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Team Nexperia

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

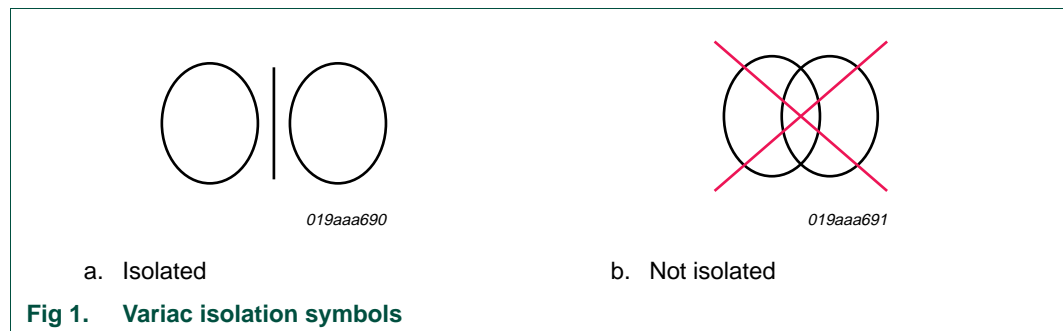
Lethal voltage and fire ignition hazard



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](#).



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.

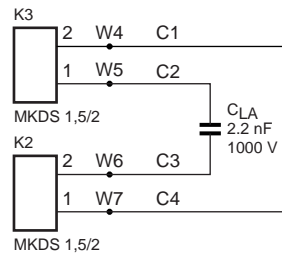
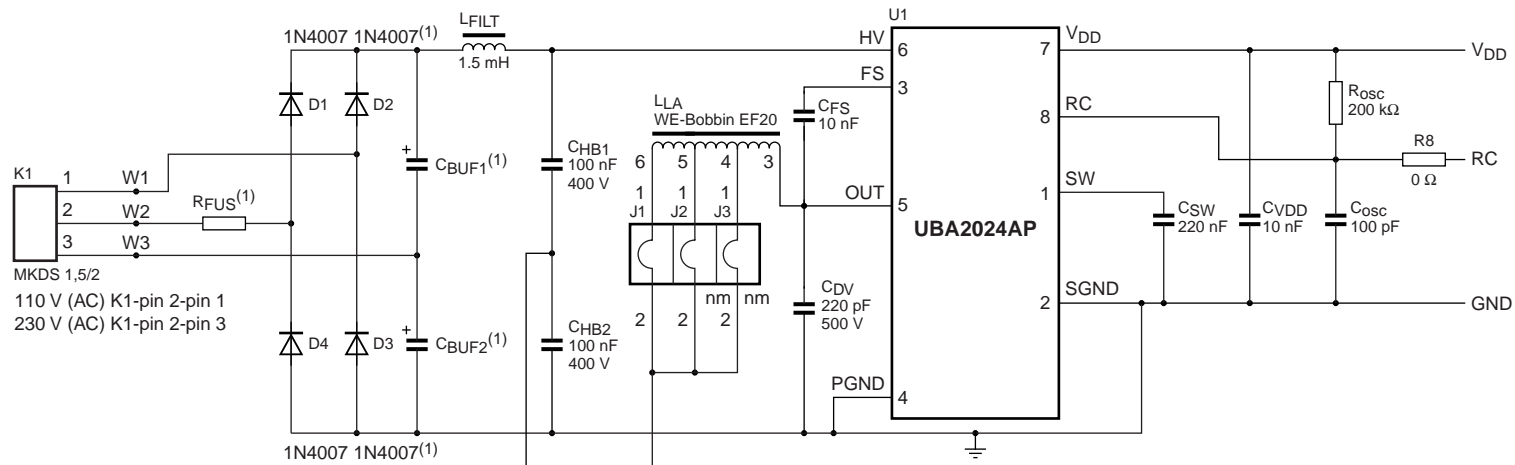
The circuit is set-up to perform a quasi preheat so the lamp will turn on approximately 0.7 s after the mains voltage has been applied to the board. For detailed design steps on the 18 W lamp solution or how to set-up lamps with other power ratings please consult the application note *AN10713 "18 W CFL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

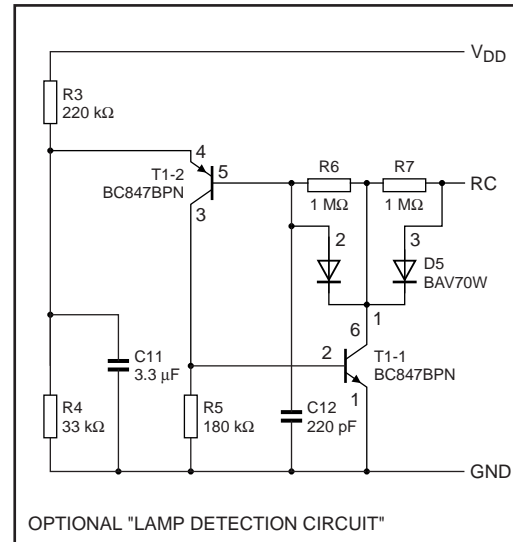
120 V (AC):
 R_FUS = 6.8 Ω/1 W
 C_BUF1, C_BUF2 = 22 μF/200 V
 D2 and D3 NOT mounted
 K1 mounted on position 1, 2

230 V (AC):
 R_FUS = 10 Ω/1 W
 C_BUF1 = 10 μF/400 V
 C_BUF2 = 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.



019aab382

Fig 2. Schematic diagram

3. Specification



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



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); $\pm 15\%$; 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); $\pm 15\%$; 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.

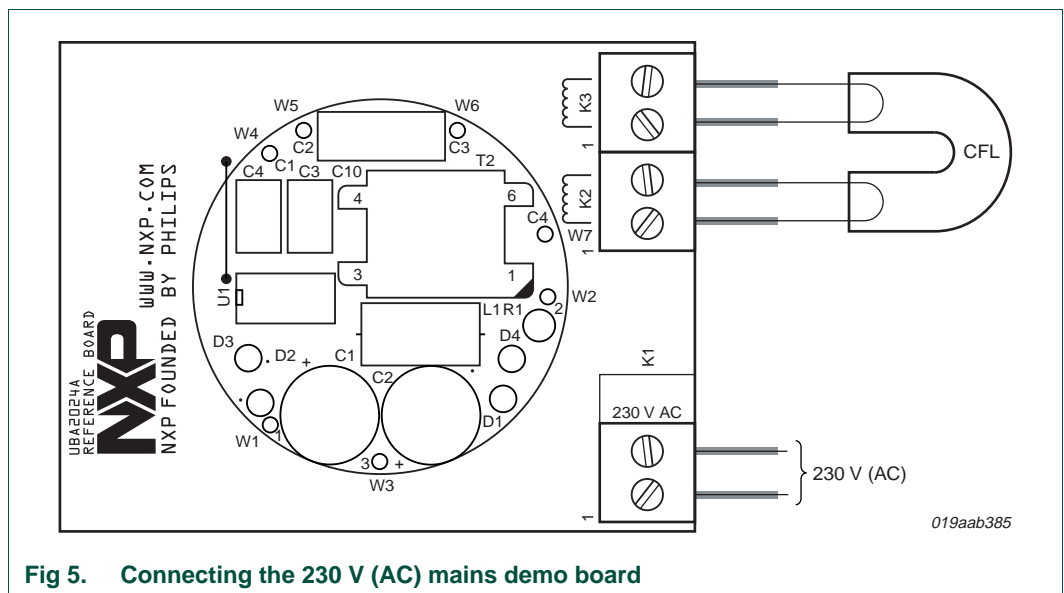


Fig 5. Connecting the 230 V (AC) mains demo board

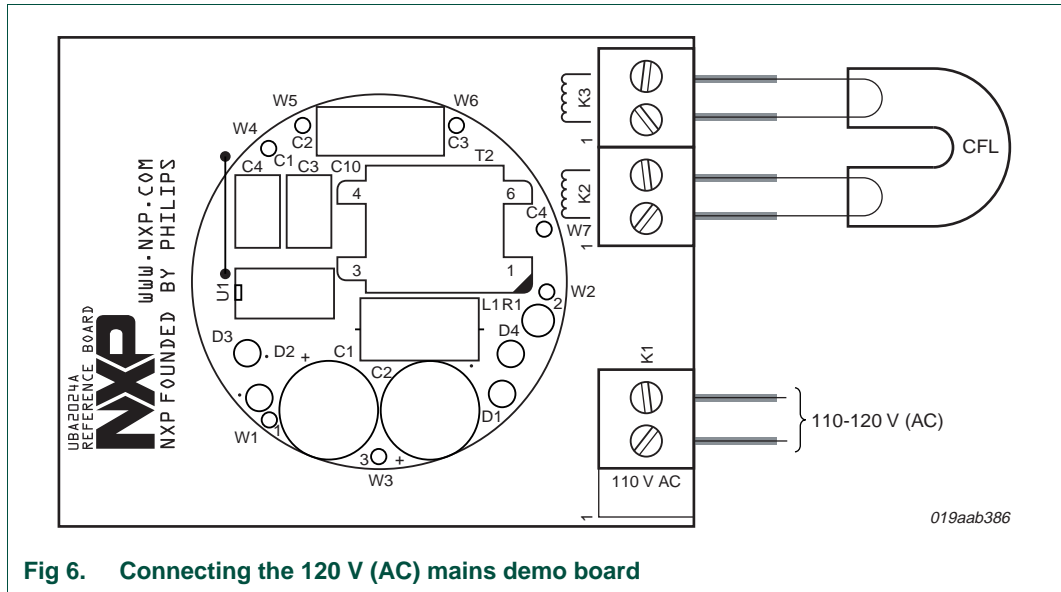


Fig 6. Connecting the 120 V (AC) mains demo board

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.

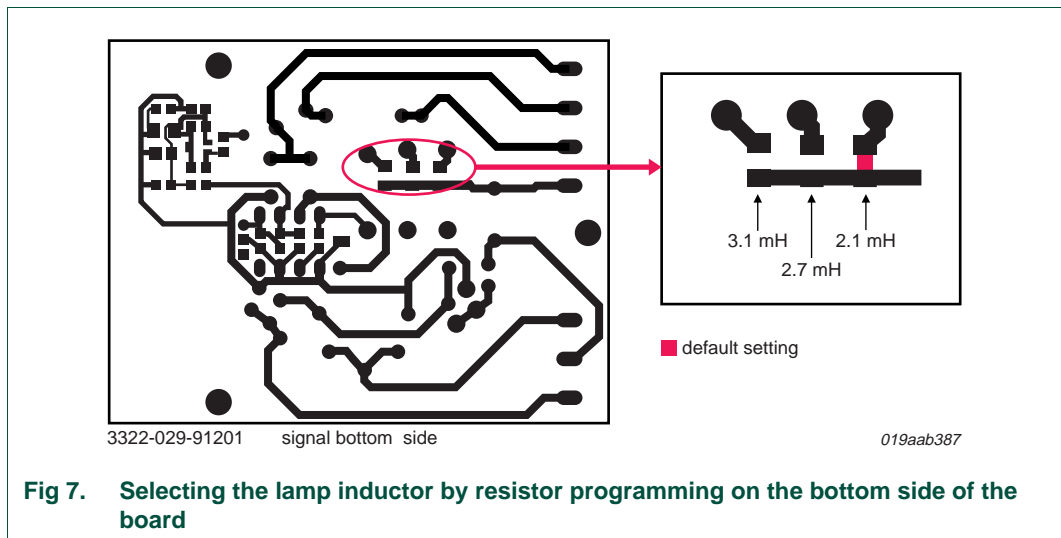


Fig 7. Selecting the lamp inductor by resistor programming on the bottom side of the board

3.3 Bill of material 18 W lamp

Table 1. 18 W lamp (16.5 W; 145 mA burner; requiring warm ignition; $f_0 = 45$ 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 μ F; 200 V | |
| C _{BUF1} | buffer capacitor | high temperature electrolytic type | | 10 μ F; 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 k Ω ; 1/8 W; 1 % | 200 k Ω ; 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 k Ω ; 0.125 W; 1 % |
| R4 | resistor | preferably E24 high accuracy value type | 33 k Ω ; 0.125 W; 1 % |
| R5 | resistor | | 180 k Ω ; 0.125 W |
| R6, R7 | resistor | | 1 M Ω ; 0.125 W |
| C11 | ignition time-out capacitor | MLCC X7R type with a voltage rating ≥ 10 V | 3.3 μ F; 10 V |
| C12 | capacitor | ceramic or MLCC N0P or leaded C0G type | 220 pF; 16 V |
| D5 | double diode common cathode | | |

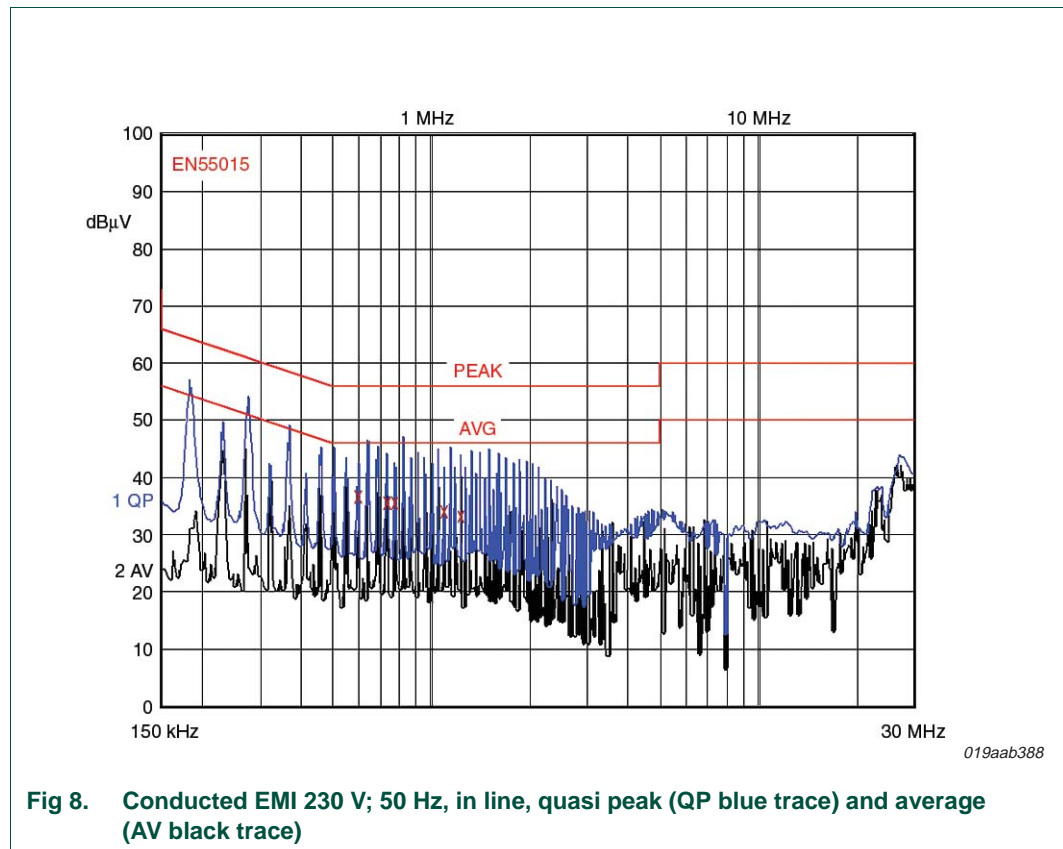
Table 2. Components values for the optional lamp detection circuit

| Reference | Description | Remarks | Value |
|------------|--|------------------------------|----------|
| Q1-1, Q2-2 | PNP/NPN transistor in one package or use separate transistors. | $h_{fe} > 100$ at 10 μ A | BC847BNP |
| Q1-1 | | $h_{fe} > 100$ at 10 μ A | BC847B |
| Q2-2 | | $h_{fe} > 100$ at 10 μ A | 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.



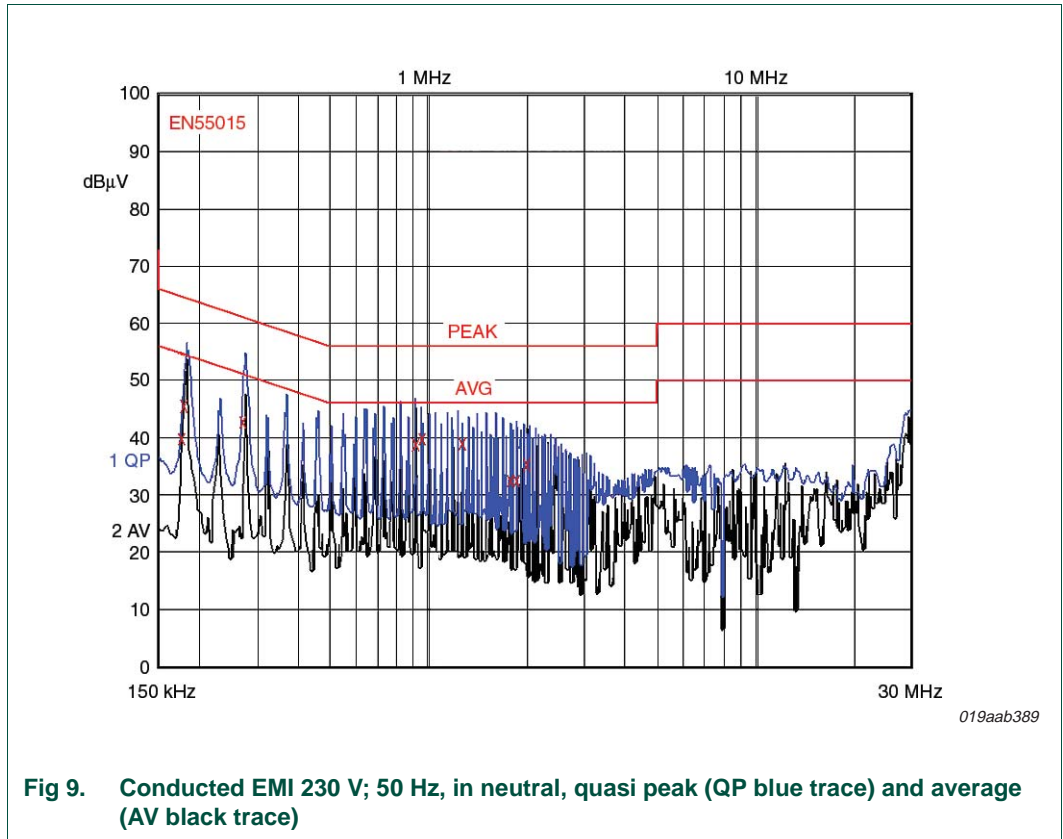


Fig 9. Conducted EMI 230 V; 50 Hz, in neutral, quasi peak (QP blue trace) and average (AV black trace)

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; $f_0 = 46$ 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; $f_0 = 46$ kHz)

| Reference | Description | Remarks | 115 V; 60 Hz | 230 V; 50 Hz |
|------------------|-------------------------------------|--|-----------------------------|-----------------------------|
| C _{F5} | 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 k Ω ; 1/8 W; 1 % | 110 k Ω ; 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; $f_0 = 42.5$ kHz)

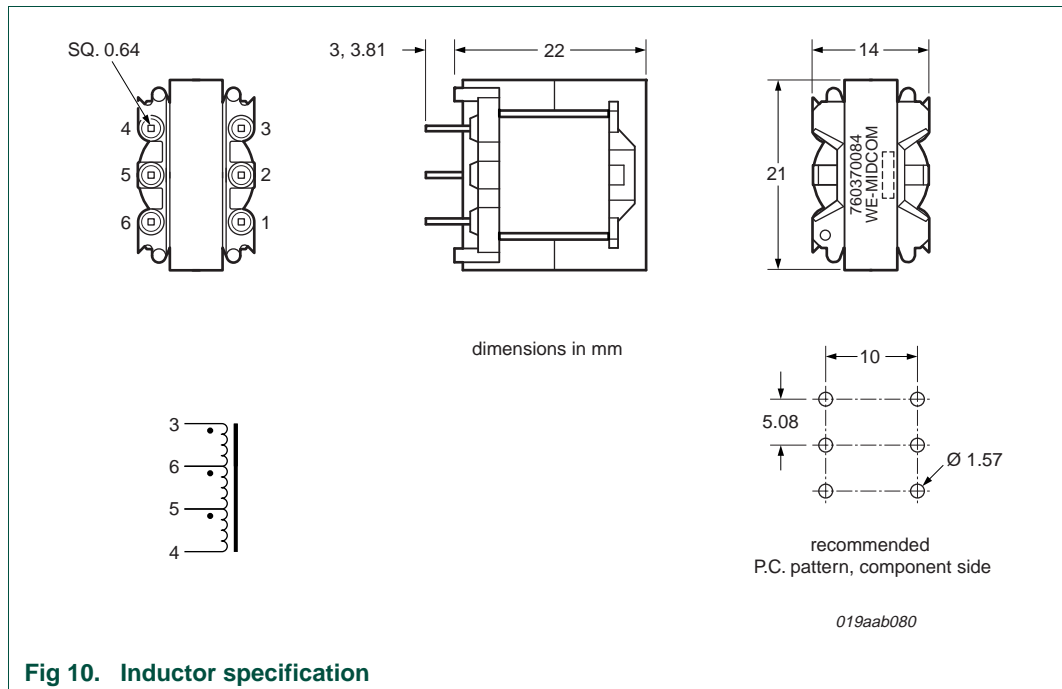
| Reference | Description | Remarks | 115 V; 60 Hz | 230 V; 50 Hz |
|---------------------------------------|---|--|-----------------------------|-----------------------------|
| R _{FUS} | fusible inrush current limiter resistor | special type, fusible, high peak power | 8.2 Ω | 33 Ω |
| D1, D2 | voltage doubler diodes | | 1N4007 | |
| D1, D4 | bridge rectifier diodes | | | 1N4007 |
| C _{BUF1} , C _{BUF2} | buffer capacitors | high temperature electrolytic type | 15 μ F; 200 V | |
| C _{BUF1} | buffer capacitor | high temperature electrolytic type | | 4.7 μ F; 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 _{F5} | 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 k Ω ; 1/8 W; 1 % | 120 k Ω ; 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; $f_0 = 44$ 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 μ F; 200 V | |
| C _{BUF1} | buffer capacitor | high temperature electrolytic type | | 6.8 μ F; 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 k Ω ; 1/8 W; 1 % | 200 k Ω ; 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



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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Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

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