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Kind regards,

Team Nexperia

# UM10393

UBA2024P DIP8 13 W demo board

Rev. 3 — 25 January 2011

User manual

## Document information

Info	Content
<b>Keywords</b>	UBA2024P, half-bridge CFL driver, non-dimmable
<b>Abstract</b>	This document describes the correct use of the UBA2024P half-bridge CFL driver demo boards for both 120 V and 230 V mains voltages and some circuit examples for up to 13 W.



**Revision history**

Rev	Date	Description
v.3	20110125	third issue
v.2	20100407	second issue
v.1	20091002	First issue

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# 1. Introduction

## 1.1 Safety warning

**WARNING**

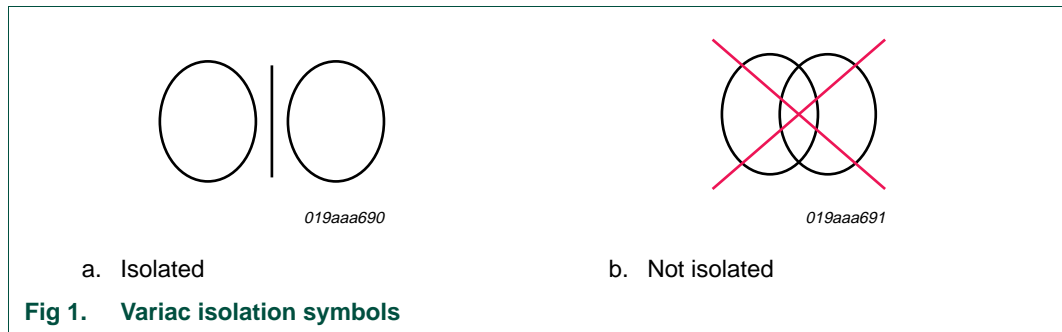
**Lethal voltage and fire ignition hazard**



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.

The board needs to be connected to mains voltage. Touching the reference board during operation must be avoided at all times. 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. These devices can be recognized by the symbols shown in [Figure 1](#):



## 1.2 General description

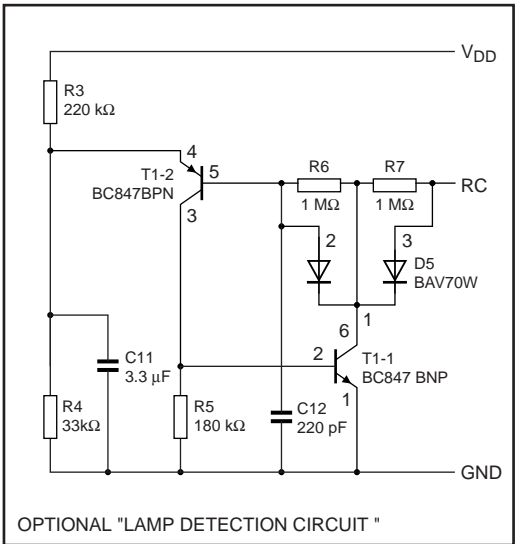
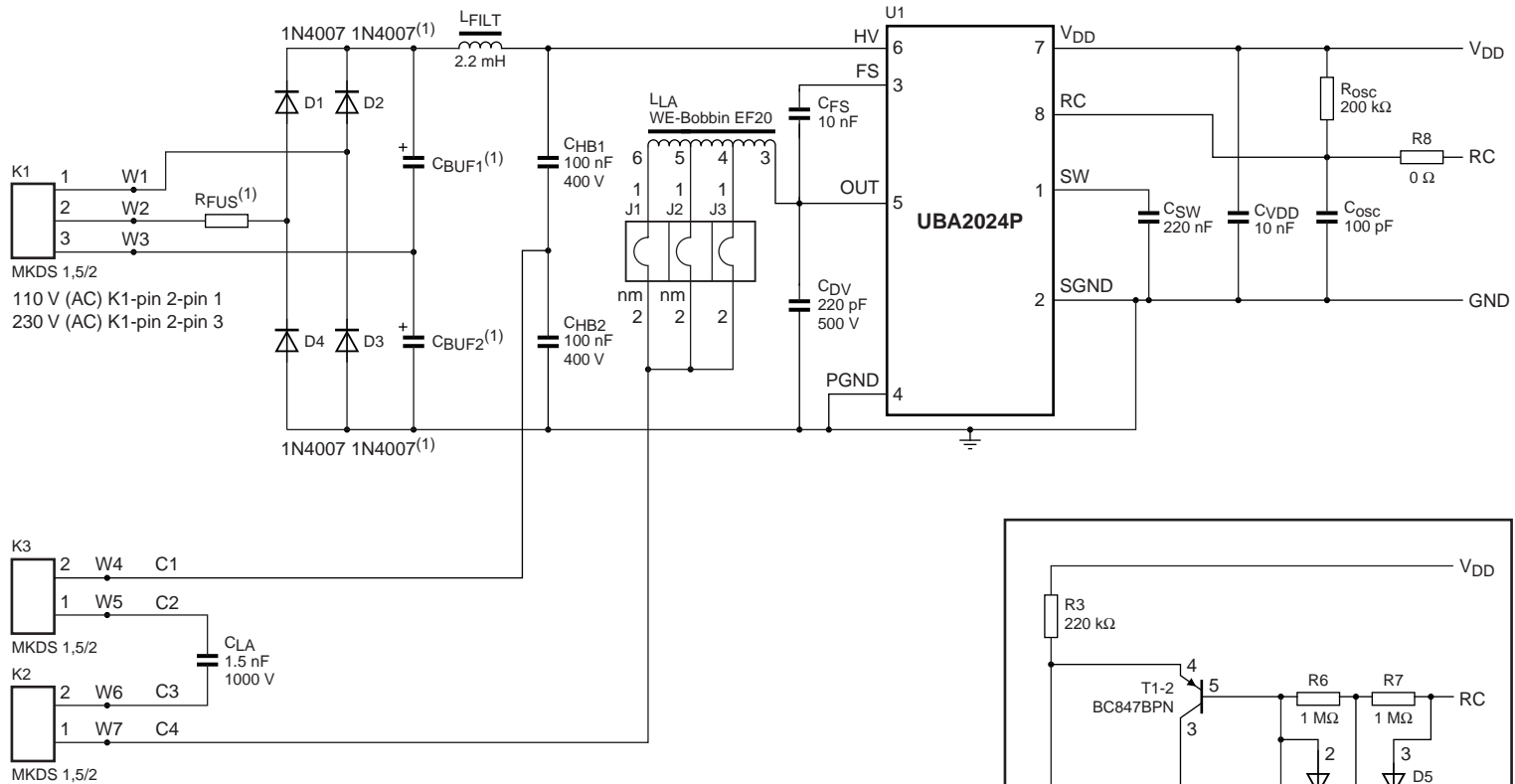
The UBA2024P circuit is a half-bridge driver IC, which has been set-up to drive a standard PLC-18W, G24q-2 socket based lamp or similar lamp types with a nominal lamp power of 12.5 W. The total power drawn from the mains is about 13 W at a nominal mains voltage of 230 V (RMS); 50 Hz or 120 V (RMS); 60 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 UBA2024P demo board is not recommended for driving lower voltage linear lighting lamps like the T5 or the T8. For these type of lamps the UBA2021 is the better option. The IC is able to drive lamps up to 15 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 do 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 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 set either to 90 to 130 V (RMS) or to 200 to 250 V (RMS). Both voltage range strappings have been incorporated in one board layout. This makes it easier to set-up the same board with a different voltage range. Since the IC was basically 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 the board 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 UBA2024P is used in a non-integrated ballast or a 'matchbox' type of ballast, the protection circuit is a requirement.

2. Schematic diagram



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

120 V (AC):  
 RFUS = 6.8 Ω/1 W  
 CBUF1, CBUF2 = 10 μF/200 V  
 D2 and D3 NOT mounted  
 K1 mounted on position 1, 2

230 V (AC):  
 RFUS = 10 Ω/1 W  
 CBUF = 6.8 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  
 J2 = 2.7 mH  
 J3 = 3.1 mH, default set for 13 W

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

Fig 2. Schematic diagram

### 3. Specification



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Fig 3. UBA2024P 230 V (AC) mains demo board



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Fig 4. UBA2024P 120 V (AC) mains demo board

The UBA2024P demo board is set-up to drive an 13 W burner with a G24q-1 type of socket. The specifications for this setup are:

#### 230 V (AC):

- Input voltage range: 230 V (AC);  $\pm 15\%$ ; 50 Hz
- Input power: 13 W at 230 V (AC)
- Input current: 105 mA at 230 V (AC)
- Power factor: 0.55
- Running frequency 44 kHz; start frequency 110 kHz
- 700 ms quasi-preheat

#### 120 V (AC):

- Input voltage range: 120 V (AC);  $\pm 15\%$ ; 60 Hz
- Input power: 13 W at 120 V (AC)
- Input current: 180 mA at 120 V (AC)
- Power factor: 0.58
- 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 13 W; 4-pin; G24q-1
- Philips PL-C 13 W; 4-pin; G24q-1
- General Electric F13DBX ECO 4P; G24q-1

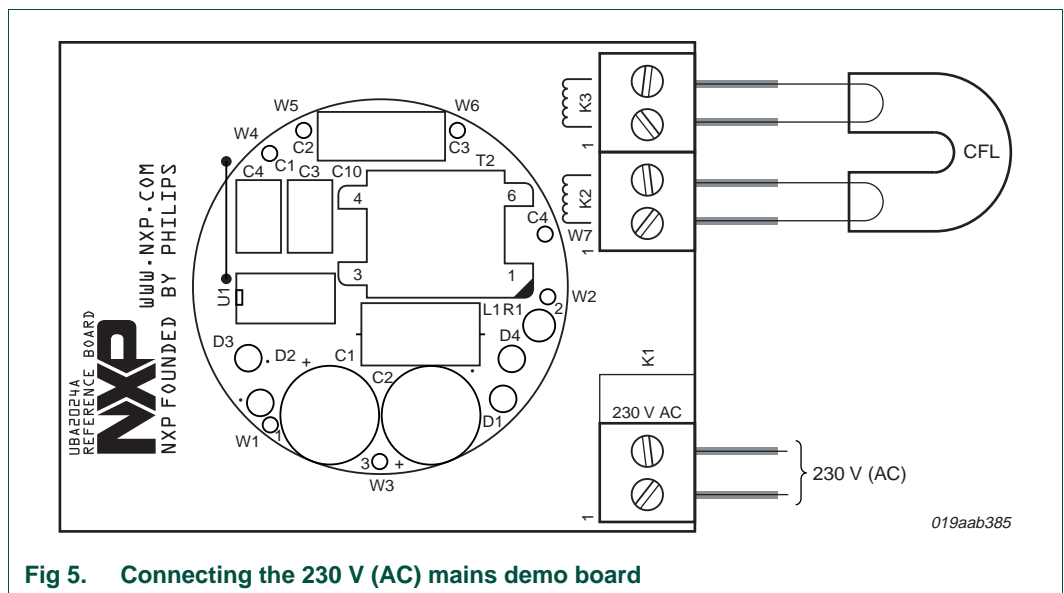
The following burners are electrically possible and safe to use:

- Osram Dulux T/E 13 W; 4-pin; Gx24q-1
- Philips PL-T 13 W; 4-pin; Gx24q-1
- General Electric F13TBX ECO 4P; GX24q-1
- All T2 or T3 12.5 W burners with 80 V lamp voltage and 165 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 is visible.



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



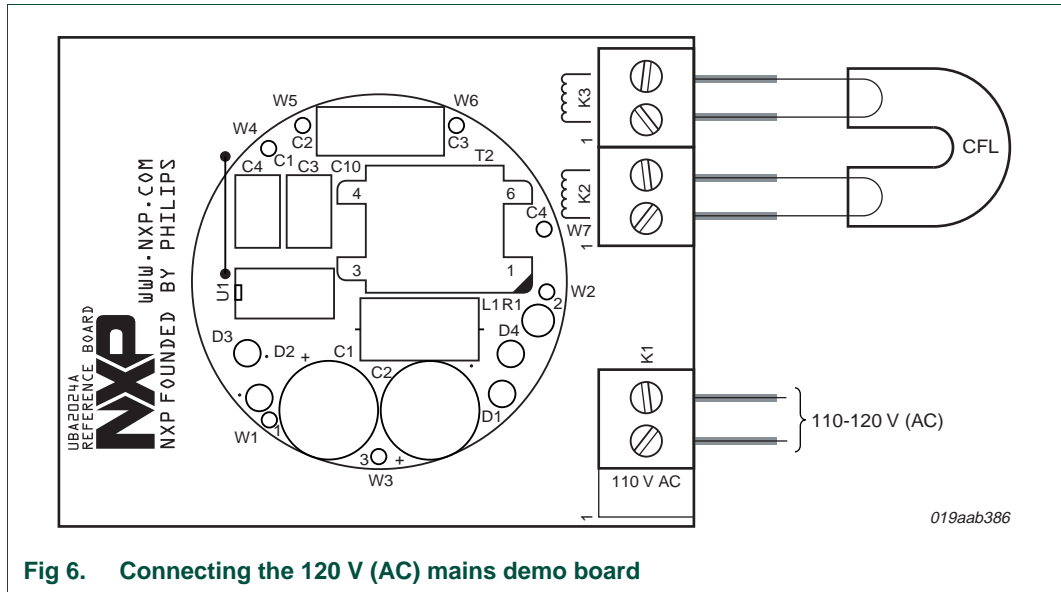


Fig 6. Connecting the 120 V (AC) mains demo board

### 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*).

[Figure 5](#) shows how to select a different lamp inductor. The inductor can be set for 3.1 mH (default setting on delivery for the 13 W lamp), 2.7 mH, and 2.1 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.

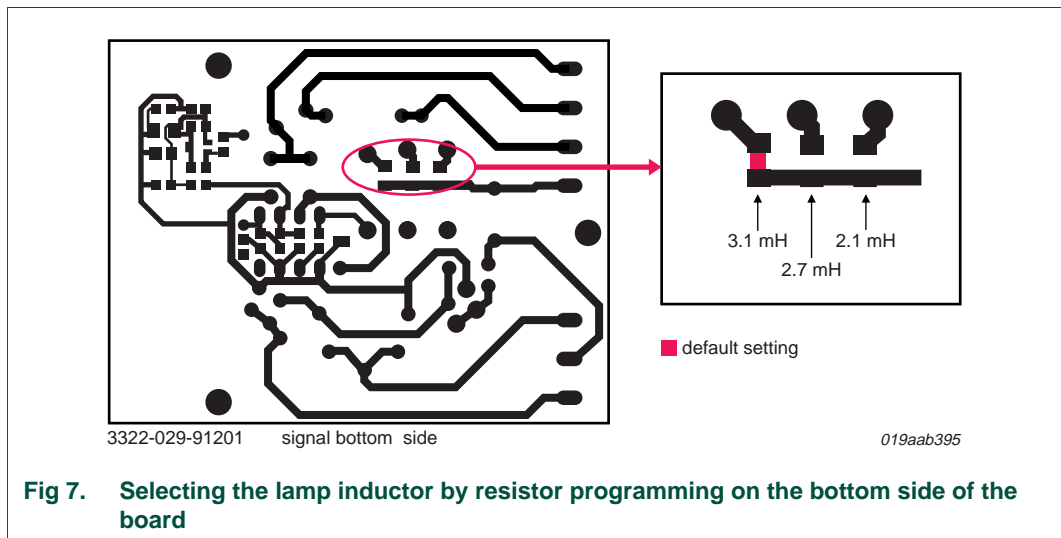


Fig 7. Selecting the lamp inductor by resistor programming on the bottom side of the board

### 3.3 Bill of material 13 W lamp

**Table 1. 13 W lamp (12 W; 150 mA burner; requiring warm ignition;  $f_0 = 44$  kHz)**

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R <sub>FUS</sub>	fusible inrush current limiter resistor	special type, fusible, high peak power	6.8 $\Omega$	10 $\Omega$
D1, D2	voltage doubler diodes		1N4007	-
D1, D4	bridge rectifier diodes		-	1N4007
C <sub>BUF1</sub> , C <sub>BUF2</sub>	buffer capacitors	high temperature electrolytic type	10 $\mu$ F; 200 V	-
C <sub>BUF1</sub>	buffer capacitor	high temperature electrolytic type	-	6.8 $\mu$ F; 400 V
L <sub>FILT</sub>	filter inductor	axial type	2.2 mH; 200 mA	2.2 mH; 200 mA
C <sub>HB1</sub> , C <sub>HB1</sub>	half-bridge capacitors		100 nF; 400 V	100 nF; 400 V
C <sub>LA</sub>	lamp capacitor	high voltage polypropylene film type capable of withstanding peak voltages	1.5 nF; 800 V	1.5 nF; 800 V
L <sub>LA</sub>	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see <a href="#">Section 6</a> ); J1 = open; J2 = open; J3 = closed	3.1 mH	3.1 mH
C <sub>DV</sub>	dV/dt limiting capacitor		220 pF; 500 V	220 pF; 500 V
C <sub>FS</sub>	floating supply buffer capacitor	SMD: X7R type; leaded: PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C <sub>VDD</sub>	low voltage supply buffer capacitor	SMD: X7R type; leaded: PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C <sub>OSC</sub>	oscillator capacitor	SMD: NP0 type; leaded: C0G type, preferably high accuracy value type	100 pF; 50 V; 2 %	100 pF; 50 V; 2 %
R <sub>OSC</sub>	oscillator resistor	Preferably E96 series high accuracy value type	200 k $\Omega$ ; 1/8 W; 1 %	200 k $\Omega$ ; 1/8 W; 1 %
C <sub>SW</sub>	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 743 32112	UBA2024P	UBA2024P

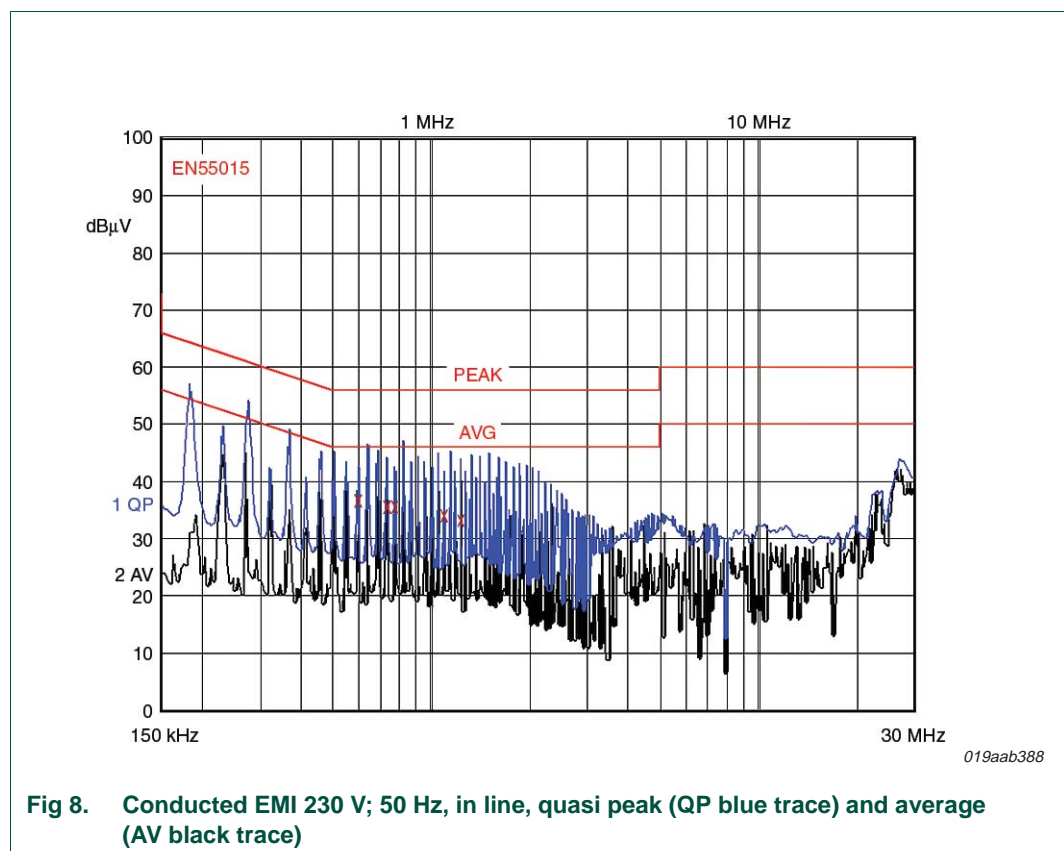
**Table 2. Components values for the optional lamp detection circuit**

Reference	Description	Remarks	Value
R3	resistor	preferably E24 series high accuracy value type	220 k $\Omega$ ; 0.125 W; 1 %
R4	resistor	preferably E24 high accuracy value type	33 k $\Omega$ ; 0.125 W; 1 %
R5	resistor		180 k $\Omega$ ; 0.125 W
R6, R7	resistor		1 M $\Omega$ ; 0.125 W
C11	ignition time-out capacitor	MLCC X7R type with a voltage rating $\geq 10$ V	3.3 $\mu$ F; 10 V
C12	capacitor	ceramic or NP0; 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 $\mu$ A	BC847BNP
	Q1-1	$h_{fe} > 100$ at 10 $\mu$ A	BC847B
	Q2-2	$h_{fe} > 100$ at 10 $\mu$ A	BC857B

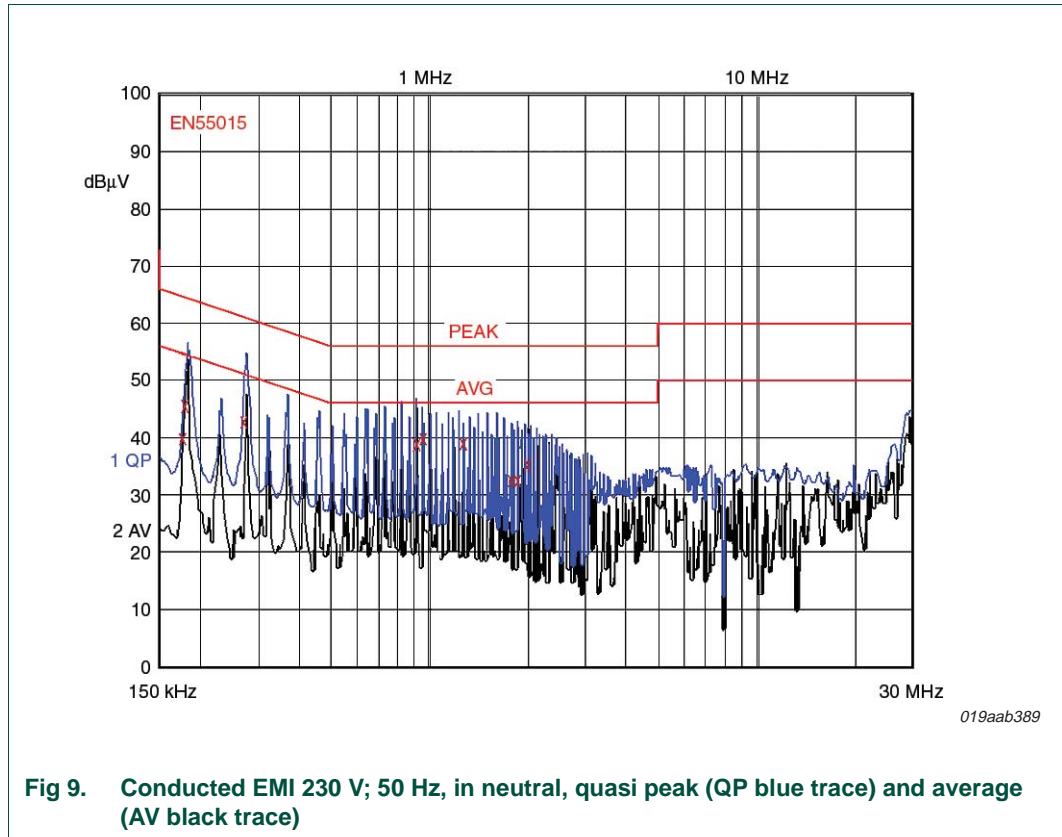
## 4. Conduction emissions test

Conducted emissions have been measured in neutral and line wires using a pre-compliance test setup and 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)**



## 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;  $f_0 = 46$  kHz)**

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R <sub>FUS</sub>	fusible inrush current limiter resistor	special type, fusible, high peak power	10 $\Omega$	39 $\Omega$
D1, D2	voltage doubler diodes		1N4007	-
D1, D4	bridge rectifier diodes		-	1N4007
C <sub>BUF1</sub> , C <sub>BUF2</sub>	buffer capacitors	high temperature electrolytic type	10 $\mu$ F; 200 V	-
C <sub>BUF1</sub>	buffer capacitor	high temperature electrolytic type	-	3.3 $\mu$ F; 400 V
L <sub>FILT</sub>	filter inductor	axial type	2.7 mH; 200 mA	2.7 mH; 200 mA
C <sub>HB1</sub> , C <sub>HB1</sub>	half-bridge capacitors		47 nF; 400 V	47 nF; 400 V
C <sub>LA</sub>	lamp capacitor	high voltage polypropylene film type capable of withstanding peak voltages	1.5 nF; 800 V	1.5 nF; 800 V
L <sub>LA</sub>	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see <a href="#">Section 6</a> ); J1 = open; J2 = open; J3 = short	3.1 mH	3.1 mH
C <sub>DV</sub>	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;  $f_0 = 46$  kHz)**

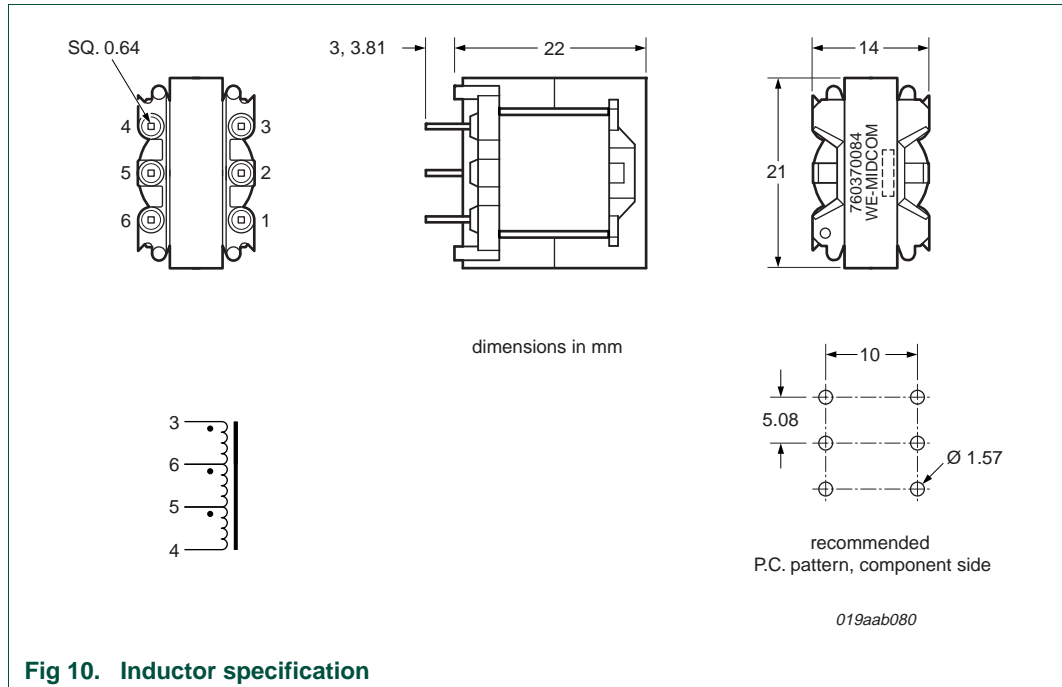
Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
C <sub>F5</sub>	floating supply buffer capacitor	SMD: X7R type; leaded: PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C <sub>VDD</sub>	low voltage supply buffer capacitor	SMD: X7R type; leaded: PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C <sub>OSC</sub>	oscillator capacitor	SMD: NP0 type; leaded: C0G type, preferably high accuracy value type	180 pF; 50 V; 2 %	180 pF; 50 V; 2 %
R <sub>OSC</sub>	oscillator resistor	preferably E24 series high accuracy value type	110 k $\Omega$ ; 1/8 W; 1 %	110 k $\Omega$ ; 1/8 W; 1 %
C <sub>SW</sub>	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;  $f_0 = 42.5$  kHz)**

Reference	Description	Remarks	115 V; 60 Hz	230 V; 50 Hz
R <sub>FUS</sub>	fusible inrush current limiter resistor	Special type, fusible, high peak power	8.2 $\Omega$	33 $\Omega$
D1, D2	voltage doubler diodes		1N4007	-
D1, D4	bridge rectifier diodes		-	1N4007
C <sub>BUF1</sub> , C <sub>BUF2</sub>	buffer capacitors	high temperature electrolytic type	15 $\mu$ F; 200 V	-
C <sub>BUF1</sub>	buffer capacitor	high temperature electrolytic type	-	4.7 $\mu$ F; 400 V
L <sub>FILT</sub>	filter inductor	axial type	2.7 mH; 200 mA	2.7 mH; 200 mA
C <sub>HB1</sub> , C <sub>HB1</sub>	half-bridge capacitors		47 nF; 400 V	47 nF; 400 V
C <sub>LA</sub>	lamp capacitor	High voltage polypropylene film type capable of withstanding peak voltages	1.5 nF; 800 V	1.5 nF; 800 V
L <sub>LA</sub>	lamp inductor	E20 core for lamp powers up to 23 W; Würth electronic type: 760370084 (see <a href="#">Section 6</a> ); J1 = open; J2 = open J3 = short	3.1 mH	3.1 mH
C <sub>DV</sub>	dV/dt limiting capacitor		220 pF; 500 V	220 pF; 500 V
C <sub>F5</sub>	floating supply buffer capacitor	SMD: X7R type; leaded: PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C <sub>VDD</sub>	low voltage supply buffer capacitor	SMD: X7R type; leaded: PET type; high temperature	10 nF; 50 V	10 nF; 50 V
C <sub>OSC</sub>	oscillator capacitor	SMD: NP0 type; Leaded: C0G type, preferably high accuracy value type	180 pF; 50 V; 2 %	180 pF; 50 V; 2 %
R <sub>OSC</sub>	oscillator resistor	preferably E24 series high accuracy value type	120 k $\Omega$ ; 1/8 W; 1 %	120 k $\Omega$ ; 1/8 W; 1 %
C <sub>SW</sub>	sweep time capacitor	SMD: X7R type; leaded: PET type; high temperature	68 nF; 50 V	68 nF; 50 V

## 6. 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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