UBA2024

Half-bridge power IC for CFL lamps

Rev. 6.2 — 1 November 2010 Product data sheet

1. General description

The UBA2024 is a family of high-voltage monolithic Integrated Compact Fluorescent Lamp (CFL) drivers for a large range of lamp powers. Specific versions are optimized for 230 V and 110 V mains supplies. The product family integrates full CFL controller functionality with high voltage half-bridge transistors. All products in the UBA2024 family are pin-to-pin compatible enabling a single application design covering a wide range of power ratings.

The IC features a soft start function, an adjustable internal oscillator and an internal drive function with a high-voltage level shifter for driving the half-bridge.

To guarantee an accurate 50 % duty cycle, the oscillator signal is passed through a divider before being fed to the output drivers.

2. Features and benefits

- The common feature set includes:
  - high power efficiency
  - a high integration level with low component counts enabling small form factor electronic ballast
  - integrated bootstrap diode
  - soft start function
  - minimum glow time control
  - integrated low-voltage supply
  - adjustable operating frequency as a result of the embedded oscillator
  - an accurate 50 % duty cycle provided by an embedded oscillator signal
  - integrated half-bridge power transistors
  - an internal drive function with a high-voltage level shifter up to 550 V (300 V for the UBA2024BP and UBA2024BT)

3. Applications

- Driver for any kind of half-bridge configured load up to 23 W, provided that the maximum junction temperature is not exceeded
- Designed for electronically self-ballasted CFL lamps

4. Ordering information

Table 1. Ordering information

Type number	Package		
	Name	Description	Version
UBA2024P[1]	DIP8	plastic dual in-line package; 8 leads (300 mil)	SOT97-1
UBA2024T[1]	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
UBA2024AP[2]	DIP8	plastic dual in-line package; 8 leads (300 mil)	SOT97-1
UBA2024AT[3]	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
UBA2024BP[4]	DIP8	plastic dual in-line package; 8 leads (300 mil)	SOT97-1
UBA2024BT[4]	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1

[1] For this type number, $R_{DS(on)}$ = 9 Ω and I_{SAT} = 900 mA.

[2] For this type number, $R_{DS(on)}$ = 6 Ω and I_{SAT} = 1350 mA.

[3] For this type number, $R_{DS(on)}$ = 6.4 Ω and I_{SAT} = 1200 mA.

[4] For this type number, $R_{DS(on)}$ = 2 Ω and I_{SAT} = 2500 mA.

5. Block diagram

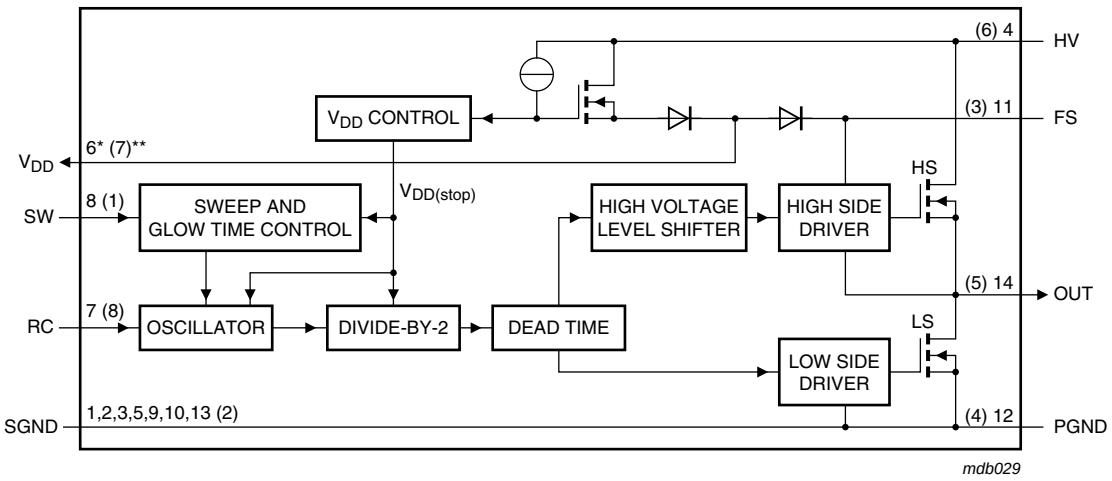


Fig 1. Block diagram

6. Pinning information

6.1 Pinning

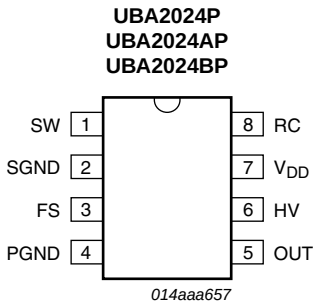


Fig 2. Pinning diagram SOT97-1

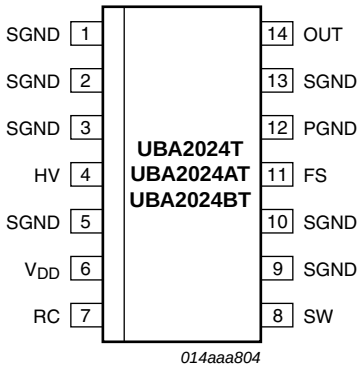


Fig 3. Pinning diagram SOT108-1

6.2 Pin description

Table 2. Pin description

Symbol	Pin SOT97-1	Pin SOT108-1	Description
SW	1	8	sweep timing input
SGND	2	1, 2, 3, 5, 9, 10, 13	signal ground
FS	3	11	high-side floating supply output
PGND	4	12	power ground
OUT	5	14	half-bridge output
HV	6	4	high-voltage supply
V_{DD}	7	6	internal low-voltage supply output
RC	8	7	internal oscillator input

7. Functional description

7.1 Supply voltage

The UBA2024 does not require an external low-voltage supply as the mains supply voltage applied to pin HV powers it. The IC derives its own low supply voltage from this for its internal circuitry.

7.2 Start-up state

With an increase of the supply voltage on pin HV, the IC enters the start-up state. In the start-up state the high-side power transistor is not conducting and the low-side power transistor is switched on. The internal circuit is reset and the capacitors on the bootstrap pin FS and low-voltage supply pin V_{DD} are charged. Pins RC and SW are switched to ground. The start-up state is defined until $V_{DD} = V_{DD(startup)}$.

7.3 Sweep mode

The IC enters the sweep mode when the voltage on pin $V_{DD} > V_{DD(startup)}$. The capacitor on pin SW is charged by I_{SW} and the half-bridge circuit starts oscillating. The circuit enters the start-up state again when the voltage on pin $V_{DD} < V_{DD(stop)}$.

The sweep time (t_{sweep}) is determined by the charge current ($I_{ch(sw)}$) and the external capacitor (C_{SW}). Typical the total sweep time set by C_{SW} is:

$$t_{sweep} = C_{SW}\,(nF) \times 10.3\ ms \quad (1)$$

During the sweep time the current flowing through the lamp electrodes performs some preheating of the filaments. See Figure 5.

7.4 Reset

A DC reset circuit is incorporated in the high-side driver. The high-side transistor is switched off when the voltage on pin FS is below the high-side lockout voltage $V_{float(UVLO)}$.

7.5 Oscillation

The oscillation is based upon the 555-timer function. A self oscillating circuit is made with the external resistor R_{OSC} and the capacitor C_{OSC} (see Figure 4).

To realize an accurate 50 % duty cycle, an internal divider is used. This reduces the bridge frequency to half the oscillator frequency.

The output voltage of the bridge will change at the falling edge of the signal on pin RC. The design equation for the half-bridge frequency is:

$$f_{osc} = \frac{1}{k \times R_{OSC} \times C_{OSC}} \quad (2)$$

An overview of the oscillator signal, internal LS and HS drive signals and the output is given in Figure 4.

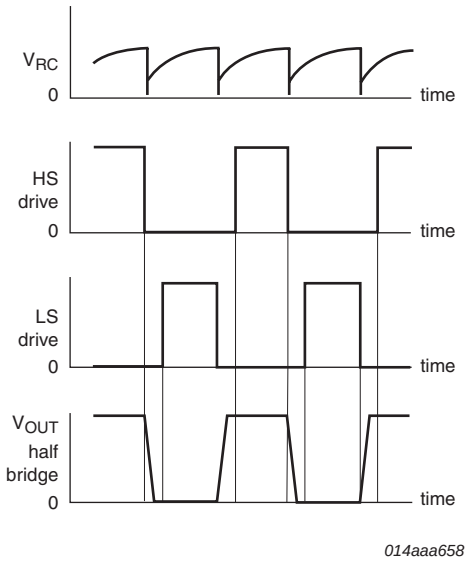


Fig 4. Oscillator, drivers and output signals

When entering the sweep mode (V_{SW} = 0 V), the bridge oscillator starts at 2.5 times the nominal bridge frequency and sweeps down to the nominal frequency (bridge), set by R_{OSC} and C_{OSC}. During the sweep mode the amplitude of the RC oscillator on pin RC, will swing between $V_{trip(osc)low}$ and $V_{SW} + 0.4V_{trip(osc)high}$. The amplitude of the RC oscillator will continue to increase until $V_{SW} + 0.4V_{trip(osc)high} = V_{trip(osc)high}$, this determines the end of the sweep time. The voltage on pin SW however will continue to rise until it reaches supply voltage level.

During this continuous decrease in frequency, the circuit approaches the resonance frequency of the load, and this causes a high voltage across the load, which ignites the lamp. The sweep to resonance time should be much larger than the settling time of the supply voltage on pin HV, to guarantee that the full high-voltage is present at the moment of ignition. See Figure 5.

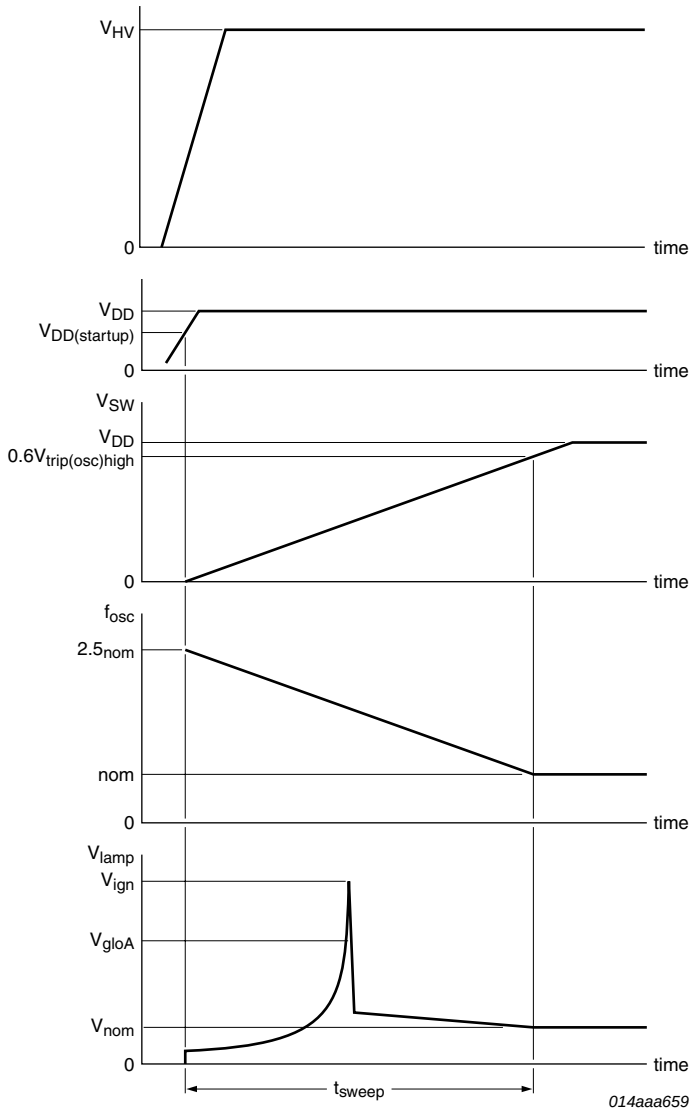


Fig 5. Start-up frequency behavior

7.6 Non-overlap time

The non-overlap time is defined as the time when both MOSFETs are not conducting. The non-overlap time is fixed internally.

8. Limiting values

Table 3. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{HV}	voltage on pin HV	normal operation			
		UBA2024P	-	373	V
		UBA2024AP	-	373	V
		UBA2024T	-	373	V
		UBA2024AT	-	373	V
		UBA2024BP	-	187	V
		UBA2024BT	-	187	V
		mains transients during 0.5 s			
		UBA2024P	-	550	V
		UBA2024AP	-	550	V
		UBA2024T	-	550	V
		UBA2024AT	-	550	V
		UBA2024BP	-	300	V
		UBA2024BT	-	300	V
V_{FS}	voltage on pin FS		V_{HV}	V_{HV} + 14	V
V_{DD}	supply voltage	low voltage; DC supply	0	14	V
I_{DD}	supply current	low voltage; peak value is internally limited; T_{amb} = 25 °C	0	5	mA
V_{PGND}	voltage on pin PGND	referenced to SGND	–1	+1	V
V_{RC}	voltage on pin RC	I_{RC} < 1 mA	0	V_{DD}	V
V_{SW}	voltage on pin SW	I_{SW} < 1 mA	0	V_{DD}	V
SR	slew rate	pin OUT; repetitive	–4	+4	V/ns
T_j	junction temperature	[1]	–40	+150	°C
T_{amb}	ambient temperature		–40	+150	°C
T_{stg}	storage temperature		–55	+150	°C

[1] The maximum junction temperature must not be exceeded.

9. Thermal characteristics

Table 4. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]		
		SO14 package		95	K/W
		DIP8 package		95	K/W
$R_{th(j-c)}$	thermal resistance from junction to case	in free air	[1]		
		SO14 package		8	K/W
		DIP8 package		16	K/W

[1] In accordance with IEC 60747-1

10. Characteristics

Table 5. Characteristics

T_j = 25 °C; all voltages are measured with respect to SGND; positive currents flow into the IC.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
High-voltage supply						
V_{HV}	voltage on pin HV	mains transients during 0.5 s; $I_{HV} < 30$ µA				
		UBA2024P	0	-	550	V
		UBA2024AP	0	-	550	V
		UBA2024T	0	-	550	V
		UBA2024AT	0	-	550	V
		UBA2024BP	0	-	250	V
		UBA2024BT	0	-	250	V
V_{FS}	voltage on pin FS	mains transients during 0.5 s; $I_{HV} < 30$ µA				
		UBA2024P	0	-	564	V
		UBA2024AP	0	-	564	V
		UBA2024T	0	-	564	V
		UBA2024AT	0	-	564	V
		UBA2024BP	0	-	264	V
		UBA2024BT	0	-	264	V
Low-voltage supply						
V_{DD}	supply voltage	V_{HV} = 100 V; $R_{osc} = \infty$; $V_{SW} = V_{DD}$; V_{RC} = 0 V	11.4	12.5	13.3	V
Start-up state						
I_{HV}	current on pin HV	V_{HV} = 100 V; $R_{osc} = \infty$; $V_{SW} = V_{DD}$; V_{RC} = 0 V	-	-	0.39	mA
$V_{DD(startup)}$	start-up supply voltage		10	11	12	V
$V_{DD(stop)}$	stop supply voltage		8	8.5	9	V
$V_{DD(hys)}$	hysteresis of supply voltage		2	2.5	3	V

Table 5. Characteristics *...continued*

T_j = 25 °C; all voltages are measured with respect to SGND; positive currents flow into the IC.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Output stage						
R_{on}	on-state resistance	HS transistor; V_{HV} = 310 V; I_D = 100 mA				
		UBA2024P	-	9.7	11	Ω
		UBA2024T	-	9.7	11	Ω
		UBA2024AP	-	6.5	7.4	Ω
		UBA2024AT	-	7.0	8.0	Ω
		HS transistor; V_{HV} = 160 V; I_D = 100 mA				
		UBA2024BP	-	2.0	2.35	Ω
		UBA2024BT	-	2.0	2.35	Ω
		LS transistor; I_D = 100 mA				
		UBA2024P	-	8.5	9.4	Ω
		UBA2024T	-	8.5	9.4	Ω
		UBA2024AP	-	5.7	6.3	Ω
		UBA2024AT	-	6.2	6.9	Ω
		UBA2024BP	-	2.3	2.55	Ω
		UBA2024BT	-	2.3	2.55	Ω
V_F	forward voltage	HS; I_F = 200 mA	-	-	2.0	V
		LS; I_F = 200 mA	-	-	2.0	V
		bootstrap diode; I_F = 1 mA	0.7	1.0	1.3	V
I_{Dsat}	drain saturation current	HS; V_{DS} = 30 V; $T_j \leq 125$ °C; V_{HV} = 310 V				
		UBA2024P	900	-	-	mA
		UBA2024AP	1350	-	-	mA
		UBA2024T	900	-	-	mA
		UBA2024AT	1200	-	-	mA
		HS; V_{DS} = 30 V; $T_j \leq 125$ °C; V_{HV} = 160 V				
		UBA2024BP	2500	-	-	mA
		UBA2024BT	2500	-	-	mA
		LS; V_{DS} = 30 V; $T_j \leq 125$ °C				
		UBA2024P	900	-	-	mA
		UBA2024AP	1350	-	-	mA
		UBA2024T	900	-	-	mA
		UBA2024AT	1200	-	-	mA
		UBA2024BP	2500	-	-	mA
		UBA2024BT	2500	-	-	mA
t_{no}	non-overlap time		1	1.35	1.7	µs
$V_{float(UVLO)}$	undervoltage lockout floating voltage		3.6	4.2	4.8	V

Table 5. Characteristics *...continued*

T_j = 25 °C; all voltages are measured with respect to SGND; positive currents flow into the IC.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{FS}	current on pin FS	V_{HV} = 310 V; V_{FS} = 12.2 V				
		UBA2024P, UBA2024T	10	14	18	μA
		UBA2024AP, UBA2024AT	10	14	18	μA
		V_{HV} = 160 V; V_{FS} = 12.2 V				
		UBA2024BP, UBA2024BT	10	14	18	μA
Internal oscillator						
f_{osc}	oscillator frequency	V_{SW} = 0 V	-	150	-	kHz
		V_{SW} = V_{DD}	-	-	60	kHz
		operating; nominal; R_{OSC} = 100 kΩ; C_{OSC} = 220 pF; V_{SW} = V_{DD}	40.05	41.32	42.68	kHz
$\Delta f_{osc}/f_{osc}$	relative oscillator frequency variation	R_{OSC} = 100 kΩ; C_{OSC} = 220 pF; −20 °C ≤ T_j ≤ +150 °C	-	2	-	%
k_H	high-level trip point factor		0.382	0.395	0.408	
$V_{trip(osc)high}$	high oscillator trip voltage	$V_{trip(osc)high}$ = k_H × V_{DD}	4.58	4.94	5.29	V
k_L	low-level trip point factor		0.030	0.033	0.038	
$V_{trip(osc)low}$	low oscillator trip voltage	$V_{trip(osc)low}$ = k_L × V_{DD}	0.367	0.413	0.483	V
K_{osc}	oscillator constant	R_{OSC} = 100 kΩ; C_{OSC} = 220 pF	1.065	1.1	1.35	V
Sweep function						
$I_{ch(sweep)}$	sweep charge current	V_{SW} = 0 V	215	280	345	nA
t_{sweep}	sweep time	C_{SW} = 33 nF; V_{DD} = 12.2 V	0.28	0.35	0.45	s

11. Electrostatic discharge

Table 6. ElectroStatic Discharge (ESD) overview

Model	Class	JEDEC classification criteria
ESDH (human body model)	1C	pass at ESD pulse 1000 V
		fail at ESD pulse 2000 V
ESDC (charged device model)	C2	pass at ESD pulse 200 V
		fail at ESD pulse 500 V
ESDM (machine model)	B	pass at 200 V ≥ ESD pulse < 400 V

12. Application information

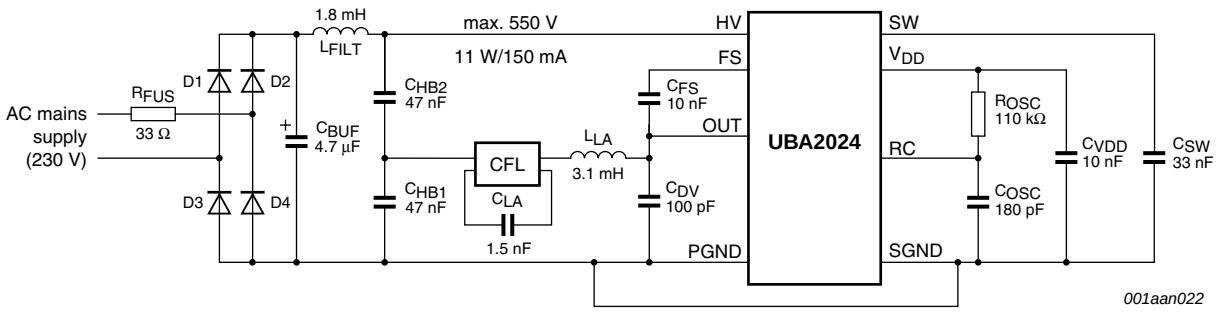


Fig 6. Schematic of 230 V standard compact fluorescent lamp application using UBA2024

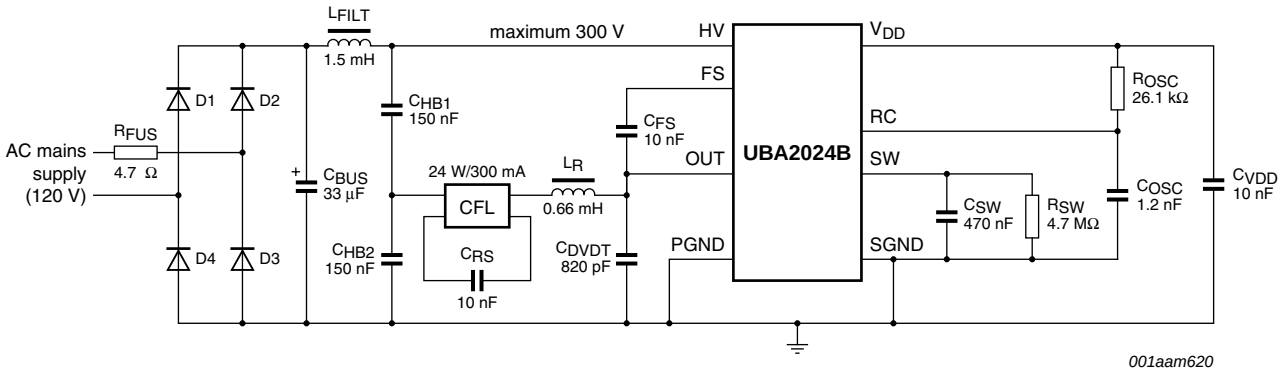
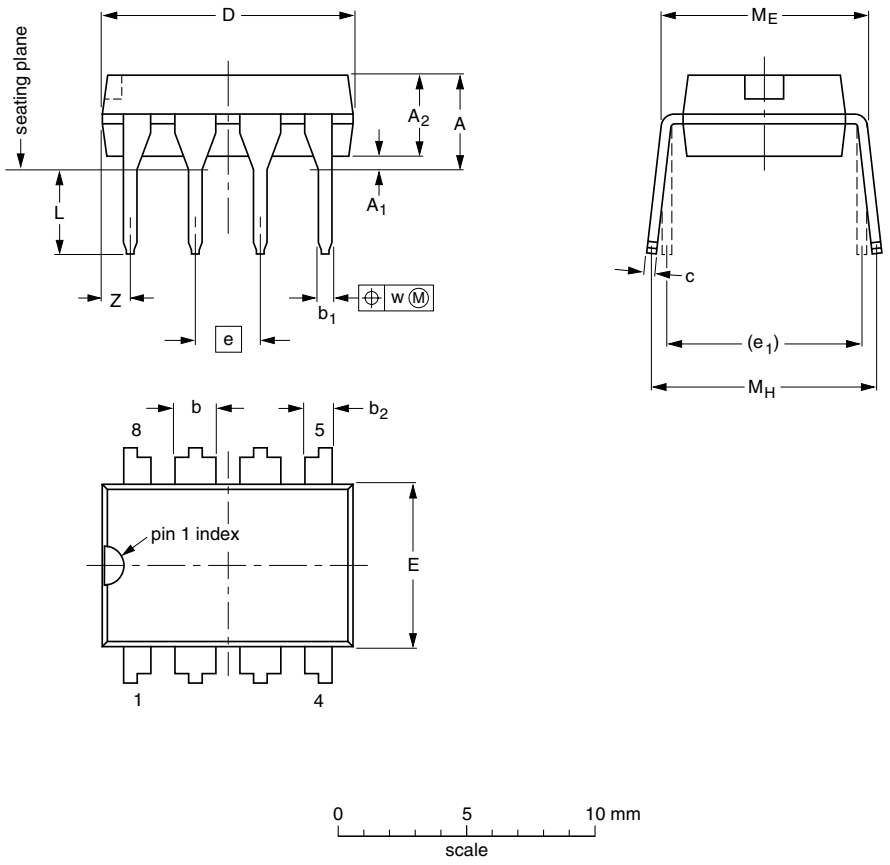


Fig 7. Schematic of 120 V standard compact fluorescent lamp application using UBA2024B

13. Package outline

DIP8: plastic dual in-line package; 8 leads (300 mil) **SOT97-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.02	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.045

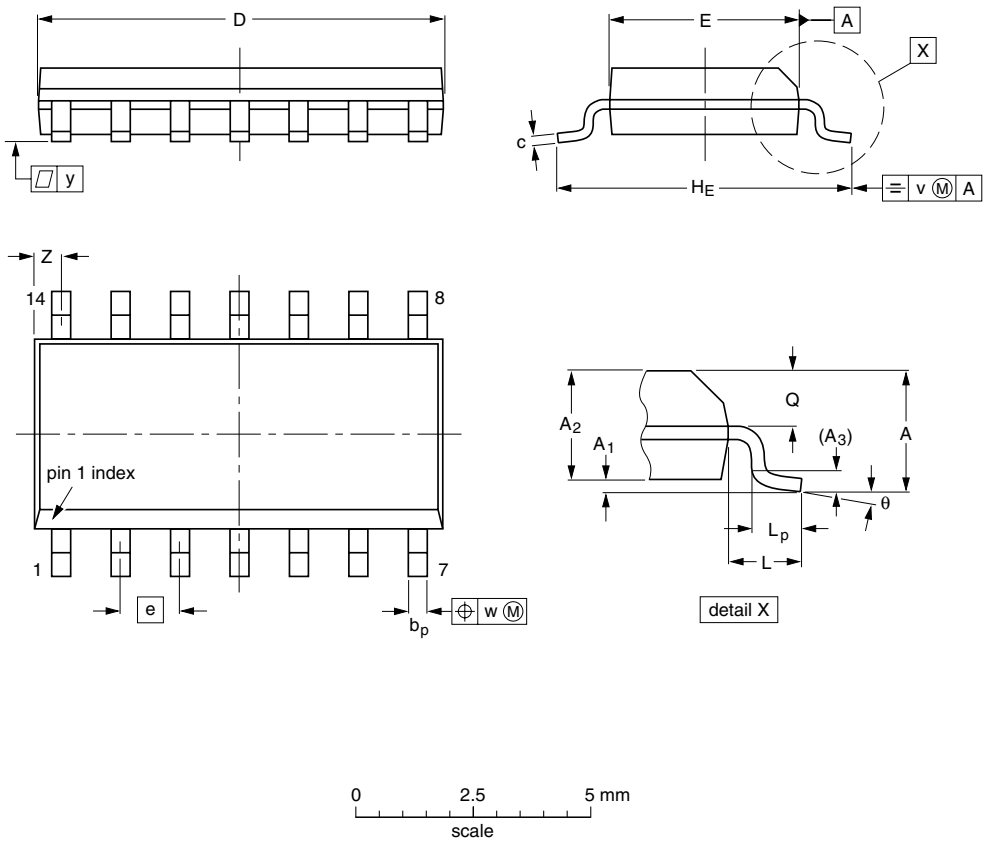
Note

1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT97-1	050G01	MO-001	SC-504-8			~~99-12-27~~ 03-02-13

Fig 8. Package outline SOT97-1 (DIP8)

SO14: plastic small outline package; 14 leads; body width 3.9 mm **SOT108-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT108-1	076E06	MS-012				~~99-12-27~~ 03-02-19

Fig 9. Package outline SOT108-1 (SO14)

14. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
UBA2024 v.6.2	20101101	Product data sheet	-	UBA2024 v.5
Modifications:	• Figure 5 on page 6 has been changed. • The glow time section has been removed. • ESD values have been removed from Table 3 “Limiting values” on page 7, added in to Table 6 “ElectroStatic Discharge (ESD) overview” on page 10 and one error corrected. • Table 3 “Limiting values” on page 7: table notes 2 and 3 have been removed. • Table 5 “Characteristics” on page 8: – V_{DD} supply voltage minimum value has been changed. – V_F forward voltage HS maximum value has been changed. – K_L low-level trip point factor maximum value has been changed. – $V_{trip(osc)low}$ low oscillator trip voltage maximum value has been changed. • Figure 6 on page 11 have been changed.			
UBA2024 v.5	20100916	Product data sheet	-	UBA2024 v.4
UBA2024 v.4	20090917	Product data sheet	-	UBA2024 v.3
UBA2024 v.3	081016	Product data sheet	-	UBA2024 v.2
UBA2024 v.2	040203	Product data sheet	-	UBA2024 v.1
UBA2024 v.1	030813	Product data sheet	-	-

15. Legal information

15.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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16. Contact information

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

17. Contents

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