UM10359

UBA2016AT HFTL demo board with boost and dimming

Rev. 1.1 — 1 July 2011 **User manual**

Document information

Info	Content
Keywords	UBA2016AT, ballast, 28 W 2D lamp, dimming, boost
Abstract	This User manual describes a demonstration (demo) board using the UBA2016AT controller for driving a 28 W fluorescent lamp.

Revision history

Rev	Date	Description
v.1.1	20110701	second version
v.1	20110303	first version

Contact information

For more information, please visit: **http://www.nxp.com**

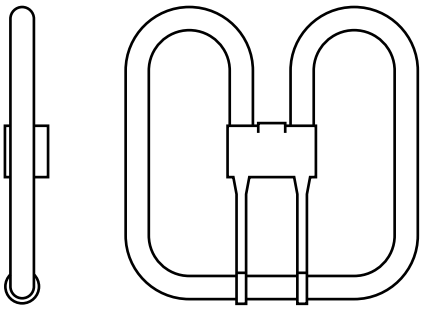
For sales office addresses, please send an email to: **salesaddresses@nxp.com**

1. Introduction

This User manual describes a demonstration (demo) board with boost and dimming functionality using the UBA2016AT controller. The demo board drives a 28 W 2D (square) fluorescent lamp.

019aaa577

Fig 1. UBA2016AT demo board



019aaa578

Fig 2. Mechanical drawing of a 28 W 2D 4-pin lamp

2. 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 demo board is powered by AC mains voltage. Avoid touching the board when power is applied. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments.

3. Specification

Table 1. Demo board specification

Description	Value/Comment
Ballast type	electronic
Starting method	programmed start with pre-heat
Number of lamp terminals	4
Line voltage	220 V to 240 V AC
Line frequency	50/60 Hz
Number of lamps	1
Dimming interface	1 V to 10 V
Transient protection	complies with IEC 61547

Table 2. Lamps supported

Lamp type	Description
SQE28835 4 pins	OSRAM square CFL 28 W

Table 3. Ballast performance

Lamp type	Number of lamps	Rated lamp power (W)	Maximum THD	Maximum lamp current crest factor	Power factor	Nominal lamp current (mA)	Minimal lamp current (mA)
SQE28835 (OSRAM)	1	28	10 %	1.7	>0.95	300	5.0

4. Board description

Refer to Figure 3.

The demo board input section comprises a fuse, surge protection against fast AC transients, EMI filter, double-side rectifier and Power Factor Correction (PFC). The output of the PFC connects to a buffer electrolytic capacitor to supply the half-bridge circuit which is connected to the lamp. The PFC and half-bridge circuit is controlled by the UBA2016AT controller IC. An input is provided to control dimming of the lamp light output.

The PFC is implemented as an up-converter in boundary conduction mode. The resonant circuit is voltage fed by the half-bridge which comprises two NMOST transistors. The resonant circuit includes a transformer for electrode heating.

The ballast circuit design used in the demo board is typical for driving most lamps rated above 25 W, and is proven to be a cost-effective application.

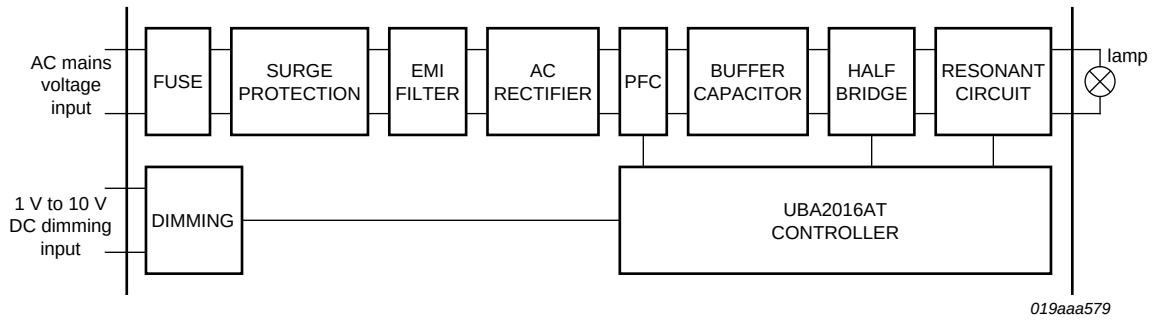
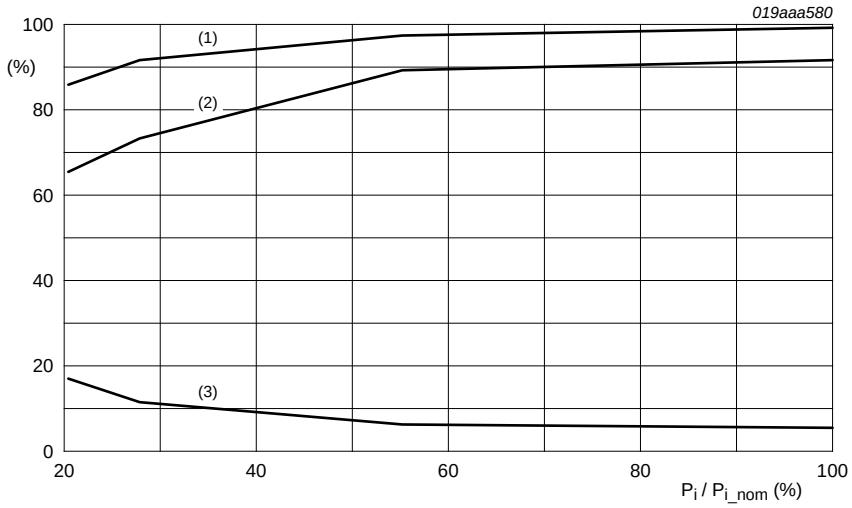


Fig 3. Block diagram

4.1 Performance indicators

4.1.1 Efficiency, power factor and THD



Measured with a dummy lamp (resistors only).

(1) Power factor.

(2) Efficiency.

(3) Total harmonic distortion.

Fig 4. THD, power factor and efficiency at several dimming settings

4.1.1.1 Dimming curve

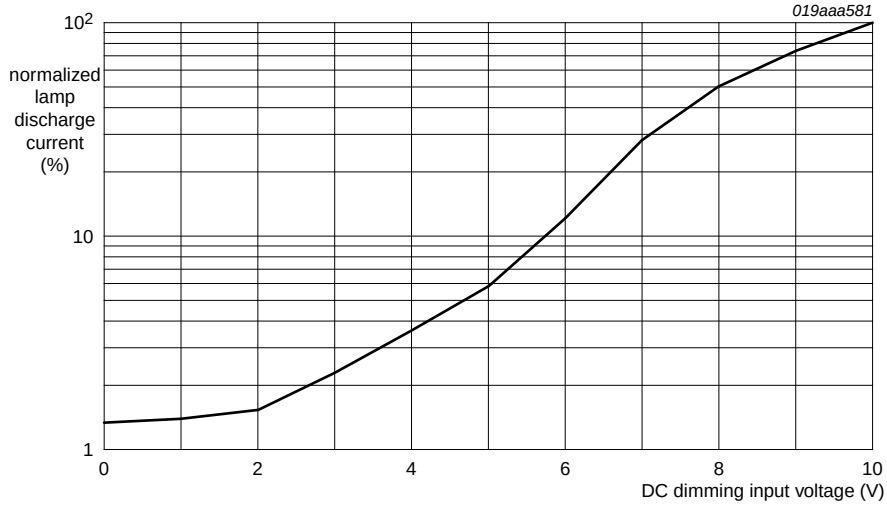


Fig 5. Normalized lamp discharge current as a function of the DC dimming input voltage

4.1.1.2 Lamp current boost at startup

A boost function is implemented to enable reduced lamp run-up times. This is needed typically for outdoor applications or for amalgam lamps.

At startup the lamp current is boosted during a pre-defined time by the RC network on the BOOST pin.

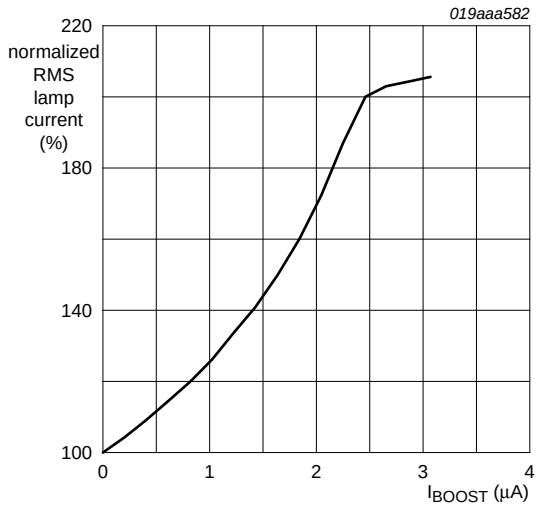
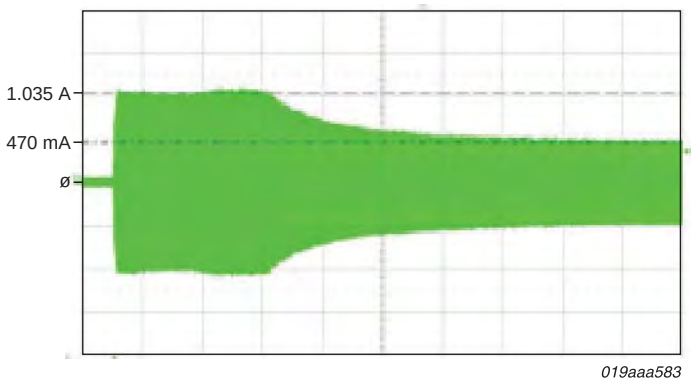


Fig 6. Lamp current as a function of BOOST pin input current

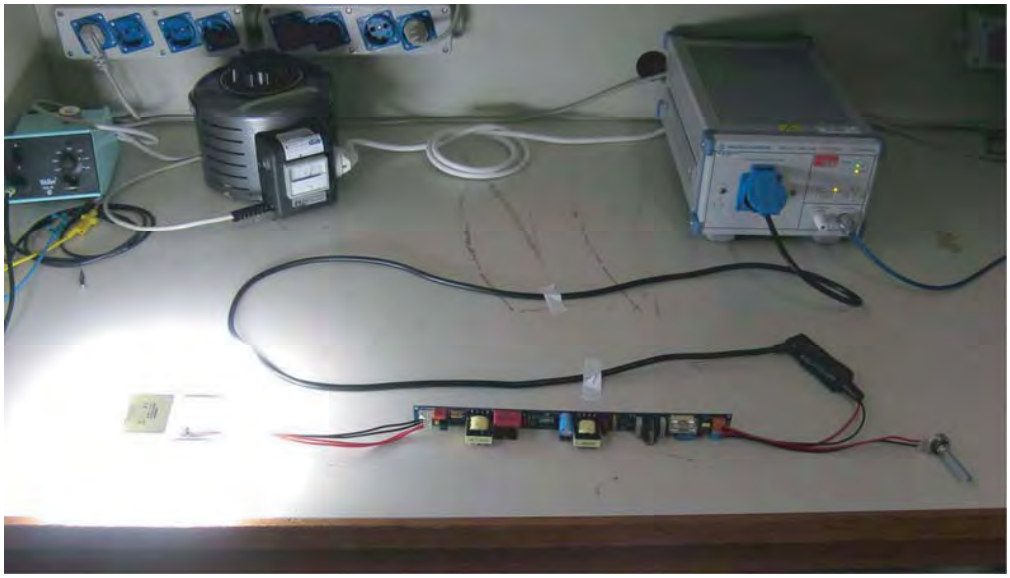


y axis = 500 mA/div; Δy = 565 mA; x axis = 1 s/div.

Fig 7. Boost function of the lamp current at startup

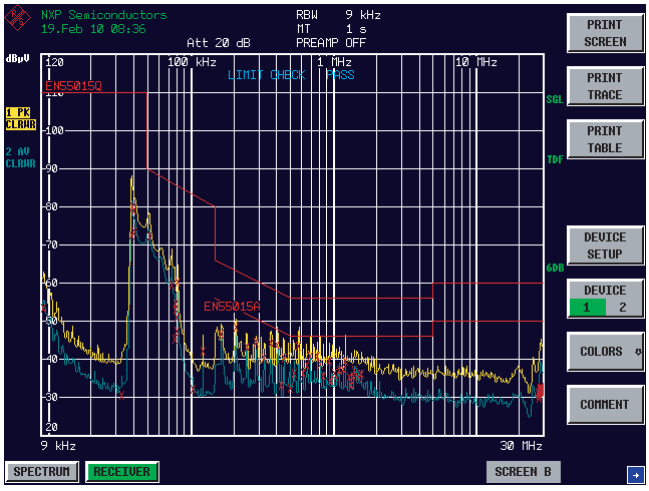
4.1.2 EMI conducted emission

The demo board with lamp complies with EN55015 quasi-peak and average measurements, no metal shielding is required.



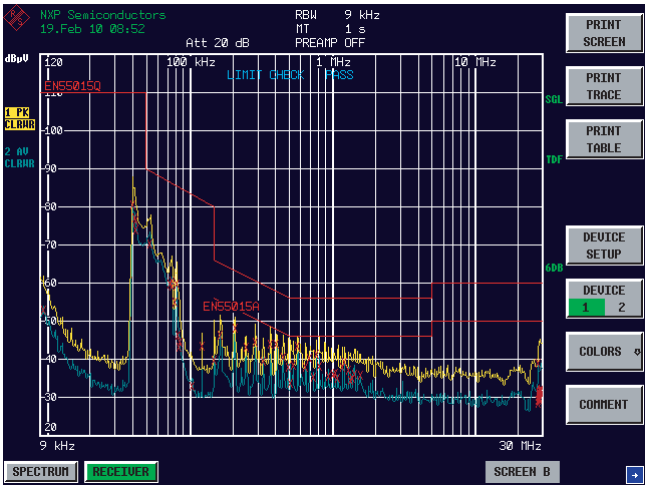
019aaa584

Fig 8. EMI conducted emission test setup



019aaa585

a. Line L



019aaa586

b. Line N

Fig 9. EMI conducted emission results

5. Wiring

The ballast circuit can be connected as shown in Figure 10. If no dimming is required, the dimmer input must be left floating.

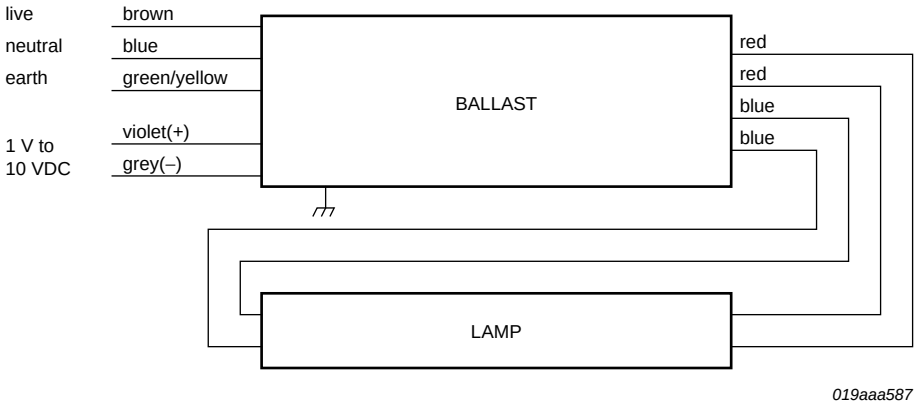
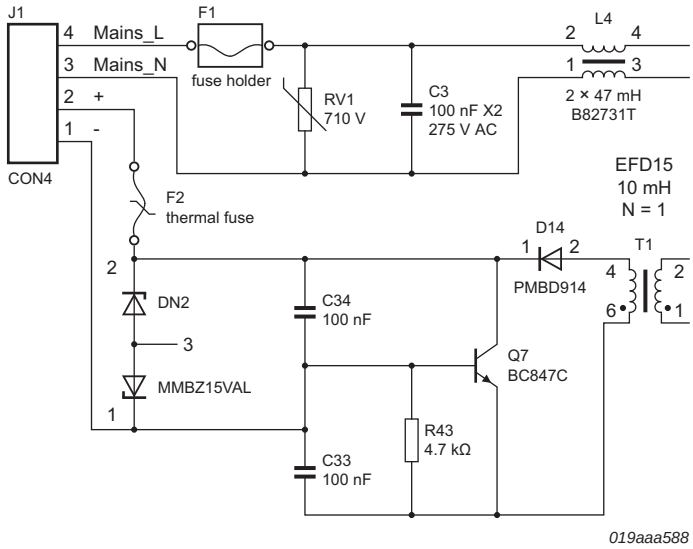


Fig 10. Wiring diagram

The earth/chassis connection must be connected to the earth tag J3 shown in Figure 13. There is no provision for an earth connection on the mains connector. If a metal fixture is used, it must also be connected to the earth tag J3.

6. Dimming without external voltage source

The ballast circuit is designed to be dimmed with a voltage source from 1 V to 10 V DC. However, it is possible to dim with an external potentiometer of 470 kΩ. This function is intended for demonstration purposes only. The potentiometer must be connected to pin 1 (grey wire) and pin 2 (violet wire) of connector J1.



Zener diode DN2 is optional.

Fig 11. J1 connector pin-out schematic diagram

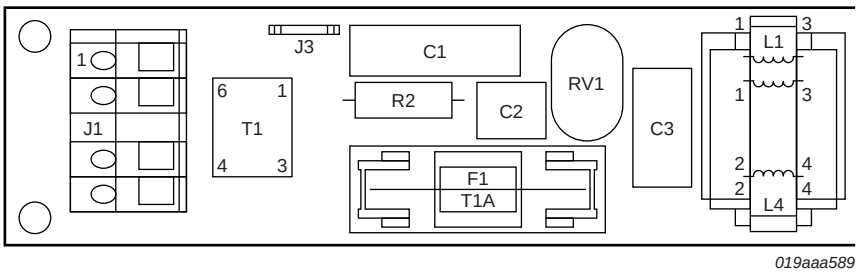


Fig 12. J1 connector; pin-out location of pin 1

7. Schematic diagram

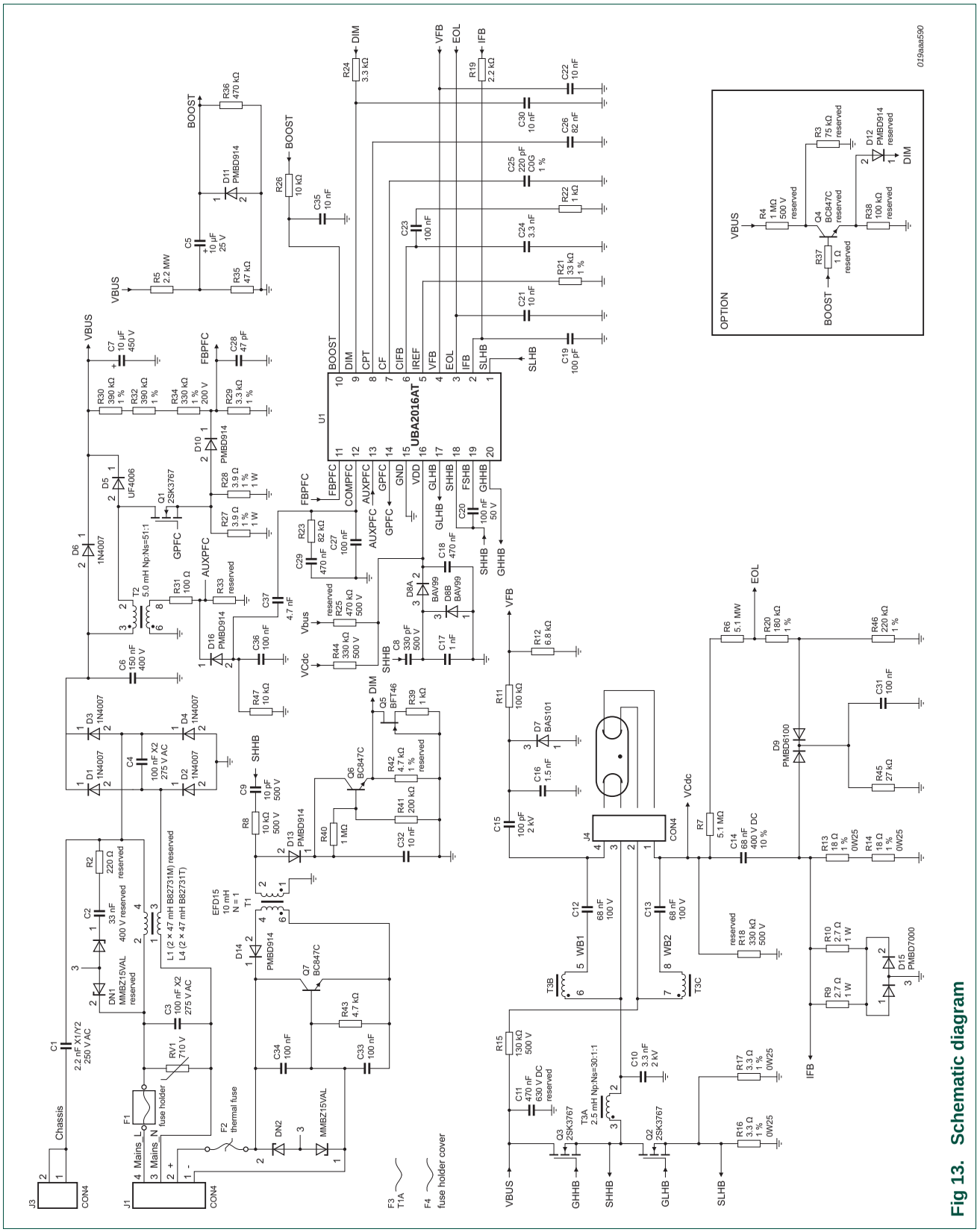
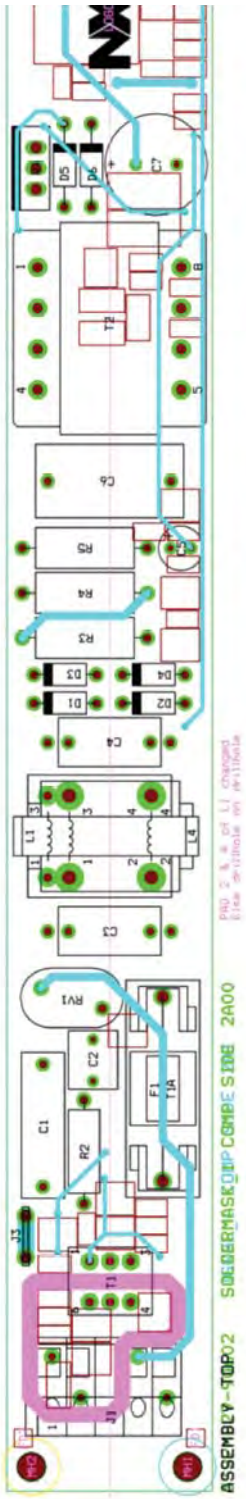


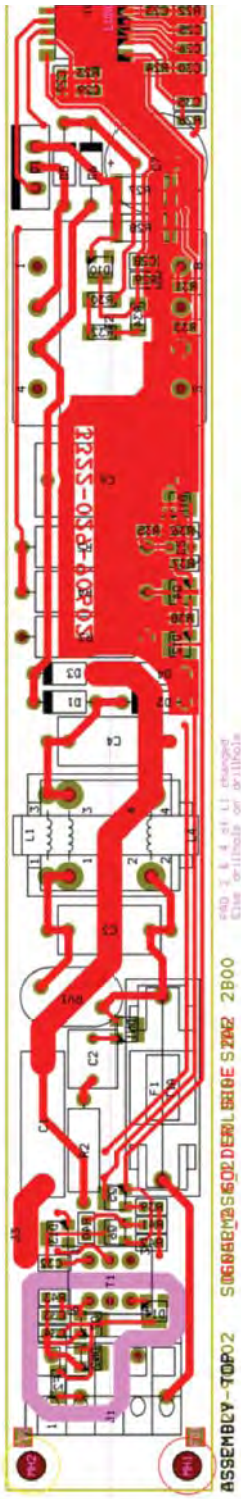
Fig 13. Schematic diagram

8. Layout



019aaa591

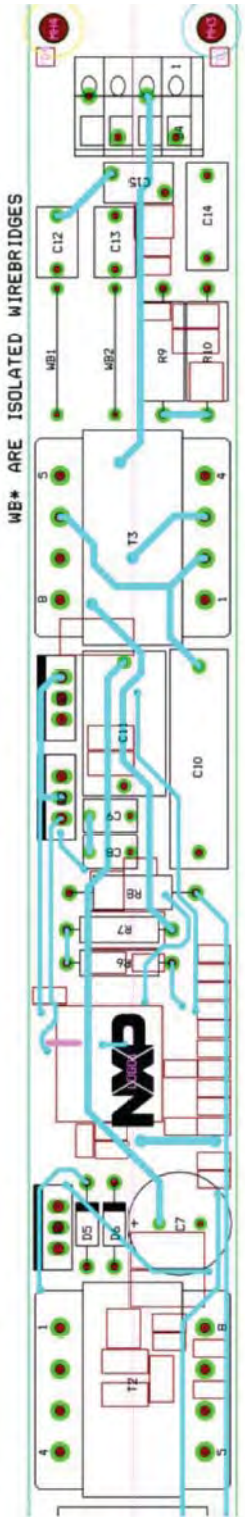
a. Top view



019aaa592

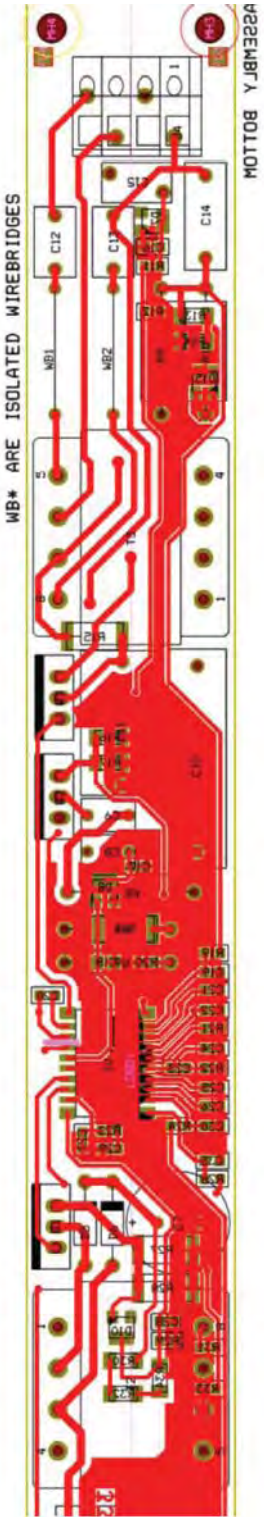
b. Bottom view

Fig 14. PCB layout top and bottom views (1)



019aaa593

a. Top view



019aaa594

b. Bottom view

Fig 15. PCB layout top and bottom views (2)

9. PCB components

Table 4. PCB components

Designator	Description	Part identifier	Manufacturer
0001	PCB UBA2016AT	3322-029-90603	QPI Group
0002	mains supply plug	1038 SW	APSA
0003	potentiometer, 470 kΩ	23ESB474MMF50NF	Tyco Electronics
0004	lamp socket	26.715.4701.50	Prime light
C1	2.2 nF X1/Y2, 20 %	F17102221000	Vishay
C2	33 nF, mounting reserved, 10 %	BFC237058333	Vishay
C3, C4	100 nF X2, 10 %	BFC233912104	Vishay
C5	10 μF, 10 %	199D106X9025C1V1E3	Vishay
C6	150 nF, 10 %	146-MEF2G154K	Xicon
C7	10 μF, 20 %	UBT2W100MHD	Nichicon
C8	330 pF, 10 %	D331K20Y5PL63L6R	Vishay
C9	10 pF, 10 %	D100J20C0GL63L6R	Vishay
C10	3.3 nF, 5 %	FKP1-3300/2KV/5	WIMA
C11	470 nF, mounting reserved, 10 %	BFC233912474	Nichicon
C12, C13	68 nF, 5 %	140-PEI2A683J-RC	Xicon
C14	68 nF, 10 %	MKP4-.068/400/10 P10	WIMA
C15	100 pF, 10 %	564R20TST10	Vishay
C16	1.5 nF, 5 %	C0603C152J1GACTU	Kemet
C17	1 nF, 5 %	C0603C102J5GACTU	Kemet
C18, C29	470 nF, 5 %	VJ0805Y474JXJRW1BC	Vishay
C19	100 pF, 5 %	C0603C101J5GACTU	Kemet
C20, C23, C26, C27, C31, C33, C34	100 nF, 5 %	VJ0603Y104JXACW1BC	Vishay
C21, C22, C30, C32, C35	10 nF, 20 %	VJ0603Y103MXAAT	Vishay
C24	3.3 nF, 10 %	C0603C332J3RACTU	Kemet
C25	220 pF, 1 %	06035A221FAT2A	AVX
C28	47 pF, 5 %	VJ0603A470JXBCBC	Vishay
C29	470 nF, 20 %	C0603C474M4PACTU	Kemet
D1, D2, D3, D4, D6	1N4007	1N4007-E3/51	Vishay
D5	UF4006	UF4006-E3/54	Vishay
D7	BAS101	BAS101,215	NXP
D8	BAV99	BAV99,215	NXP
D9	PMBD6100	PMBD6100	NXP
D10, D11, D12, D13, D14	PMBD914, D12 mounting reserved	PMBD914 /T3	NXP
D15	PMBD7000	PMBD7000	NXP
DN1, DN2	MMBZ15VAL, DN1 mounting reserved	MMBZ15VAL	NXP

Table 4. PCB components *…continued*

Designator	Description	Part identifier	Manufacturer
F1	fuseholder	MCHTC-15M	MULTICOMP
F2	thermal fuse	1206L110WR	Littelfuse
F3	T 1 A	0034.3117	SCHURTER
F4	fuse holder cover	MCHTC-150M	MULTICOMP
J1	CON4	250-003/K180-4813	WAGO
J3	CON4	63755-1	Tyco/AMP
J4	CON4	250-204/000-009	WAGO
L1	2 × 47 mH B82731M, mounting reserved	B82731M2501A030	Epcos
L4	2 × 47 mH B82731T	B82731T2451A020	Epcos
Q1, Q2, Q3	2SK3767	2SK3767(Q)	Toshiba
Q4, Q6, Q7	BC847C, Q4 mounting reserved	BC847C	NXP
Q5	BFT46	BFT46	NXP
R2	220 Ω, 5 %, mounting reserved,	RC20GF221J	IRC
R3	75 kΩ, 5 %, mounting reserved	294-75K-RC	Xicon
R4	1 MΩ, 5 %, mounting reserved	294-1M-RC	Xicon
R5	2.2 MΩ, 5 %	294-2.2M-RC	Xicon
R6, R7	5.1 MΩ, 5 %	CF1/2C515J	KOA Speer
R8, R26	10 kΩ, 1 %	CMF6010K000FKEB	Vishay
R9, R10	2.7 Ω, 5 %	294-2.7-RC	Xicon
R11, R38	100 kΩ, 5 %, R38 mounting reserved	CRCW0603100KJNEB	Vishay
R12	5.6 kΩ, 5 %	CRCW06035K60JKEA	Vishay
R13, R14	18 Ω, 1 %	CRCW120618R0FKEA	Vishay
R15	130 kΩ, 5 %	CRCW2512130KFKEG	Vishay
R16, R17	2.7 Ω, 1 %	CRCW12062R70FKEA	Vishay
R18	330 kΩ, 5 %, mounting reserved	CRCW2512330KJNEG	Vishay
R19, R33	2.2 kΩ, 5 %, R33 mounting reserved	CRCW06032K20JNEB	Vishay
R20	180 kΩ, 1 %	CRCW0603180KFKEA	Vishay
R21	33 kΩ, 1 %	CRCW0603110KFKEA	Vishay
R22, R39	1 kΩ, 5 %	CRCW06031K00JNEA	Vishay
R23	82 kΩ, 5 %	CRCW060382K0JNEA	Vishay
R24	3.3 kΩ, 5 %	CRCW06033K30JNEB	Vishay
R37	1 Ω, 5 %, mounting reserved	CRCW06031R00FKTA	Vishay
R27, R28	3.9 Ω, 1 %	CRL2512-FW-3R90ELF	Bourns
R29	3.3 kΩ, 1 %	CRCW06033K30FKEA	Vishay
R30, R32	390 kΩ, 1 %	CRCW1206390KFKEA	Vishay
R31	100 Ω, 5 %	CRCW0603100RJNEB	Vishay
R34	330 kΩ, 1 %	CRCW1206330KFKEA	Vishay
R35	47 kΩ, 5 %	CRCW060347K0JNEB	Vishay
R36	470 kΩ, 5 %	CRCW0603470KJNEB	Vishay
R40	1 MΩ, 5 %	CRCW06031M00JNEB	Vishay
R41	200 kΩ, 5 %	CRCW0603200KJNEA	Vishay

Table 4. PCB components *…continued*

Designator	Description	Part identifier	Manufacturer
R42	4.7 kΩ, 1 %, mounting reserved	CRCW06034K70FKEA	Vishay
R43	4.7 kΩ, 5 %	CRCW06034K70JNEB	Vishay
R45	27 kΩ, 5 %	CRCW060327K0JNEB	Vishay
R46	220 kΩ, 1 %	CRCW0603220KFKEA	Vishay
RV1	710 V	V10E275P	Littelfuse
T1	EFD15, 10 mH, N = 1, 10 %	750311081, rev00	Wurth
T2	5.0 mH Np:Ns = 51 : 1, 10 %	750311083, rev01	Wurth
T3	2.5 mH Np:Ns = 30 : 1 : 1, 10 %	750311082, rev01	Wurth
U1	UBA2016AT	UBA2016AT	NXP
WB1	jumper wire		NXP
WB2	jumper wire		NXP

10. Abbreviations

Table 5. Abbreviations

Acronym	Description
AC	Alternating Current
CFL	Compact Fluorescent Lamp
DC	Direct Current
EMI	ElectroMagnetic Interference
HF	High Frequency
IEC	International Electrotechnical Commission
NMOST	N-channel Metal Oxide Semiconductor Transistor
PFC	Power Factor Correction
RC	Resistor Capacitor
THD	Total Harmonic Distortion
TL	TubuLar (fluorescent lamp)

11. Legal information

11.1 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

11.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors accepts no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

Evaluation products — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

11.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

12. Contents

For more information, please visit: http://www.nxp.com
For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 1 July 2011
Document identifier: UM10359