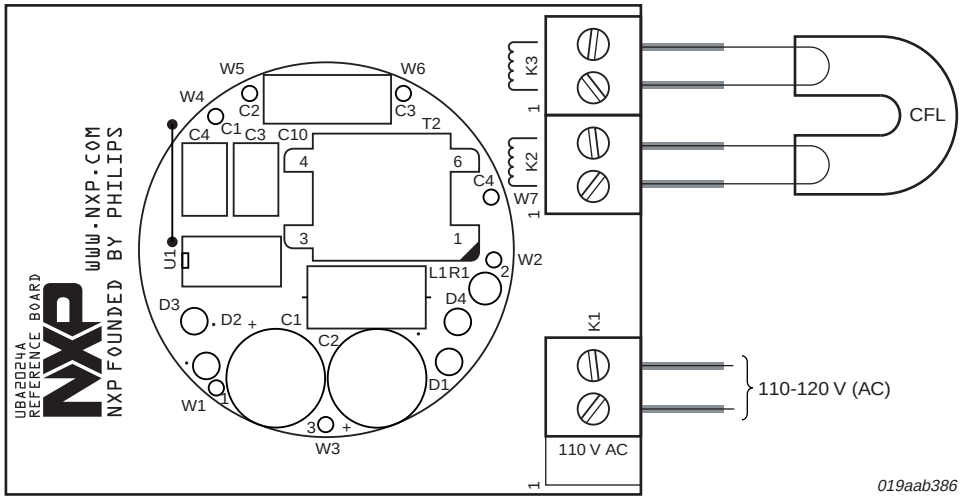


Fig 6. Connecting the 120 V (AC) mains demo board

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*).

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.

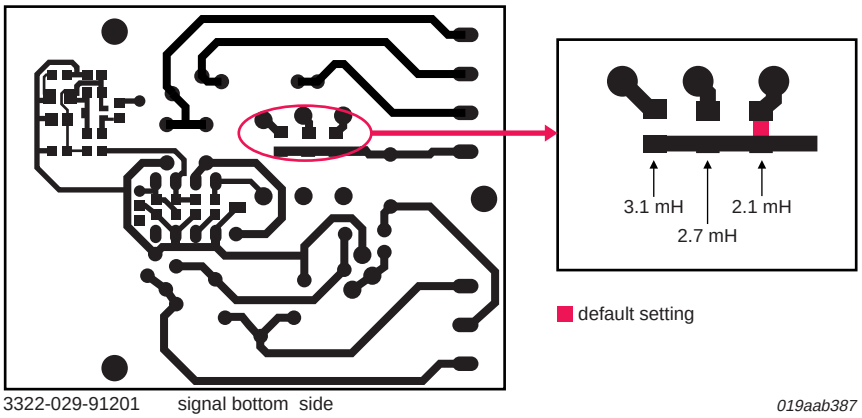


Fig 7. Selecting the lamp inductor by resistor programming on the bottom side of the board

3.3 Bill of material 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 888 01112	UBA2024AP	UBA2024AP

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 N0P or leaded C0G type	220 pF; 16 V
D5	double diode common cathode		

Table 2. Components values for the optional lamp detection circuit

Reference	Description	Remarks	Value
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. Conduction emissions test

Conducted emissions have been measured in neutral and line wires using a pre-compliance test setup, considering the limits for lighting applications, i.e. EN55015. The measurements have been performed at 230 V (AC) line voltage. The results are shown in Figure 8 and Figure 9. The emission level is below both the quasi peak and the average limits with an acceptable margin.

The measurements taken are only valid for this particular board design. The board layout can be used as a guide to set-up the actual design, but there is no absolute guarantee that the final product will pass the conducted EMI test. The board shown is only part of a total product (including housing and wiring) that needs to pass.

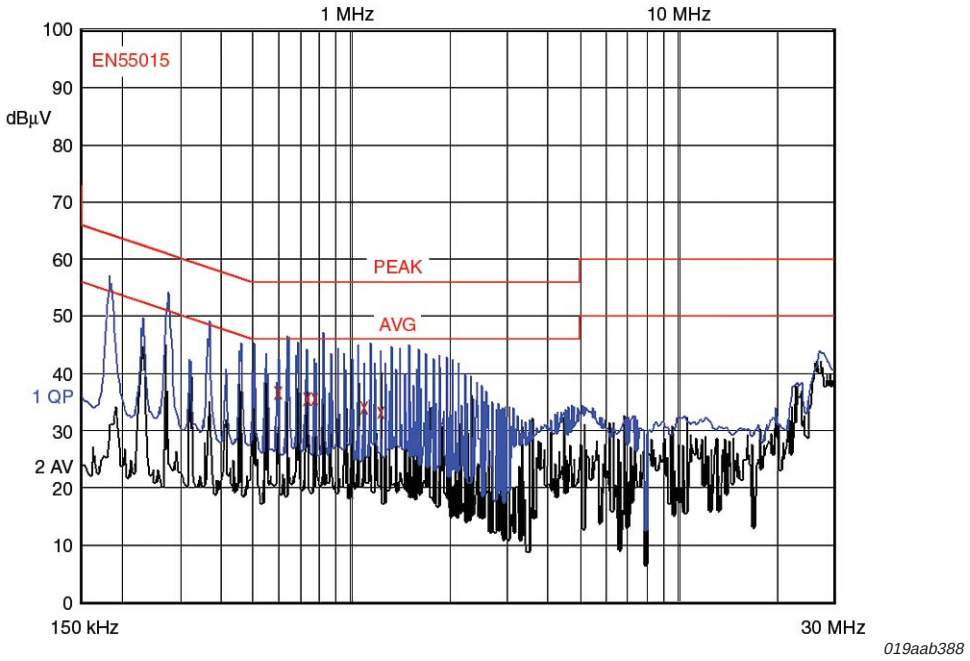


Fig 8. Conducted EMI 230 V; 50 Hz, in line, quasi peak (QP blue trace) and average (AV black trace)

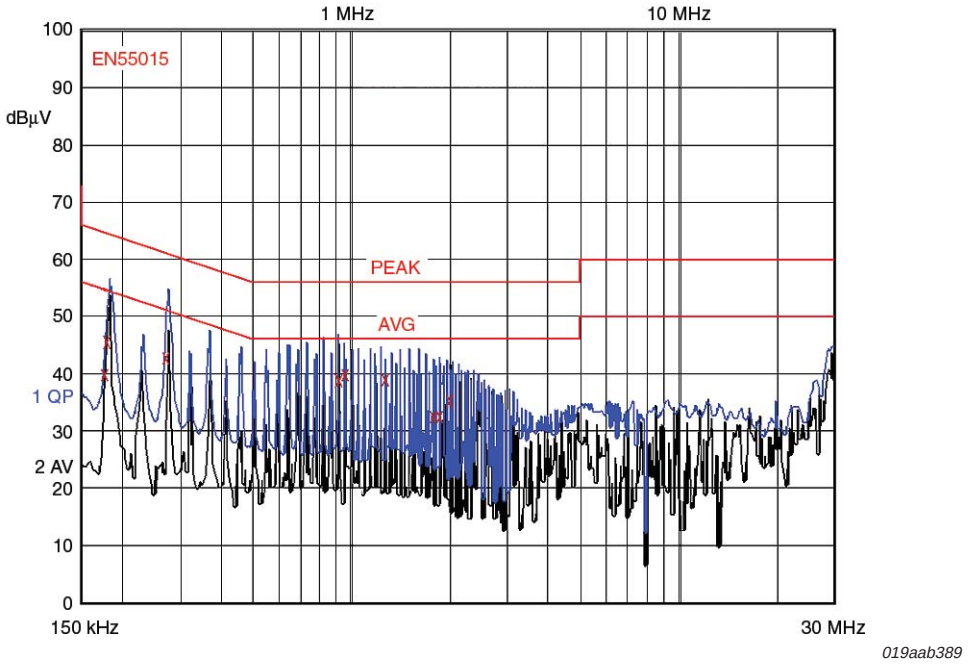


Fig 9. Conducted EMI 230 V; 50 Hz, in neutral, quasi peak (QP blue trace) and average (AV black trace)

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 = closed; J2 = open; J3 = open	3.1 mH	3.1 mH
C_{DV}	dV/dt limiting capacitor		220 pF; 500 V	220 pF; 500 V

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
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
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: film type preferably high accuracy value type	100 pF; 50 V; 2 %	100 pF; 50 V; 2 %
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

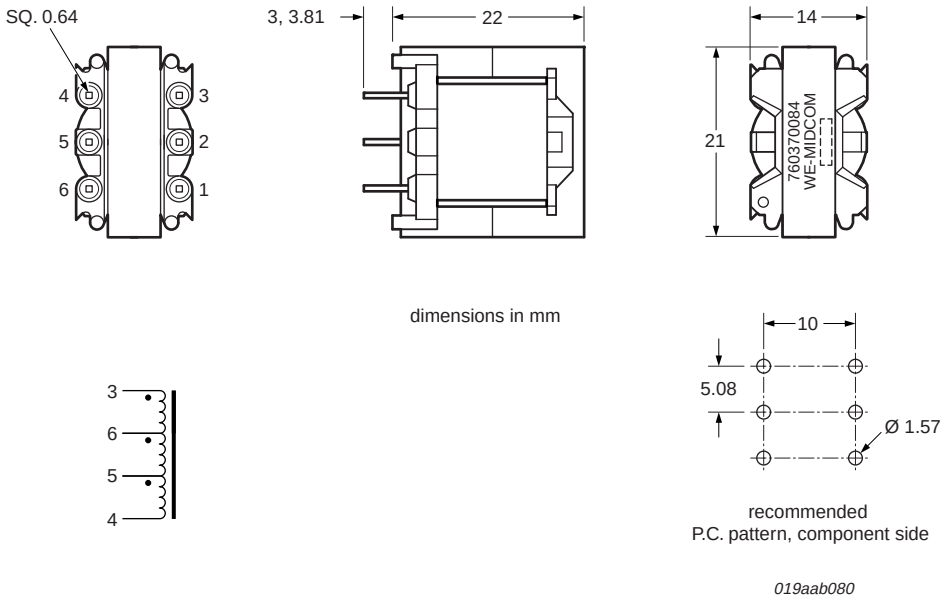


Fig 10. Inductor specification

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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