

# UM10499

230 V and 120 V reference design using UBA20260

Rev. 1 — 30 September 2011

User manual

## Document information

Info	Content
<b>Keywords</b>	UBA20260, step-dimmable, half-bridge CFL driver
<b>Abstract</b>	This document describes the correct use of the UBA20260 step-dimmable half-bridge Compact Fluorescent Lamp (CFL) driver for 230 V and 120 V demo boards.



Revision history

Rev	Date	Description
v.1	20110930	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.

### 1.1 Scope of this document

In this document, a description is given of the UBA20260 demo boards for 230 V and 120 V mains voltages using the UBA20260 power IC. A description is provided, supported by a set of measurements to show the demo boards characteristics.

The UBA20260 circuit is a half-bridge driver IC setup to drive a typical 23 W burner with a lamp current of about 240 mA. Similar lamp types with a nominal lamp power of 20 W can also be driven. The total power drawn from the mains is about 23 W at a nominal mains voltage of 230 V or 120 V (RMS). The UBA20260 board can easily be configured to drive different Compact Fluorescent Lamps (CFL) of different power ratings. Driving different CFL is possible by changing the inductor tap and installing a different lamp capacitor.

The UBA20260 demo board is not recommended for driving lower voltage linear lighting lamps like the T5 or the T8. For these types of lamps the UBA2014, UBA2021 or UBA2016 are the best options.

The IC is able to drive lamps up to 23 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 There are no THD-requirements for mains powers lower than 25 W so that a pre-conditioner function is obsolete.

**Remark:** Unless otherwise stated all voltages are AC.

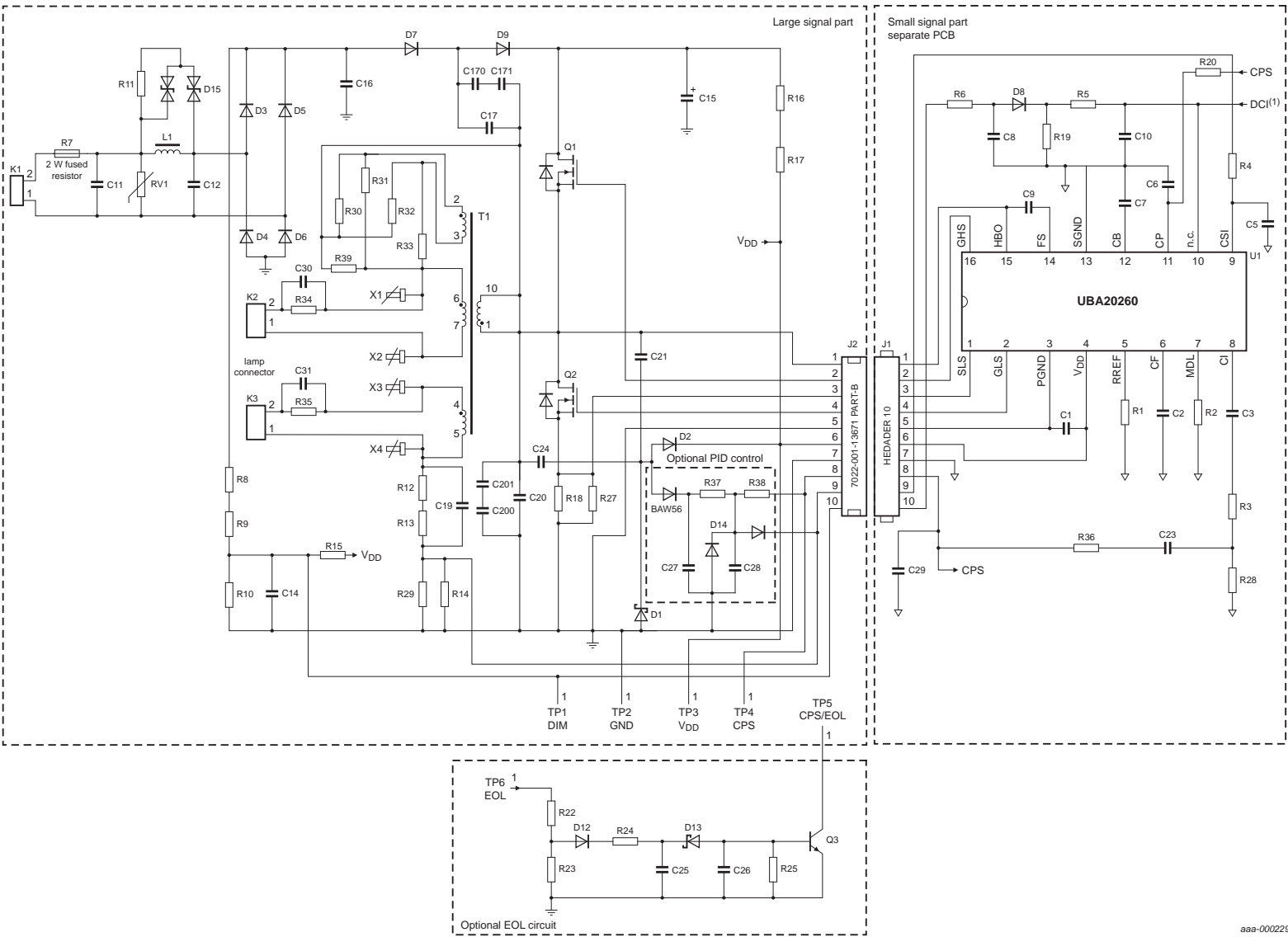
The circuit is set up to perform a preheat so the lamp switches on approximately 1 s after the mains voltage is applied to the board. Lamp current boost value is approximately 1.5. For detailed design steps, on the 18 W lamp solution or how to setup lamps with other power ratings see [Ref. 2](#).

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

The ICs are intended as cost-effective step-dimmable solutions to drive CFL with an integrated ballast (CFLi). Therefore, the ICs are equipped with a thermal, coil saturation, over-power and OverCurrent Protection (OCP) and a lamp strike failure time-out.

**Remark:** If the UBA20260 is used in a non-integrated ballast or a Matchbox type of ballast, an external lamp detection circuit is required. In addition, the standard circuit must include extra End Of Life (EOL) protection. Additional circuits can be set up to trigger the external power-down on the CP pin.

## 2. Schematic diagrams



aaa-000229

(1) To combine the PCB layout with the UBA20270 reference board, pin 10 is connected but not used.

**Fig 1. Circuit diagram UBA20260 demo board**

### 3. Safety warning

Connect the board to the mains voltage. Do not touch the board while it is connected to the mains voltage. 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.

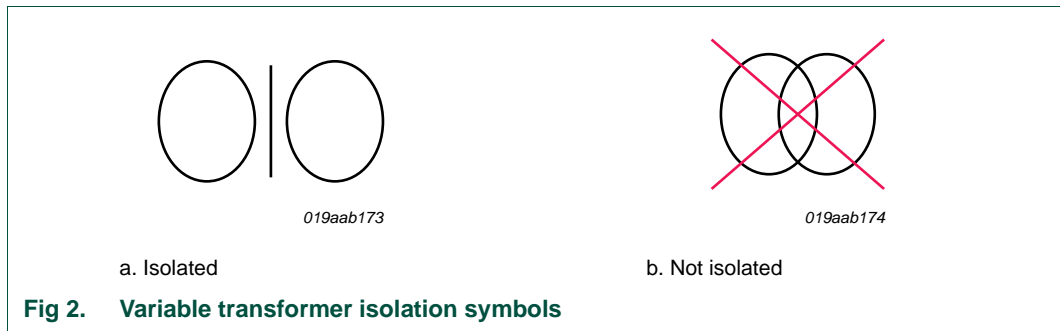


Fig 2. Variable transformer isolation symbols

### 4. Specification

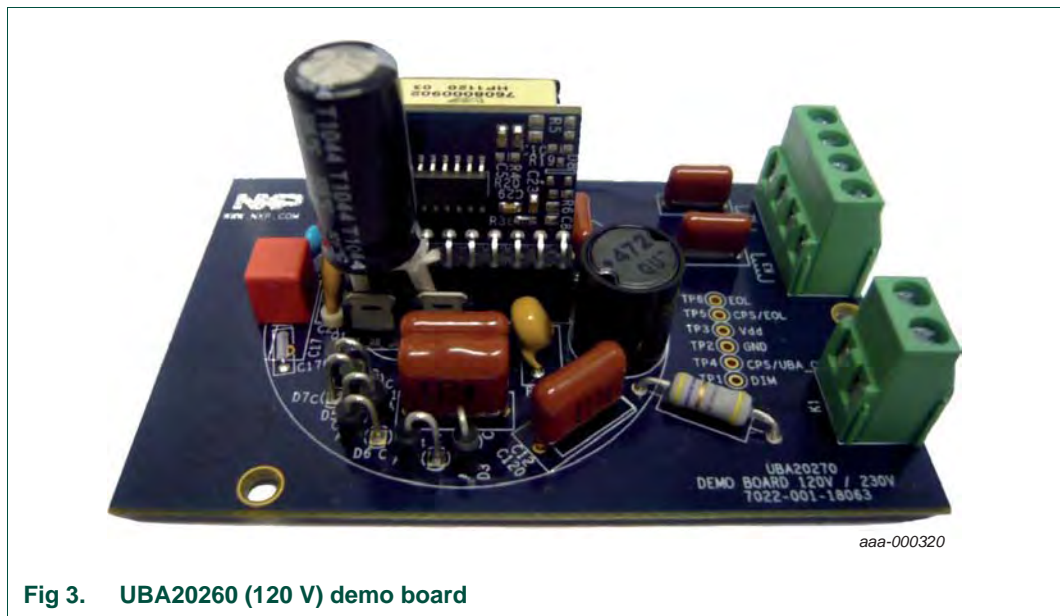
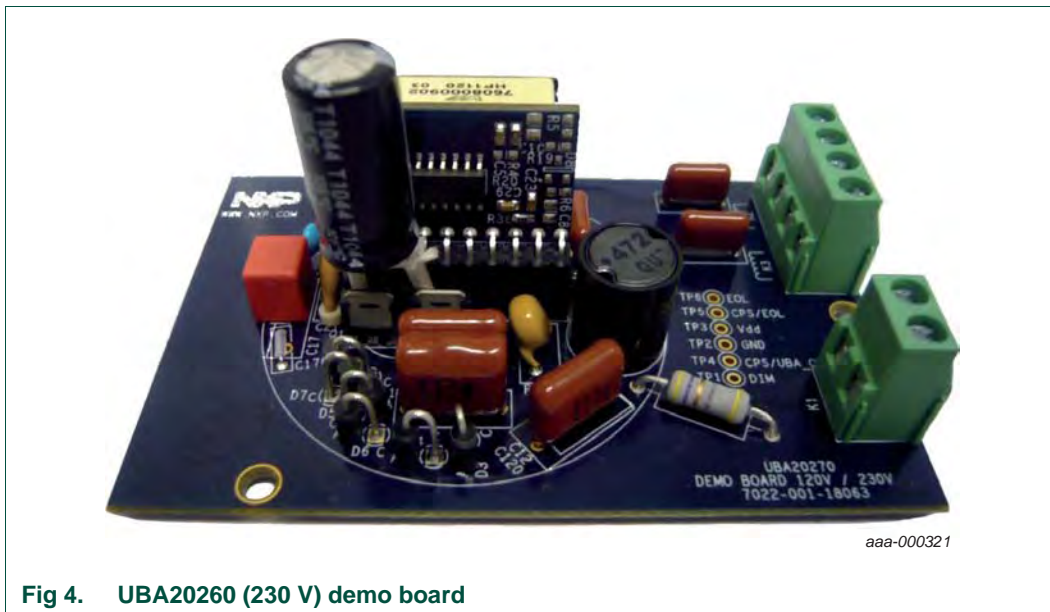


Fig 3. UBA20260 (120 V) demo board



The UBA20260 demo board is set up to drive a typical 23 W burner. The specification for each type is as follows:

#### 230 V:

- Input voltage range: 230 V; 15 %; 50 Hz
- Input power: 23 W at 230 V
- Input current: 179 mA/228 mA (boost)
- Power factor: > 0.55
- Running frequency 45 kHz; start frequency 111 kHz
- Preheat: 0.7 s
- 1.5 × lamp current boost, set for 50 s

#### 120 V:

- Input voltage range: 120 V; 15 %; 60 Hz
- Input power: 23 W at 120 V
- Input current: 328 mA/435 mA (boost)
- Power factor: > 0.55
- Running frequency 45 kHz; start frequency 111 kHz
- Preheat: 0.7 s
- 1.5 × lamp current boost, set for 50 s

**Protective functions:**

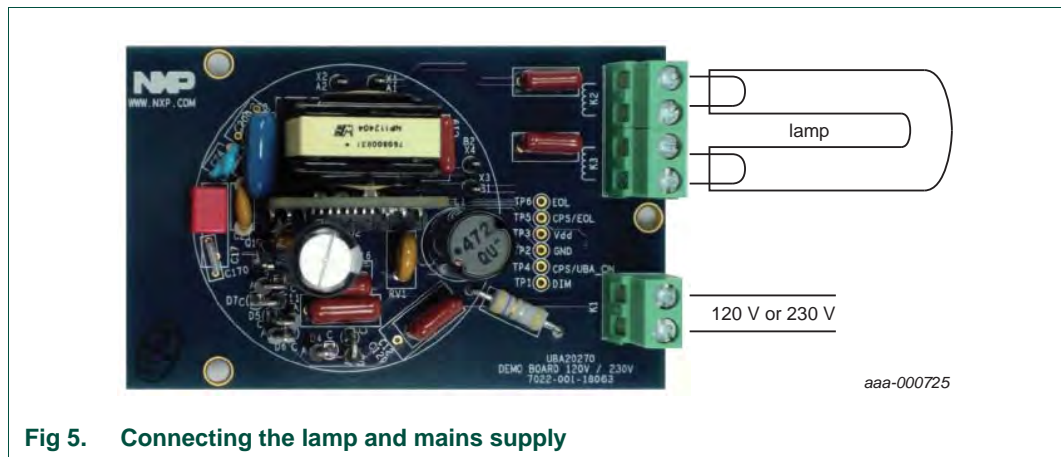
- Coil saturation set at and
  - 230 V: set to 2.3 A
  - 120 V: set to 2.8 A
- OverCurrent Protection (OCP):
  - 230 V: set to 2.3 A
  - 120 V: set to 2.8 A
- Capacitive Mode Protection (CMP)
- OverTemperature Protection (OTP)
- OverPower Protection (OPP)

**Burners:**

- 230 V: typical burner with a lamp voltage of 95 V ( $\pm 10\%$ ) and a lamp current of 160 mA ( $\pm 10\%$ ). Conditions set by resistors R31 and R32
- 120 V: typical burner with a lamp voltage of 110 V ( $\pm 10\%$ ) and a lamp current of 160 mA ( $\pm 10\%$ ). Conditions set by resistors R30 and R33

**4.1 Board connections**

The connection of the lamp and mains supply is shown in [Figure 5](#).



**Fig 5. Connecting the lamp and mains supply**

**4.2 External 6-pin controller connector**

The demo board is equipped with an external control connector intended to control the UBA20260 by a microcontroller or other external control logic. See [Figure 6](#). To be able to control the dimmer input TP1 properly, remove the SMD resistor R8. The connector carries 4 signals, two of which are supply lines, the dimmer input and the short CP pin signal (CPS).

**4.2.1 TP4 the CSP/UBA\_ON pin**

TP4 the CSP/UBA\_ON is a pin that offers multiple functions. For the 120 V version this pin is used to provide a differential gain path to the UBA20260. It cannot be used as an input or output.

This pin can be used as an external shutdown function when the UBA20260 is in the burn state. To set up for external shutdown, remove the differential gain function, R38, R36 and C29 and install R29.

The CPS pin can be directly short-circuited to ground (TP2 GND) or via an open collector output of a microcontroller. Short circuiting the CP pin to ground sets the UBA20260 in Power-down mode. This state continues as long as the IC is supplied via its V<sub>DD</sub> pin, consumption is less than 220 μA. The current from the CPS pin is < 50 mA. To end power-down, power cycle the board or short the TP3 (V<sub>DD</sub>) pin to ground. The current from this pin is < 500 μA when continuously shorted to ground (TP2). When the V<sub>DD</sub> pin is shorted to ground, the 470 nF V<sub>DD</sub> capacitor is discharged. To prevent large discharge currents, install a 1 kΩ resistor in series with the capacitor.

The V<sub>DD</sub> pin (TP3) has only a limited supply capability for external logic. Do not load this pin by more than 2 mA.

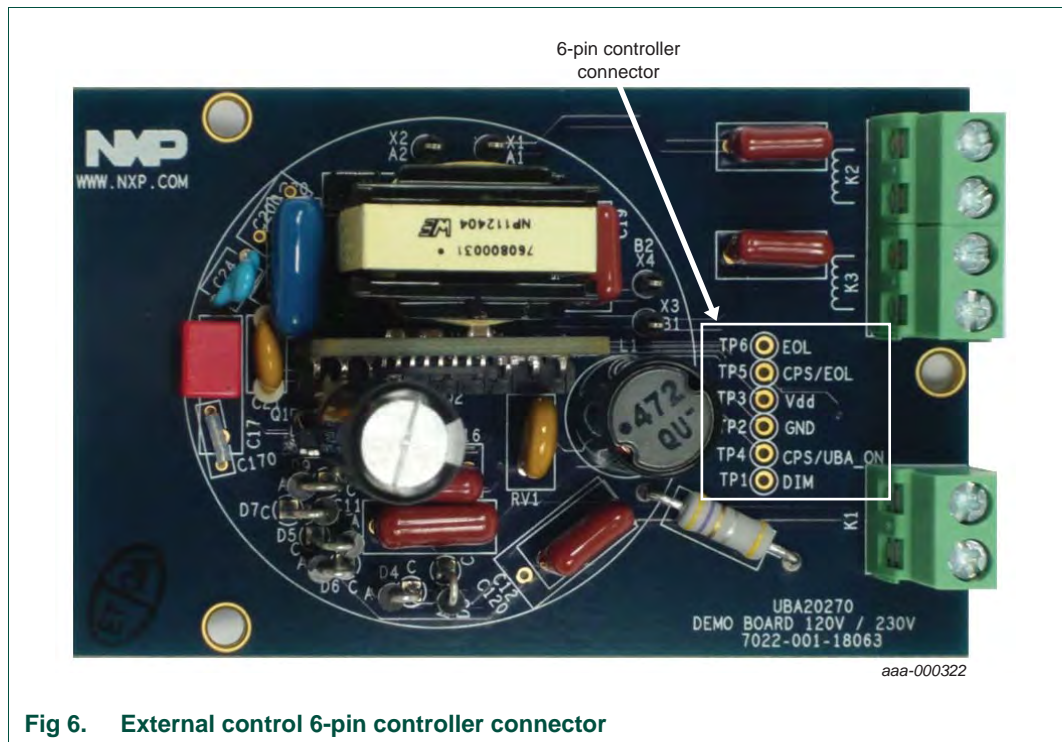


Fig 6. External control 6-pin controller connector

4.2.2 TP5 and TP6 End of life

TP5 CPS\_EOL is the out put of the external EOL circuit on the demo board. Connect this pin to TP4 CSP/UBA\_ON to use the external EOL. Setup TP for external shutdown for this application. See [Section 4.2.1](#).

TP6 is the input of the external EOL circuit. Use the auto transformer winding on T1 in order to use the external EOL. Therefore, remove R30 to R33 and install R39. In addition, hardwire TP6 to T1 pin 2 and hardwire T1 pin 3 to ground.



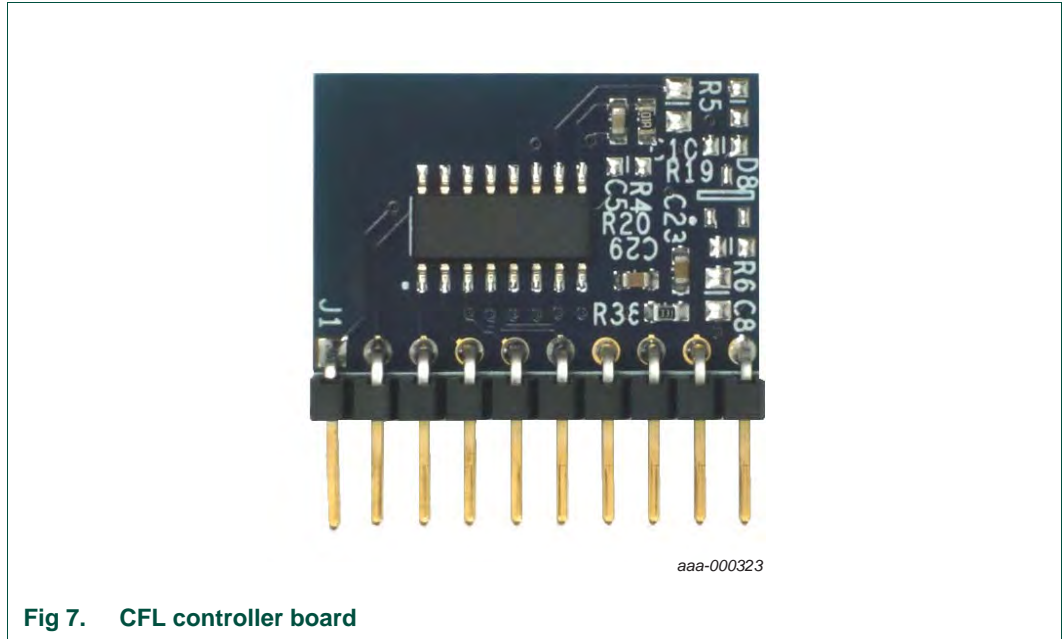


Fig 7. CFL controller board

### 4.3 Using the auto transformer

The inductor supplied with this board accommodates an auto transformer winding. The auto transformer winding lowers or raises the working voltage across the resonant tank capacitor. In addition, it increases the overall efficiency by up to 30 %. Adjust the auto transformer to the lamp voltage to the lamp type connected to the board for correct operation. See [Ref. 2](#).

[Table 1](#) shows how to set the auto transformer. The lamp voltage is the nominal lamp voltage at the rated lamp power when the lamp is not dimmed. The auto transformer is set up as follows for most of the lamps:

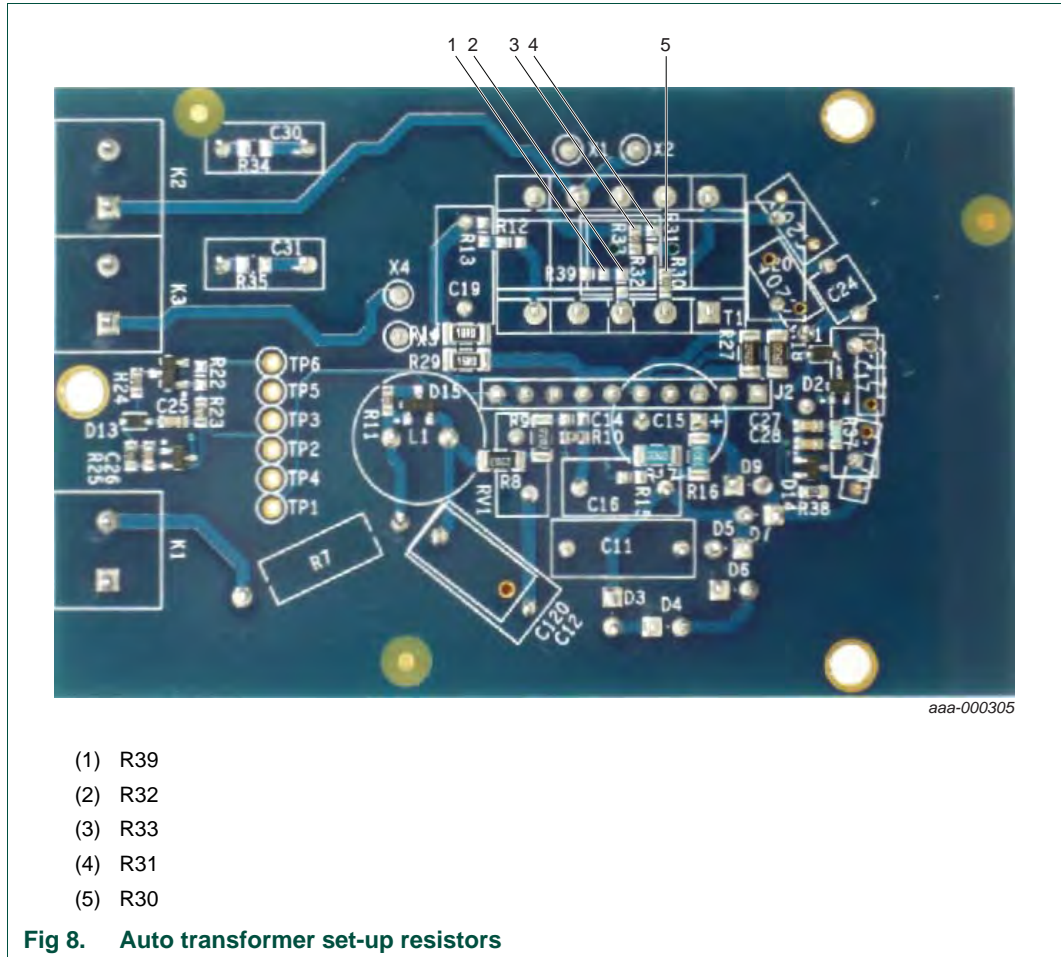
Table 1. Resistor programming

Lamp voltage	Description	Placement R39	Placement R30+R33	Placement R31+R32
$V_{lamp} < 95 \text{ V}$	Raise voltage across $C_{res}$ . The voltage source charge pump energy transfer to buffer capacitor is increased			×
$95 \text{ V} < V_{lamp} < 110 \text{ V}$	No auto transformer. Select upon lamp voltage during deep dimming performance	×		
$V_{lamp} > 110 \text{ V}$	Lower voltage across $C_{res}$ . The voltage source charge pump energy transfer to buffer capacitor is decreased		×	

If the lamp voltage is between 95 V and 110 V, the use of an auto transformer is not necessary. However, set-up and use the auto transformer in the following situations:

- where the lamp voltage is too high at low dimming levels
- when the bus voltage exceeds the buffer capacitor voltage rating

**Remark:** Only short-circuit the resistors indicated; otherwise the inductor winding is shorted.



#### 4.4 Bill Of Materials (BOM)

[Table 2](#) provides detailed component information for the common parts for the UBA20260 230 V and 120 V demo boards.

**Table 2. Common BOM for the UBA20260 230 V and 120 V demo boards**

Reference	Description and component	Package	Manufacturer
C1	470 nF; 10 %; 25 V X7R	-	KEMET
C2	100 pF; 5 %; 50 V C0G-NP0	-	Yageo
C3	220 nF; 10 %; 25 V X7R	-	KEMET
C5	1.5 nF; 10 %; 50 V X7R	-	Yageo
C6	330 nF; 10 %; 25 V X7R	-	KEMET
C7	150 nF; 10 %; 25 V X7R	-	AVX
C9	100 nF; 10 %; 50 V X7R	-	Yageo
C10	470 nF; 10 %; 25 V X7R	-	KEMET
C17	3.3 nF; 10 %; 1 KV MKP	-	Cornell Dubilier
C19	22 nF; 5 %; 400 V	-	Panasonic
C20	4.7 nF; 10 %; 1 KV MKP	-	EPCOS
C21	560 pF; 10 %; 1 KV Y5R	-	Vishay BC Components
C23	1 $\mu$ F; 10 %; 16 V X7R	-	Yageo
C24	100 pF; 10 %; 1 KV	-	Murata
C25	100 nF; 10 %; 50 V X7R	-	Yageo
C26	220 nF; 10 %; 16 V X7R	-	Murata
C27	100 nF; 10 %; 50 V X7R	-	Yageo
C28	100 nF; 10 %; 50 V X7R	-	Yageo
C29	150 nF; 10 %; 50 V X7R	-	KEMET
C30	68 nF; 5 %; 250 V	-	Panasonic
C31	68 nF; 5 %; 250 V	-	Panasonic
D1	Zener diode; 12 V; 500 mW; BZX84J-C12	SOD323	NXP Semiconductors
D2	diode; dual	SOT-323	Multicomp
D3	diodes general-purpose rectifier; 1N4007	-	Fairchild Semiconductors
D4	diodes general-purpose rectifier; 1N4007	-	Fairchild Semiconductors
D5	diodes general-purpose rectifier; 1N4007	-	Fairchild Semiconductors
D6	diodes general-purpose rectifier; 1N4007	-	Fairchild Semiconductors
D7	fast recovery diode; 1 A; 600 V; 1N4937	-	Fairchild Semiconductors
D8	general purpose; switching diodes; 200 V; 200 mA	-	NXP Semiconductors
D9	fast recovery diode; 1 A; 600 V; 1N4937	-	Fairchild Semiconductors
D12	general purpose; switching diodes; 200 V; 200 mA	-	NXP Semiconductors
D13	Zener diode; 12 V; 500 mW; BZX84J-C12	SOD323	NXP Semiconductors
D14	dual-diode; common anode	SOT-323	NXP Semiconductors
D15	not mounted	-	-
J1	pin header; right-angled; 10-pole; 2.54 mm	-	TE Connectivity Electronics or AMP
J2	7022-001-13671 PART-B	-	-
K1	terminal block; 2-pole; 5.08 mm	-	Phoenix contact

Table 2. Common BOM for the UBA20260 230 V and 120 V demo boards ...continued

Reference	Description and component	Package	Manufacturer
K2	terminal block; 2-pole; 5.08 mm	-	Phoenix contact
K3	terminal block; 2-pole; 5.08 mm	-	Phoenix contact
Q3	BC847CW; NPN; 45 V; 100 mA	SOT-323	NXP Semiconductors
R1	33 k $\Omega$ ; 0.1 W; 1 %; RC22H	-	Yageo
R2	1.2 k $\Omega$ ; 0.1 W; 1 %; RC22H	-	Yageo
R3	150 $\Omega$ ; 0.1 W; 1 %; RC22H	-	Yageo
R4	100 $\Omega$ ; 0.1 W; 1 %; RC22H	-	Yageo
R11	not mounted	-	-
R12	not mounted	-	-
R13	not mounted	-	-
R15	not mounted	-	-
R20	not mounted	-	-
R22	not mounted	-	-
R23	100 k $\Omega$ ; 0.063 W; 1 %; RC02H	-	Yageo
R24	390 k $\Omega$ ; 0.1 W; 1 %; RC02H	-	Yageo
R25	1 M $\Omega$ ; 0.1 W; 1 %; RC02H	-	Yageo
R34	not mounted	-	-
R35	not mounted	-	-
R37	22 k $\Omega$ ; 0.1 W; 1 %; RC22H	-	Yageo
R38	330E; 0.1 W; 1 %; CRCW	-	Vishay Draloric
R39	not mounted	-	-
X1	terminal; black; PK100 for A1	-	Vero
X2	terminal; black; PK100 for A2	-	Vero
X3	terminal; black; PK100 for B1	-	Vero
X4	terminal; black; PK100 for B2	-	Vero

[Table 3](#) provides detailed component information for specific parts of the UBA20260 230 V demo board.

**Table 3. Delta list of BOM for the UBA20260 (230 V) demo board**

Reference	Description and component	Package	Manufacturer
C8	not mounted	-	-
C11	47 nF; 5 %; 630 V	-	Panasonic
C12	22 nF; 5 %; 630 V	-	Panasonic
C14	not mounted	-	-
C15	10 $\mu$ F; 20 %; 400 V; 12000 HRS	-	Rubycon
C16	22 nF; 5 %; 400 V	-	Panasonic
C171	560 pF; 5 %; 1 KV	-	WIMA
L1	Choke; 4700 $\mu$ H; 0.26 A; $\pm$ 10 %	-	Panasonic
Q1	MOSFET Power; N-Channel QFET; 400 V	-	Fairchild Semiconductors
Q2	MOSFET Power; N-Channel QFET; 400 V	-	Fairchild Semiconductors
R5	not mounted	-	-
R6	not mounted	-	-
R7	4.7 $\Omega$ ; 2 W; 10 % EMC	-	Welwyn Components
R8	220 k $\Omega$ ; 0.250 W; 1 %; RC02H	-	Yageo
R9	220 k $\Omega$ ; 0.250 W; 1 %; RC02H	-	Yageo
R10	not mounted	-	-
R14	12.4E; 0.250 W; 1 %; CRCW	-	Vishay Dale
R16	not mounted	-	-
R17	not mounted	-	-
R18	2.2E; 0.250 W; 1 %; RC02H	-	Yageo
R19	not mounted	-	-
R27	2.2E; 0.250 W; 1 %; RC02H	-	Yageo
R28	2.2 k $\Omega$ ; 0.1 W; 1 %; RC02H	-	Yageo
R29	12.4E; 0.250 W; 1 %; CRCW	-	Vishay Dale
R30	0 $\Omega$ ; 0.063 W; RC02H	-	Yageo
R31	not mounted	-	-
R32	not mounted	-	-
R33	0 $\Omega$ ; 0.063 W; RC02H	-	Yageo
R36	not mounted	-	-
RV1	VDR; 275 V; 12 J	-	Vishay BC Components
T1	driver transformer; 2.0 mH	-	Xicon
U1	CFL driver; UBA20260	SO16	NXP Semiconductors

[Table 4](#) provides detailed component information for specific parts of the UBA20260 120 V demo board.

**Table 4. Delta list of BOM for the UBA20260 (120 V) demo board**

Reference	Description and component	Package	Manufacturer
C8	not mounted	-	-
C11	47 nF; 5 %; 400 V	-	Panasonic
C12	22 nF; 5 %; 400 V	-	Panasonic
C14	not mounted	-	-
C15	22 $\mu$ F; 20 %; 250 V; Al. El	-	Rubycon
C16	22 nF; 5 %; 400 V	-	Panasonic
C171	560 pF; 5 %; 1 KV	-	WIMA
L1	Choke; 4700 $\mu$ H; 0.26 A; $\pm$ 10 %	-	Panasonic
Q1	MOSFET Power; N-Channel QFET; 400 V	-	Fairchild Semiconductors
Q2	MOSFET Power; N-Channel QFET; 400 V	-	Fairchild Semiconductors
R5	not mounted	-	-
R6	not mounted	-	-
R7	4.7 $\Omega$ ; 10 %; 2 W EMC	-	Welwyn Components
R8	100 k $\Omega$ ; 0.250 W; 1 %; WCR	-	Yageo
R9	100 k $\Omega$ ; 0.250 W; 1 %; WCR	-	Yageo
R10	not mounted	-	-
R14	12.4E; 0.250 W; 1 %; CRCW	-	Vishay Dale
R16	not mounted	-	-
R17	not mounted	-	-
R18	1.8E; 0.330 W; 1 %; ERJ8	-	Yageo
R19	not mounted	-	-
R27	1.8E; 0.330 W; 1 %; ERJ8	-	Panasonic
R28	560 $\Omega$ ; 0.1 W; 1 %; RC02H	-	Yageo
R29	12.4E; 0.250 W; 1 %; CRCW	-	Vishay Dale
R30	not mounted	-	-
R31	0 $\Omega$ ; 0.063 W; RC02H	-	Yageo
R32	0 $\Omega$ ; 0.063 W; RC02H	-	Yageo
R33	not mounted	-	-
R36	330E; 0.1 W; 1 %; CRCW	-	Vishay Draloric
RV1	VDR; 150 V; 20 J	-	Vishay BC Components
T1	driver transformer; 1.0 mH	-	Xicon
U1	CFL driver; UBA20260	SO16	NXP Semiconductors

## 5. SO16 package thermal considerations

The UBA20260 in the SO16 package is mounted on a separate board perpendicular onto the main signal PCB. The reason for this is that the IC is not directly subjected to the thermal radiated heat of the lamp. In this way, distance is created between lamp filaments and the IC. The horizontal signal PCB acts as a heat shield for thermal radiated heat.

The PCB is mounted horizontally into a lamp base for most applications. However, the UBA20260 is an SMD component and means the IC is very close to the lamp filaments. The lamp filaments would directly radiate heat onto the IC and limit the IC drive capabilities. Therefore, it is recommended to either mount some form of heat shield between the lamp filaments and the PCB. Alternatively, mount the PCB vertically into the lamp socket to increase the distance between the IC and lamp filaments.

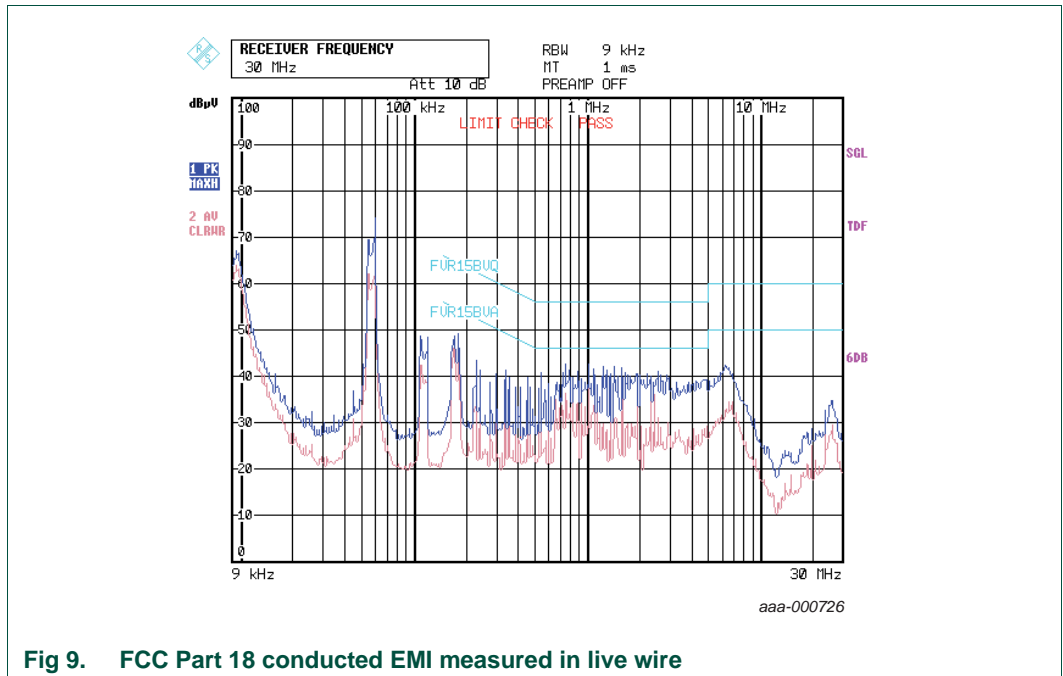
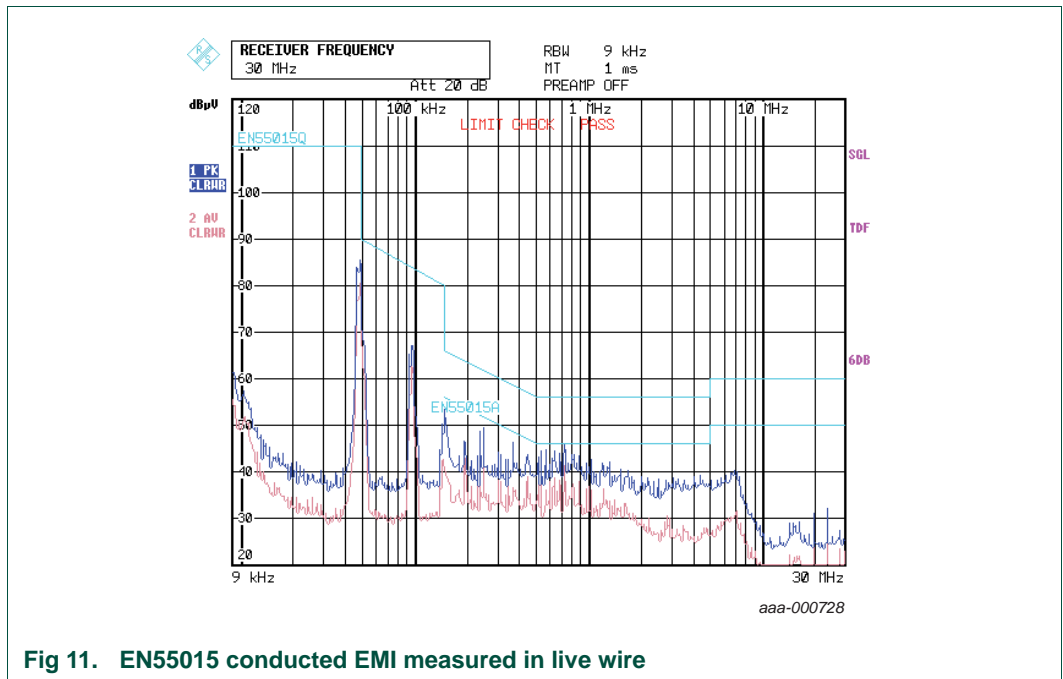
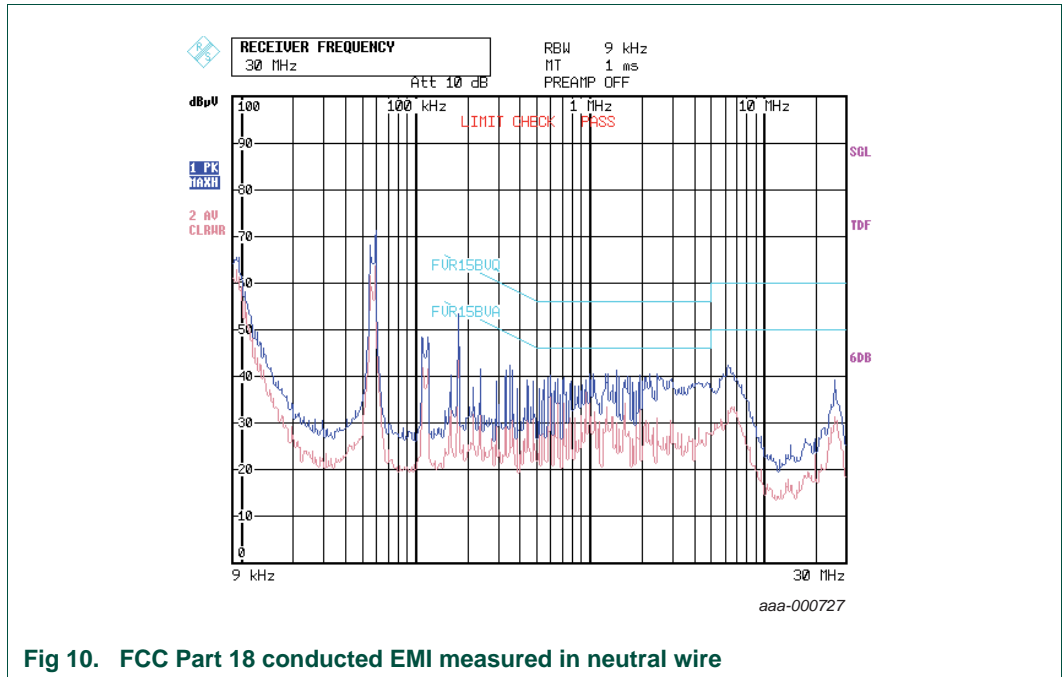


Fig 9. FCC Part 18 conducted EMI measured in live wire





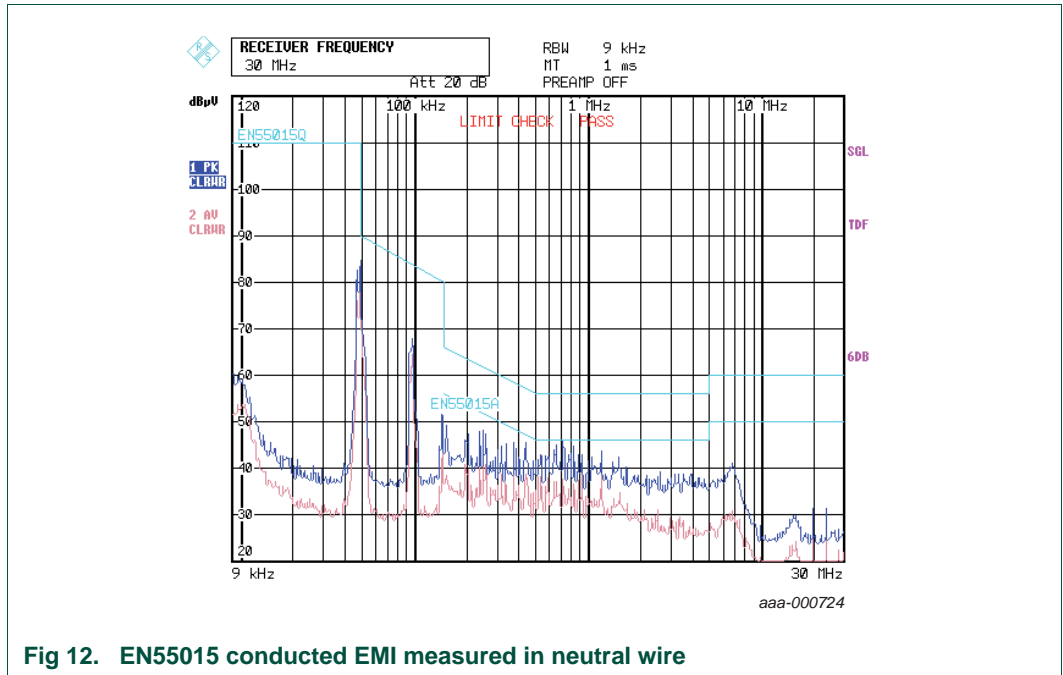


Fig 12. EN55015 conducted EMI measured in neutral wire

6. PCB layout

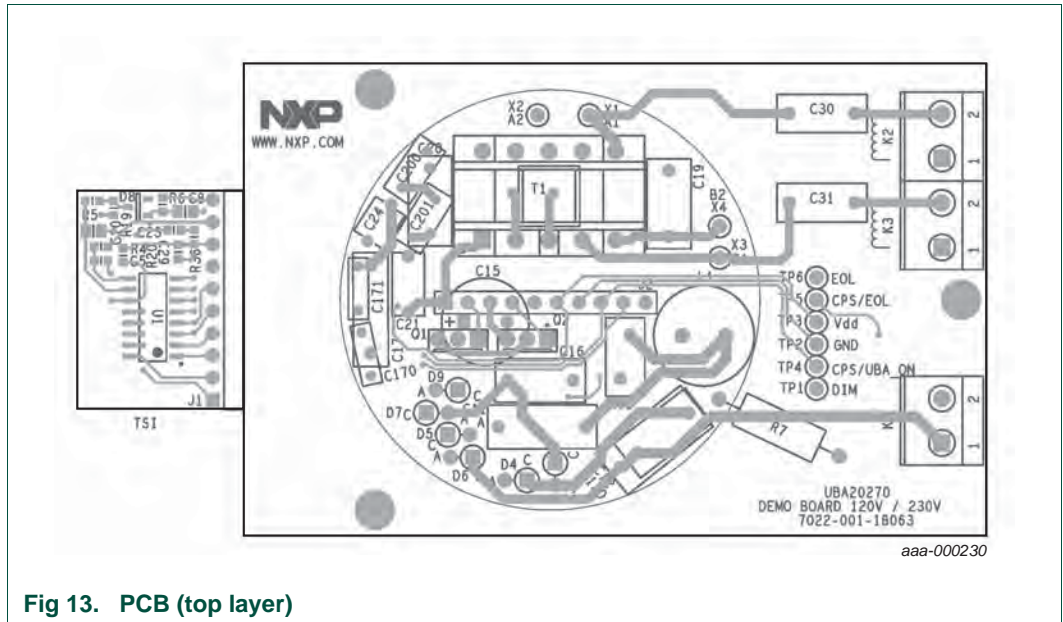


Fig 13. PCB (top layer)

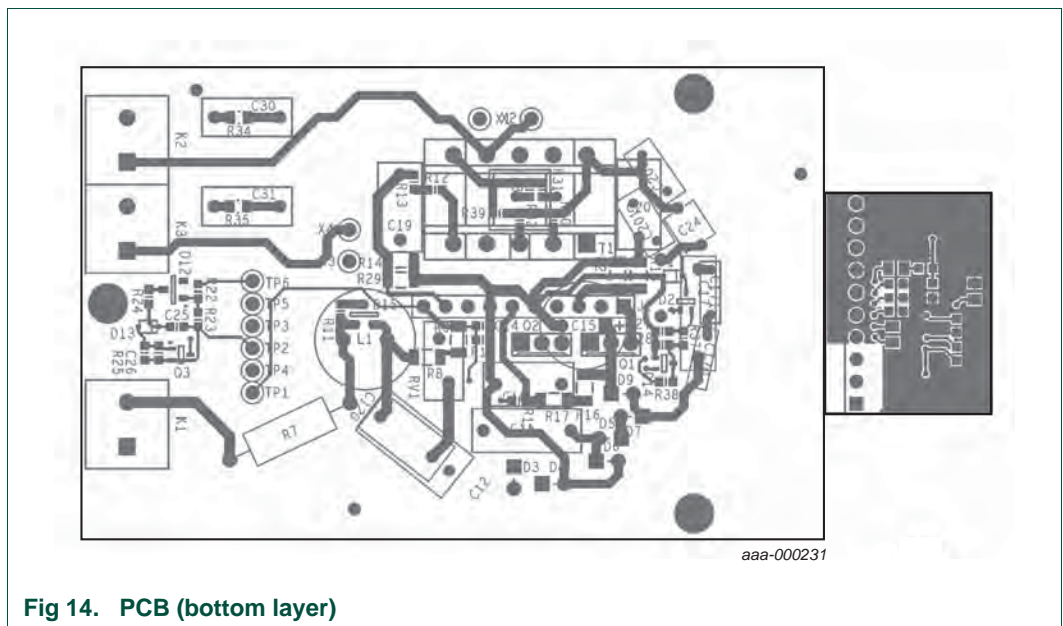


Fig 14. PCB (bottom layer)

## 7. Inductor specification

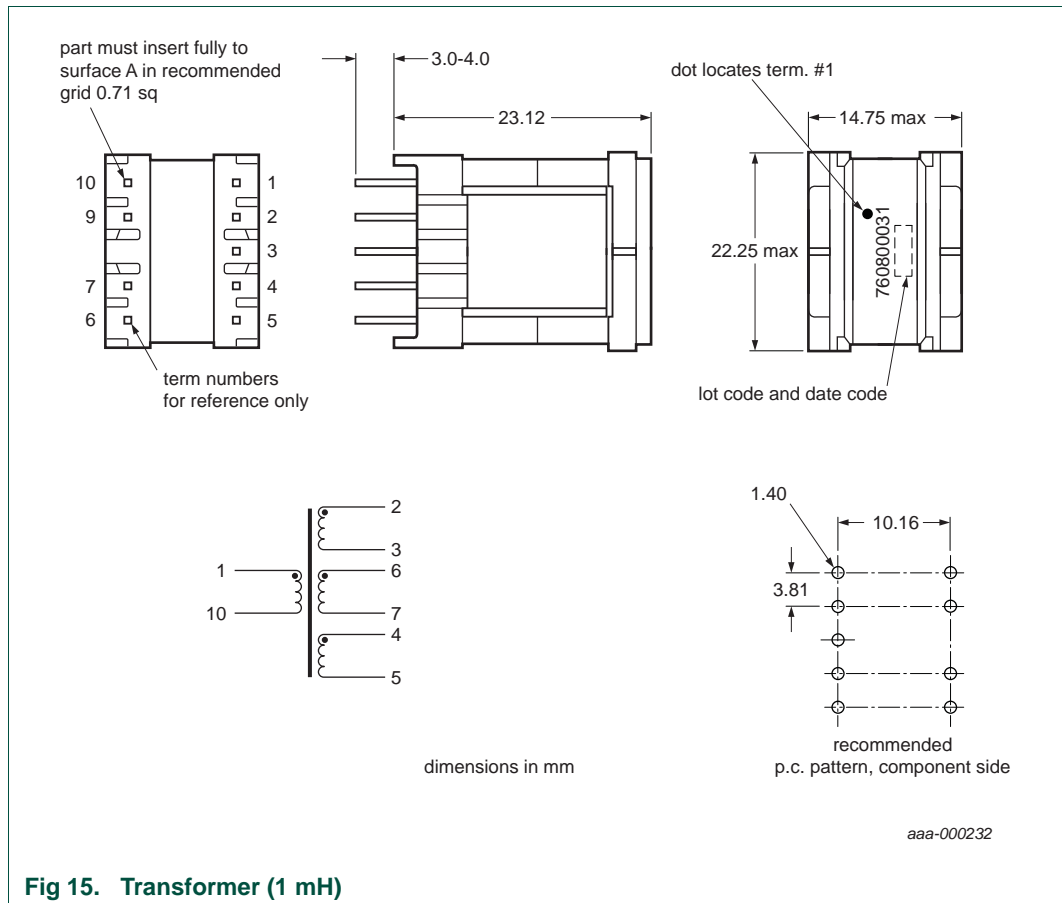


Fig 15. Transformer (1 mH)

Transformer electrical specifications, centered at 25 °C, are as follows:

### DC resistance (at 20 °C):

- 1 to 10, 1.7 Ω, ±10 %
- 2 to 3, 0.8 Ω, ±10 %
- 4 to 5, 0.175 Ω, ±10 %
- 6 to 7, 0.19 Ω, ±10 %

### Dielectric rating:

- 1 kV (AC), 1 minute tested by applying 1.25 kV (AC) for 1 s between pins 1 to 2 (3 + 6, 4 + 7)

### Inductance:

- 1.0 mH ±10 %, 10 kHz, 100 mV (AC), 0 mA (DC), 1 to 10, Ls
- 2.5 μH ±15 %, 10 kHz, 100 mV (AC), 0 mA (DC), 6 to 7, Ls
- 2.4 μH ±15 %, 10 kHz, 100 mV (AC), 0 mA (DC), 4 to 5, Ls
- 44.0 μH ±15 %, 10 kHz, 100 mV (AC), 0 mA (DC), 2 to 3, Ls

**Saturation current:**

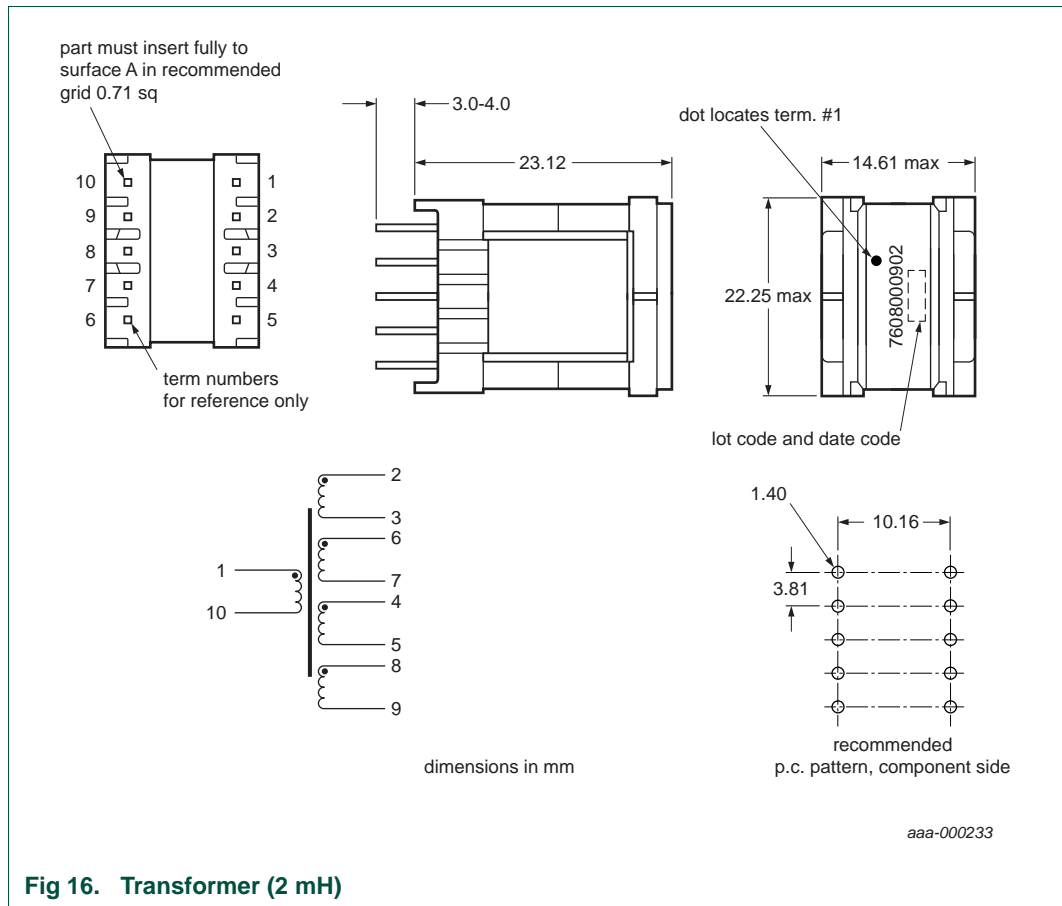
- 2.2 A saturation current causing 20 % roll off from initial inductance.

**Turns ratio:**

- (1 to 10):(6 to 7), (25.93):(1),  $\pm 2$  %
- (1 to 10):(4 to 5), (25.93):(1),  $\pm 2$  %
- (1 to 10):(2 to 3), (7.25):(1),  $\pm 2$  %

**Operating temperature range:**

- $-40$  °C to  $125$  °C including temperature rise.



Transformer electrical specifications centered at 25 °C is as follows:

**DC resistance (at 20 °C):**

- 1 to 10, 4.5 Ω, ±10 %
- 2 to 3, 0.75 Ω, ±10 %
- 4 to 5, 0.180 Ω, ±10 %
- 6 to 7, 0.175 Ω, ±10 %
- 8 to 9, 0.42 Ω, ±10 %

**Dielectric rating:**

- 1 kV (AC), 1 minute tested by applying 1.25 kV (AC) for 1 s between pins 1 to 2 (3 + 4, 5 + 6, 7 + 8)

**Inductance:**

- 2.0 mH ±10 %, 10 kHz, 100 mV (AC), 0 mA (DC), 1 to 10, Ls

**Saturation current:**

- 1.55 A saturation current causing 20 % roll off from initial inductance.

**Turns ratio:**

- (1 to 10):(2 to 3), (9.74):(1),  $\pm 1$  %
- (1 to 10):(6 to 7), (34.78):(1),  $\pm 1$  %
- (1 to 10):(4 to 5), (34.78):(1),  $\pm 1$  %
- (1 to 10):(8 to 9), (15.21):(1),  $\pm 1$  %

## 8. Abbreviations

Table 5. Abbreviations

Acronym	Description
CFL	Compact Fluorescent Lamp
CFLi	Compact Fluorescent Lamps with an integrated ballast
CMP	Capacitive Mode Protection
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EOL	End Of Life
ESD	ElectroStatic Discharge
MOSFET	Metal-Oxide Semiconductor Field-Effect Transistor
OCP	OverCurrent Protection
OPP	OverPower Protection
PCB	Printed-Circuit Board
RMS	Root Mean Square

## 9. References

- [1] **UBA20260** — Data sheet: 600 V driver IC for step-dimmable compact fluorescent lamps
- [2] **AN10962** — Application note: Step-dimmable CFL using the UBA2026X
- [3] **AN10803** — Application note: Triac dimmable CFL application using the UBA2028/UBA2014/UBA2027

## 10. Legal information

### 10.1 Definitions

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