UM10382

UBA2028 CFL 18 W, 120 V dimmable reference board

Rev. 03 — 27 August 2010 **User manual**

Document information

Info	Content
Keywords	UBA2028, reference board, TRIAC dimmable, charge pump
Abstract	This document is a user manual for the UBA2028 120 V TRIAC dimmable reference board with charge pump.

Revision history

Rev	Date	Description
v.3	20100827	Third issue. Modifications: • All illustrations updated to revised AQL standard. • Section 10 “Legal information” updated.
v.2	20091015	Second issue
v.1	20091012	First issue

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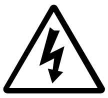
1. Introduction

WARNING

Lethal voltage and fire ignition hazard



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The UBA2028 is a high voltage power IC intended to drive and control electronically ballasted Compact Fluorescent Lamps (CFLs). The IC includes two internal 600 V, 3 Ω, Negative-channel Metal-Oxide Semiconductor (NMOS) half-bridge power circuits. This UBA2028 reference board is intended for 120 V dimmable charge pump lamp applications of 20 W and below. It can dim to below 10 % of the light output. The main input voltage range is 120 V ± 15 %, and a voltage doubler is used to make the necessary bus voltage.

2. Features

- Two internal 600 V, 3 Ω, NMOS half-bridge power circuits
- Current up to 280 mA for steady state
- Adjustable preheat time
- Adjustable preheat current
- Dimmable function
- Capacitive mode protection

3. Circuit diagram

The circuit diagram is shown in Figure 1

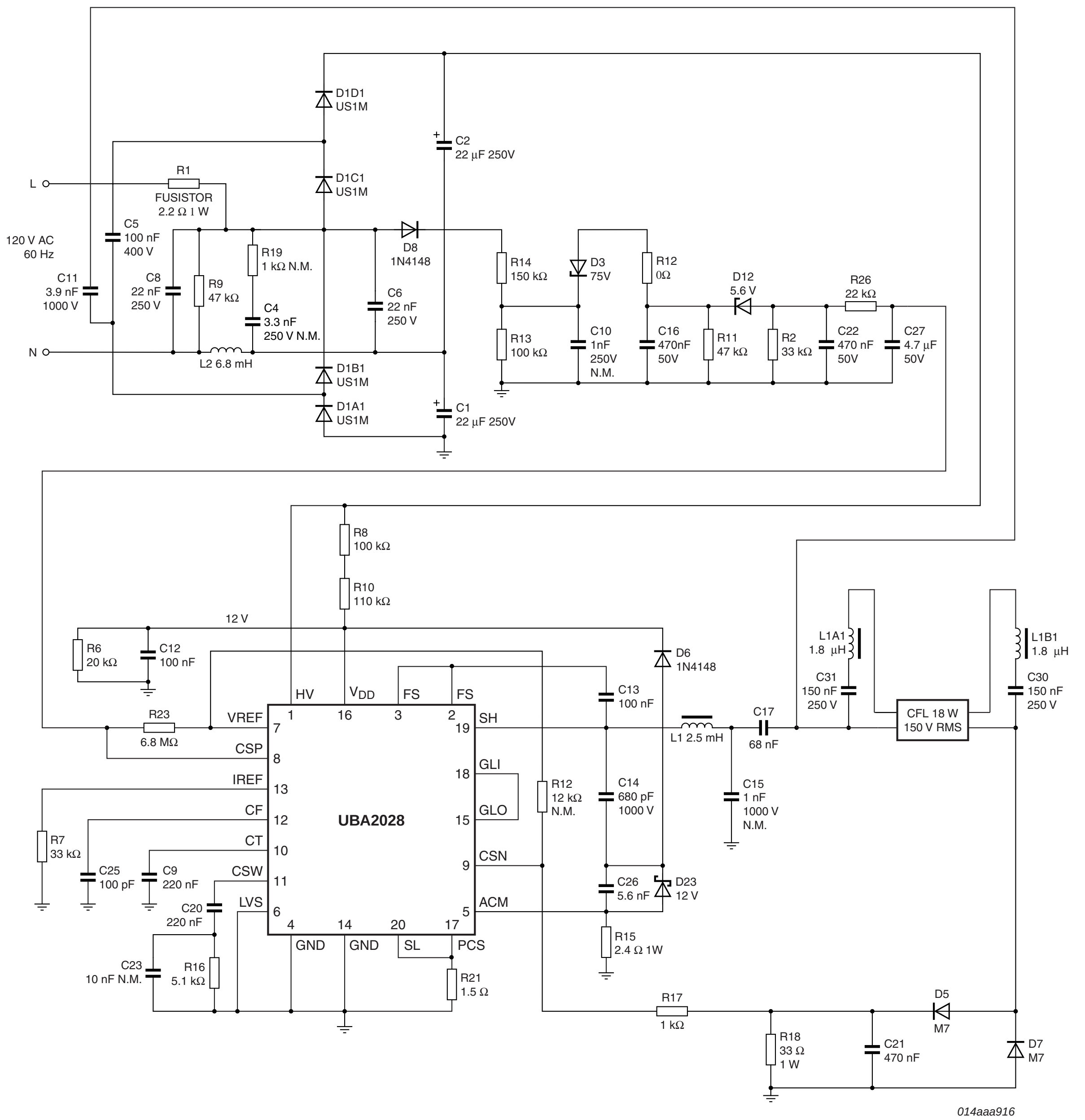


Fig 1. UBA2028 120 V (AC) circuit diagram

4. Board connection

The 120 V (AC) mains input connection and four CFL connections for the burner are connected as shown below. A fusible resistor of 2.2 Ω is placed in series with the 120 V (AC) mains input. See Figure 2:

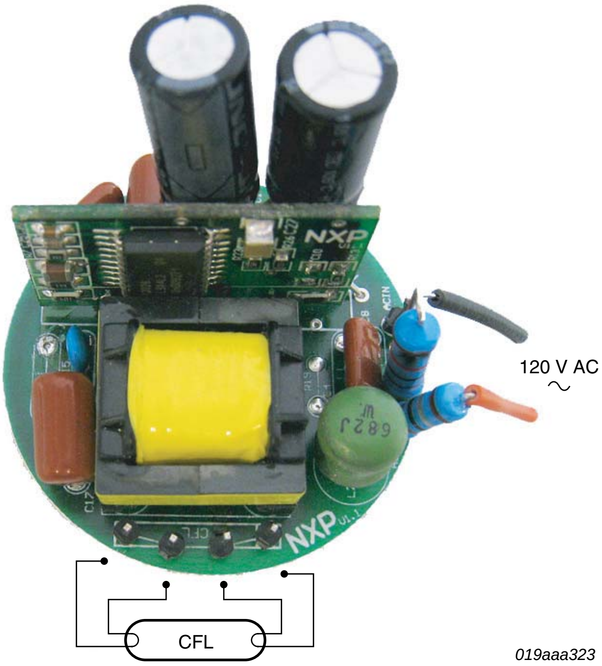


Fig 2. UBA2028 board connections

5. Circuit considerations

5.1 Preheat time selection

The preheat time can be adjusted by the capacitor C9 (CT pin) and the resistor R7 (IREF pin). Because R7 also defines the f_{min}, it is advised to change C9 to adjust the preheat time. The preheat time equation is shown below:

$$T_{pr} = \frac{C9}{(330 \times 10^{-9})} \times \frac{R7}{(33 \times 10^{3})} s$$

5.2 Preheat current selection

The preheat current can be adjusted by L1A1, L1B1, C30, C31 and R21. Because L1A1, L1B1, C30 and C31 also need to maintain enough filament current for low light output, adjusting the preheat current depends mainly on R21. Reducing the value of R21 will increase the filament preheat current.

Remark: Sufficient preheat current must be maintained for proper ignition.

5.3 Transformer selection

The transformer (L1) used for this dimmable application, needs sufficient current during low light output, to maintain a smooth mains DC voltage, so the transformer does not go into saturation during low light output. Measuring the current through L1 at low light output is means of indicating transformer performance.

5.4 Resonant and feedback capacitor selection

The resonant capacitor C15 and the feedback capacitor C11 along with the resonant inductance L1 form the resonant system. For the system to work well, the resonant frequency given by the formula below is used:

$$f = \frac{1}{[2\pi \times SQRT(L \times C)]}$$

This resonant frequency must be higher than the normal working frequency, so C11 and C15 must be selected carefully according to the above equation. Because C11 and C15 also need a support current to maintain mains DC voltage smoothly and to avoid the burner flickering at low dimming levels, the selection of C11 and C15 needs to balance to maintain the stability of the whole system.

5.5 Input filter selection

Input filter components C6, C8 and L2 need to be selected to filter the output noise of the dimmer in order to supply a smooth voltage to CSP pin, and are also needed to avoid resonance of the dimmer and the system throughout the entire dimming range. The input filter avoids ElectroMagnetic Interference (EMI) polluting the input power supply.

5.6 Burner filament current selection when a low light output is required

During low light output, because of very low current through burner, the filament temperature will go down. Under this condition, the electron emission temperature will not be enough, and not enough electrons will be emitted. So L1A, L1B, C30 and C31 need to support enough current (normal around 200 mA RMS) to the filament, in order to maintain filament temperature for low light output.

6. Measurements

Table 1. Dimming measurements using Norma D4000 power analyzer

Norma analyzer measurement	UBA2028 (no dimming)	UBA2028 (minimum dimming)
V_I (V RMS)	120	30
I_I (mA RMS)	227	159
PACT (W)	20.8	4.2
CFi	2.8	5.8
TDI	0.62	0.9
PF	0.76	0.84

For the UBA2028 no dimming measurements, the Norma D4000 power analyzer was placed between the lamp and the mains and no TRIAC dimmer was used.

For the UBA2028 minimum dimming measurements, the Norma D4000 power analyzer was placed between the TRIAC dimmer and the lamp in order to measure PACT at minimum dimming level.

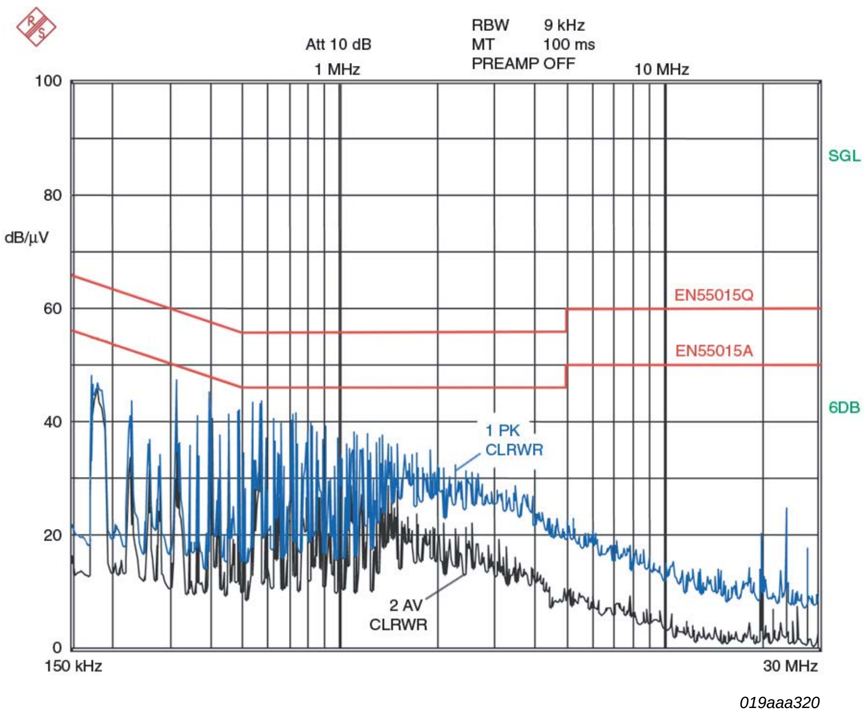


Fig 3. EMI measurements

6.1 I-transformer and V-burner under maximum and minimum light output

For dimmable applications, the burner selection is very important. When the burner is adjusted to a low light output, the burner voltage will go high, and the main voltage will go down due to the action of the TRIAC. Under these conditions, the resonant inductance needs a support current in order to maintain a smooth main DC voltage for the high voltage burner. When the high light output and the burner voltage change is not excessive when dimming to a low light output, the burner should have a voltage of approximately 100 V.

Figure 4 and Figure 5 show the measured wave of the I-transformer and V-burner with a suitable burner, for maximum and minimum light outputs. From these results, a small voltage change of the burner can be seen, and as the transformer current is less, the MOSFET will not be overloaded.

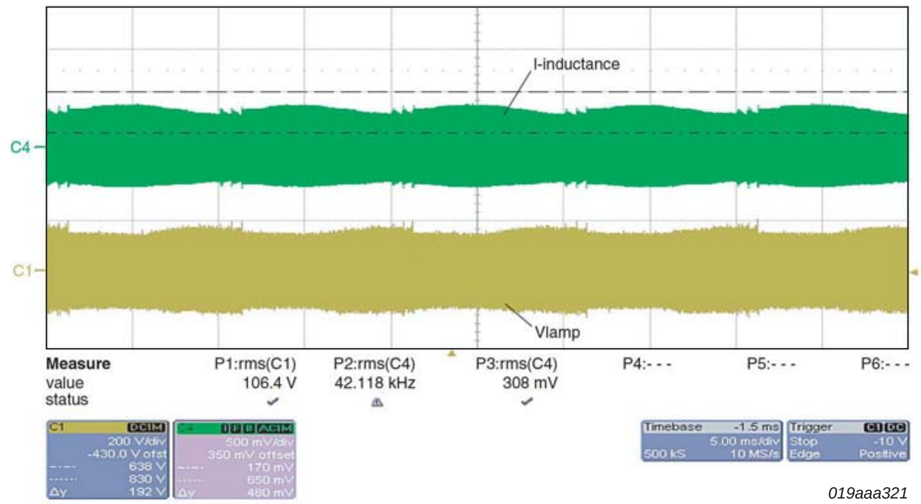


Fig 4. I-transformer and V-burner under maximum light output

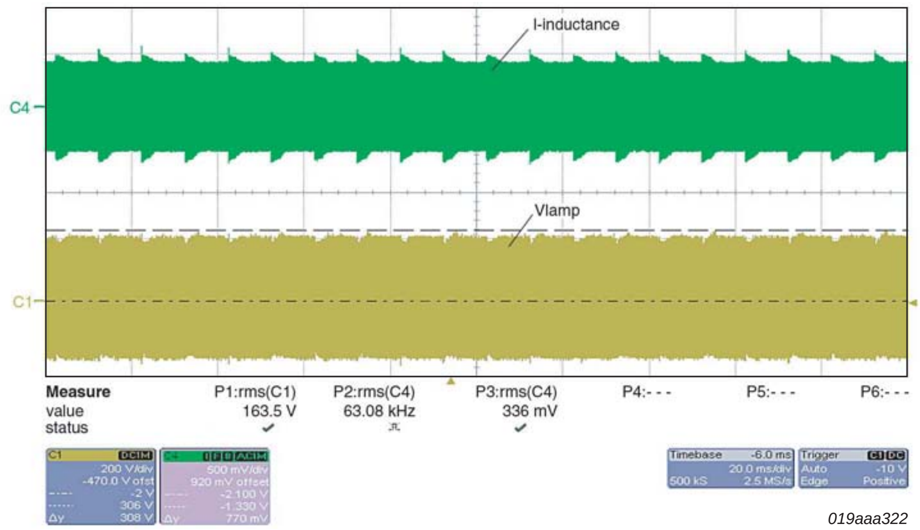
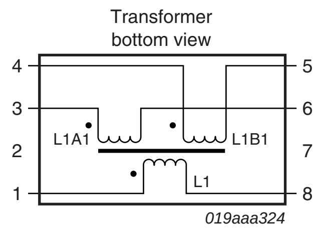


Fig 5. I-transformer and V-burner under minimum light output

7. Transformer specification

Figure 6 shows the transformer schematic:



L1 = 2.5 mH

L1A1 = 1.8 µH

L1B1 = 1.8 µH

Fig 6. Transformer schematic

7.1 Electrical characteristics

Table 2. Inductance

Section	Inductance	Resistor
Primary	2.5 mH	7 Ω
Secondary	1.8 µH	180 mΩ

7.2 Core and bobbin

- Core size: EF20
- Core material: Philips 3C85, Siemens N27 or equivalent
- Gap length: 1.0 mm

8. Bill Of Materials (BOM)

The components used for the 120 V reference board are given in Table 3

Table 3. BOM

Number	Quantity	Reference	Typical value
1	1	CFL 18 W 150 V RMS	23 W
2	2	C1, C2	22 µF; 250 V
3	1	C4	3.3 nF; 250 V
4	1	C5	100 nF; 400 V
5	2	C6, C8	22 nF; 250 V
6	2	C9, C20	220 nF
7	1	C10	1 nF; 250 V N.M.
8	1	C11	3.9 nF; 1 kV
9	1	C12	100 nF
10	1	C13	100 nF

Table 3. BOM *…continued*

Number	Quantity	Reference	Typical value
11	1	C14	680 pF; 1 kV
12	1	C15	1 nF; 1 kV N.M.
13	2	C16, C22	470 nF; 50 V
14	1	C17	68 nF
15	1	C21	470 nF
16	1	C23	10 nF; N.M.
17	1	C25	100 pF
18	1	C26	5.6 nF
19	1	C27	4.7 μF; 50 V
20	2	C30, C31	150 nF; 250 V
21	1	D3	75 V
22	2	D6, D8	1N4148
23	2	D5, D7	M7
24	4	D1D1, D1C1, D1B1, D1A1	US1M
25	1	D12	5.6 V Zener
26	1	D23	12 V Zener
27	1	L1	2.5 mH
28	1	L2	6.8 mH
29	2	L1B1, L1A1	1.8 μH
30	1	R1	fusible resistor 2.2 Ω; 1 W
31	1	R2	33 kΩ
32	1	R7	33 kΩ
33	1	R6	20 kΩ
34	1	R8	100 kΩ
35	1	R9	47 kΩ
36	1	R10	110 kΩ
37	1	R11	47 kΩ
38	1	R12	0 Ω
39	1	R13	100 kΩ
40	1	R14	150 kΩ
41	1	R15	2.4 Ω 1 W
42	1	R16	5.1 kΩ
43	1	R17	1 kΩ
44	1	R18	33 Ω;1 W
45	1	R19	1 kW; N.M.
46	1	R21	1.5 Ω
47	1	R23	6.8 MΩ
48	1	R26	22 kΩ
49	1	-	UBA2028

9. Appendix PCB layout

Figure 7 and Figure 8 show the layout of the PCB.

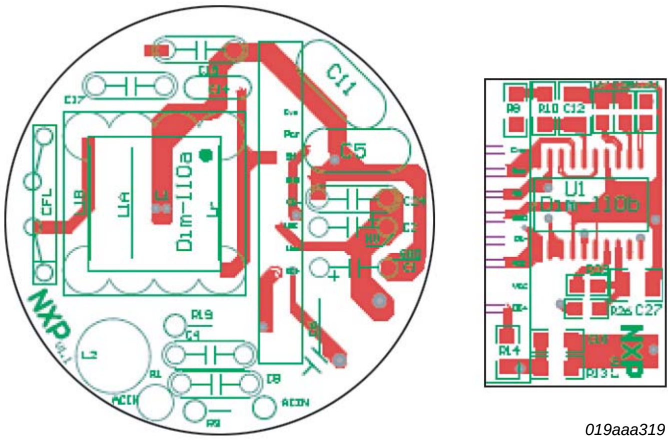


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Fig 7. UBA2028 120 V reference board; top layer

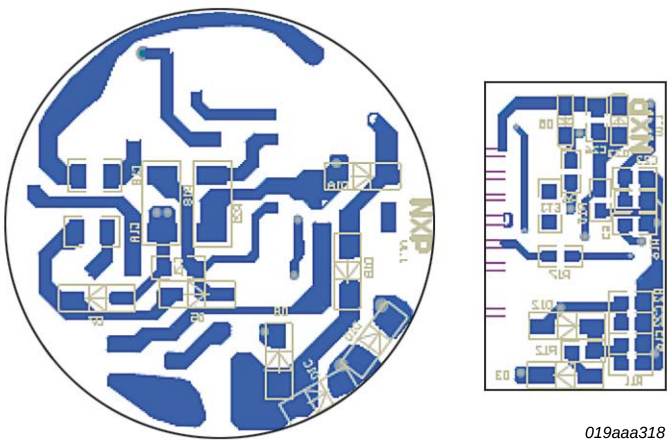

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Fig 8. UBA2028 120 V reference board; bottom layer

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11. Contents

Date of release: 27 August 2010
Document identifier: UM10382