UBA2024

Half-bridge power IC for CFL lamps

Rev. 03 — 16 October 2008 Product data sheet

1. General description

The UBA2024P is a high-voltage monolithic integrated circuit. The Integrated Circuit (IC) is designed for driving Compact Fluorescent Lamps (CFL) in a half-bridge configuration.

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

- Integrated half-bridge power transistors
- Integrated bootstrap diode
- Integrated low-voltage supply
- Adjustable oscillator frequency
- Maximum voltage of 550 V
- Minimum glow time control
- Soft start

3. Applications

- Driver for any kind of load in a half-bridge configuration
- Especially for electronically self-ballasted CFL for lamp currents up to 220 mA (RMS) under the restriction that the maximum junction temperature is not exceeded

4. Ordering information

Table 1. Ordering information

Type number	Package		
	Name	Description	Version
UBA2024P	DIP8	plastic dual in-line package; 8 leads (300 mil)	SOT97-1

5. Block diagram

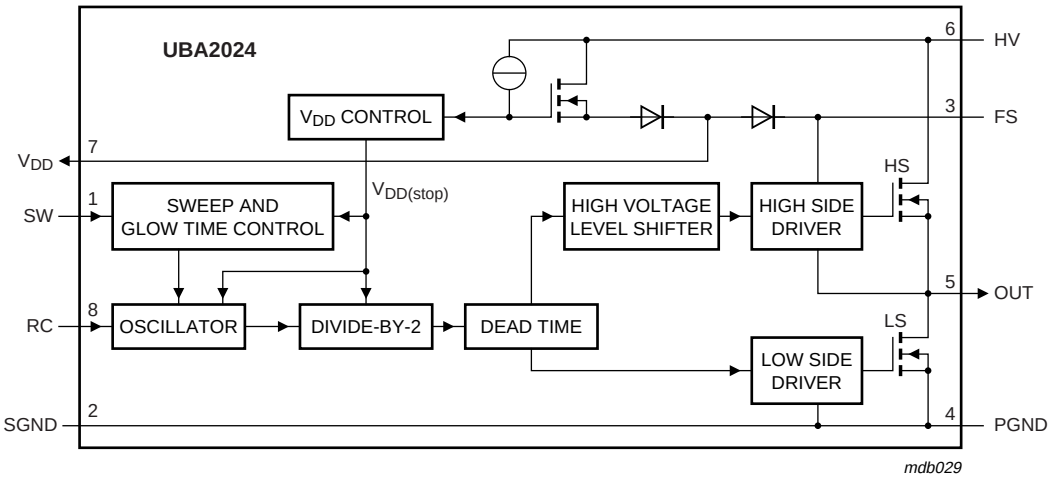


Fig 1. Block diagram

6. Pinning information

6.1 Pinning

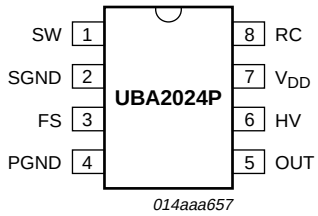


Fig 2. Pin configuration DIP8 package

6.2 Pin description

Table 2. Pin description

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

7. Functional description

7.1 Supply voltage

The UBA2024 is powered by a supply voltage applied to pin HV. The IC generates its own low supply voltage for the internal circuitry. Therefore an additional external low-voltage supply is not required.

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 $V_{DD} = V_{DD(start)}$.

7.3 Sweep mode

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

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 $V_{FS(lock)}$.

7.5 Oscillation

The oscillation is based upon the 555-timer function. With the external resistor R_{OSC} and capacitor C_{OSC} (see Figure 3) a self oscillating circuit is made, where R_{OSC} and C_{OSC} determine the oscillating frequency.

To realize an accurate 50 % duty cycle, an internal divider is used. Due to the presence of the divider, the bridge frequency is 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:

$$f_{osc} = \frac{1}{k \times R_{OSC} \times C_{OSC}}$$

An overview of the oscillator signal, internal LS and HS drive signals and the output is given in Figure 3.

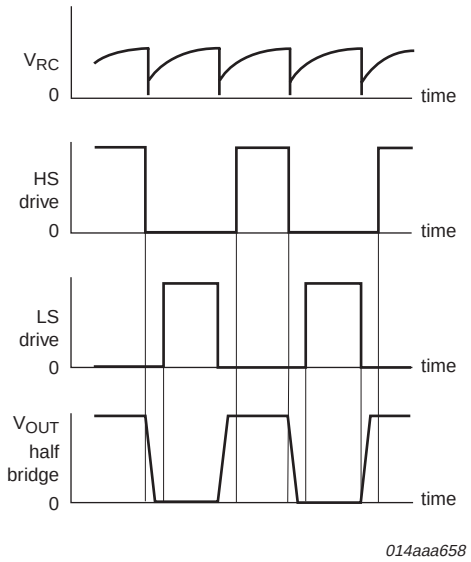


Fig 3. Oscillator, drivers and output signals

When entering the sweep mode, the oscillator starts at 2.5 times the nominal bridge frequency and sweeps down to the nominal bridge frequency f_{nom}; see Figure 4. During this continuously decreasing of the frequency, the circuit approaches the resonance frequency of the load. This causes a high voltage across the load, which ignites the lamp.

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

The amplitude of the RC oscillator is equal to the minimum value of $V_{RC(h)}$ and $V_{SW} + 0.4 \times V_{RC(h)}$.

During the sweep time a current is flowing through the lamp electrodes for preheating the filaments.

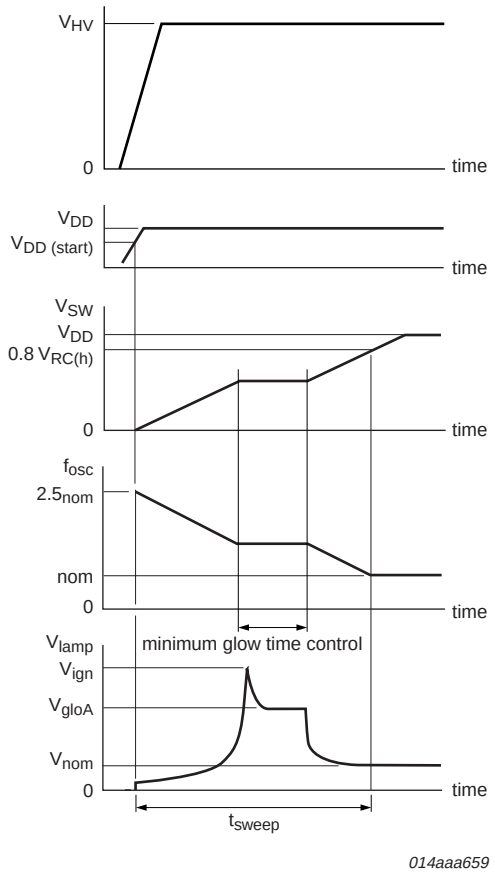


Fig 4. Start-up frequency behavior

7.6 Glow time control

The drawback of cold-started CFL lamps is its inherent glow time which reduces the switching lifetime of the electrodes (lamp). To make this glow phase as short as possible, the maximum power is given to the lamp during the glow time via a special control; see Figure 4.

7.7 Non-overlap time

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

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}	high-voltage supply voltage	normal operation		-	373	V
		mains transients during 0.5 s		-	550	V
V_{FS}	floating supply voltage			V_{HV}	V_{HV} + 14	V
V_{DD}	low-voltage output supply voltage	DC supply		0	14	V
I_{DD}	low-voltage output supply current	peak value is internally limited; T_{amb} = 25 °C		0	5	mA
V_{PGND}	power ground voltage	referenced to SGND		–1	+1	V
$V_{I(RC)}$	internal oscillator input voltage on pin RC	$I_{i(RC)}$ < 1 mA		0	V_{DD}	V
$V_{I(SW)}$	sweep time input voltage on pin SW	$I_{i(SW)}$ < 1 mA		0	V_{DD}	V
SR	slew rate output on pin OUT	repetitive		–4	+4	V/ns
T_j	junction temperature			–40	+150	°C
T_{amb}	ambient temperature			–40	+150	°C
T_{stg}	storage temperature			–55	+150	°C
V_{esd}	electrostatic discharge voltage	human body model:	[1]			
		pins HV and V_{DD}		-	1000	V
		pins SW, RC, FS, and OUT		-	2500	V
		machine model:	[2]			
		pin FS		-	200	V
		pins HV, V_{DD}, SW, RC, and OUT		-	250	V

[1] In accordance with the Human Body Model (HBM): equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

[2] In accordance with the Machine Model (MM): equivalent to discharging a 200 pF capacitor through a 1.5 kΩ series resistor and a 0.75 µH inductor.

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]	95	K/W
$R_{th(j-c)}$	thermal resistance from junction to case	in free air	[1]	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}	high-voltage supply voltage	t < 0.5 s; I_{HV} < 30 mA	0	-	550	V
V_{FS}	floating supply voltage	t < 0.5 s; I_{HV} < 30 mA	0	-	564	V
Low-voltage supply						
V_{DD}	low-voltage output supply voltage	V_{HV} = 100 V; R_{OSC} = ∞; V_{SW} = V_{DD}; V_{RC} = 0 V	11.7	12.5	13.3	V
Start-up state						
I_{HV}	high-voltage supply current	V_{HV} = 100 V; R_{OSC} = ∞; V_{SW} = V_{DD}; V_{RC} = 0 V	-	-	0.39	mA
$V_{DD(start)}$	start of oscillation voltage		10	11	12	V
$V_{DD(stop)}$	stop of oscillation voltage		8	8.5	9	V
$V_{DD(hys)}$	start-stop hysteresis voltage		2	2.5	3	V
Output stage						
$R_{HS(on)}$	HS transistor on-resistance	V_{HV} = 310 V; I_d = 100 mA	-	9.7	11	Ω
$R_{LS(on)}$	LS transistor on-resistance	I_d = 100 mA	-	8.5	9.4	Ω
$V_{HS(d)}$	HS body diode forward voltage	I_f = 200 mA	1.4	1.8	2.2	V
$V_{LS(d)}$	LS body diode forward voltage	I_f = 200 mA	1.2	1.6	2.0	V
$I_{HS(sat)}$	HS transistor saturation current	V_{ds} = 30 V; T_j ≤ 125 °C; V_{HV} = 310 V	900	-	-	mA
$I_{LS(sat)}$	LS transistor saturation current	V_{ds} = 30 V; T_j ≤ 125 °C	900	-	-	mA
$I_{O(max)}$	maximum output current	RMS value	-	-	220	mA
V_{boot}	bootstrap diode drop voltage	I_f = 1 mA	0.7	1.0	1.3	V
t_{no}	non-overlap time		1	1.35	1.7	µs
$V_{FS(lock)}$	floating supply lockout voltage		3.6	4.2	4.8	V
I_{FS}	floating supply current	V_{HV} = 310 V; V_{FS} = 12.2 V	10	14	18	µA

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
Internal oscillator						
f_{osc}	frequency range bridge oscillator	$V_{SW} = V_{DD}$	-	-	60	kHz
$f_{osc(nom)}$	nominal frequency bridge oscillator	R_{OSC} = 100 kΩ; C_{OSC} = 220 pF; $V_{SW} = V_{DD}$	40.05	41.32	42.68	kHz
$\Delta f_{osc(nom)}$	bridge oscillator frequency variation with temperature	R_{OSC} = 100 kΩ; C_{OSC} = 220 pF; ΔT = –20 to +150 °C	-	2	-	%
k_h	high-level trip point factor		0.382	0.395	0.408	
$V_{RC(h)}$	high-level trip point voltage on pin RC	$V_{RC(h)} = k_h \times V_{DD}$	4.58	4.94	5.29	V
k_l	low-level trip point factor		0.030	0.033	0.036	
$V_{RC(low)}$	low-level trip point voltage on pin RC	$V_{RC(l)} = k_l \times V_{DD}$	0.367	0.413	0.458	V
K_{osc}	oscillator constant	R_{OSC} = 100 kΩ; C_{OSC} = 220 pF	1.065	1.1	1.35	V
Sweep function						
$I_{ch(sw)}$	charge current for sweep	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. Application information

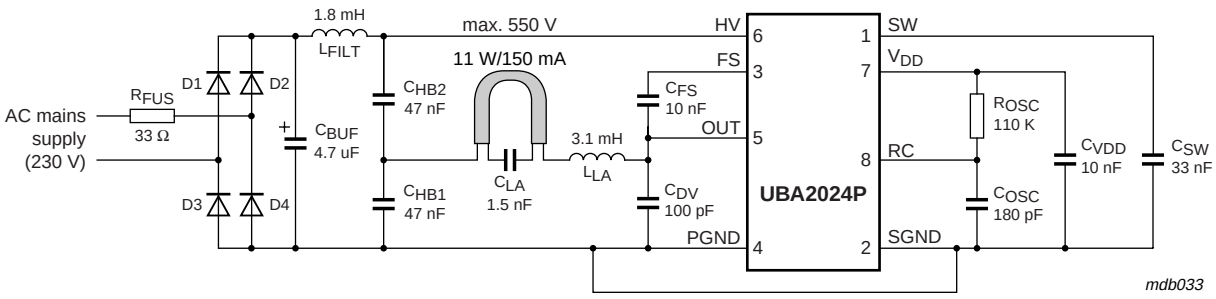
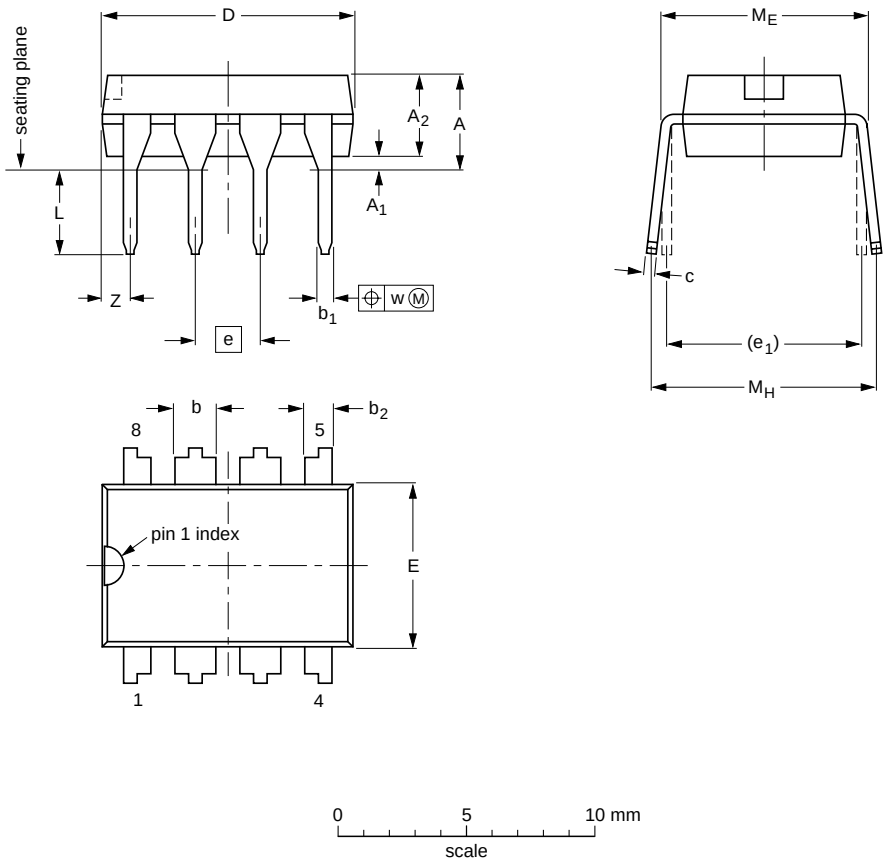


Fig 5. Schematic of standard compact fluorescent lamp application using UBA2024P

12. 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 6. Package outline SOT97-1

13. Revision history

Table 6. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
UBA2024_3	20081016	Product data sheet	-	UBA2024_2
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate.			
UBA2024_2	040203	Product data sheet	-	UBA2024_1
UBA2024_1	030813	Product data sheet	-	-

14. Legal information

14.1 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".

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