DATA SHEET

UBA2030T
Full bridge driver IC

Preliminary specification
Supersedes data of 1997 Sep 16
File under Integrated Circuits, IC11

1999 Aug 10

Philips
Semiconductors

PHILIPS

FEATURES

- Full bridge driver
- Integrated bootstrap diodes
- Integrated high voltage level shift function
- High voltage input (570 V maximum) for the internal supply
- Adjustable ‘dead time’
- Adjustable oscillator frequency
- High voltage level shifter for the bridge enable function
- Shut-down function.

APPLICATIONS

- The UBA2030T can drive the MOSFETs in any type of load configured as a full bridge
- The circuit is intended as a commutator for High Intensity Discharge (HID) lamps.

GENERAL DESCRIPTION

The UBA2030T is a high voltage integrated circuit fabricated using the BCD750 power logic process.
The circuit is designed for driving the MOSFETs in a full bridge configuration. In addition, it features a shut-down function, an adjustable oscillator and a PMOS high voltage level shifter to control the bridge enable function.
To guarantee an accurate 50% duty factor, the oscillator signal passes through a divider before being fed to the output drivers.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
UBA2030T	SO24	plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
High voltage						
V_{HV}	high voltage supply		0	–	570	V
Start-up; powered via pin HV						
I_{strtu}	start-up current		–	0.7	1.0	mA
$V_{th(osc\ strt)}$	start oscillating threshold voltage	at f_{bridge} = 500 Hz; no load	14.0	15.5	17.0	V
$V_{th(osc\ stp)}$	stop oscillating threshold voltage		11.5	13.0	14.5	V
Output drivers						
$I_{o(source)}$	output source current	$V_{DD} = V_{FSL} = V_{FSR}$ = 15 V; $V_{GHR} = V_{GHL} = V_{GLR} = V_{GLL}$ = 0 V	140	190	240	mA
$I_{o(sink)}$	output sink current	$V_{DD} = V_{FSL} = V_{FSR}$ = 15 V; $V_{GHR} = V_{GHL} = V_{GLR} = V_{GLL}$ = 15 V	200	260	320	mA
Internal oscillator						
f_{bridge}	bridge oscillating frequency	EXO pin connected to SGND	50	–	50000	Hz
External oscillator						
$f_{osc(ext)}$	external oscillator frequency	RC pin connected to SGND; $f_{bridge} = \frac{f_{osc(ext)}}{2}$	100	–	100000	Hz
Dead time control						
t_{dead}	dead time control range (adjusted externally)		0.4	–	4	µs
Bridge enable						
I_{IH}	HIGH-level input current	bridge enable active	100	–	700	µA
I_{IL}	LOW-level input current	bridge enable not active	0	–	20	µA
Shut-down						
V_{IH}	HIGH-level input voltage	shut-down active; $\left\lvert\frac{\Delta V_{SD}}{\Delta t}\right\rvert > 5$ V/ms	4.5	–	V_{DD}	V
V_{IL}	LOW-level input voltage	shut-down not active; $\left\lvert\frac{\Delta V_{SD}}{\Delta t}\right\rvert > 5$ V/ms	0	–	0.5	V

BLOCK DIAGRAM

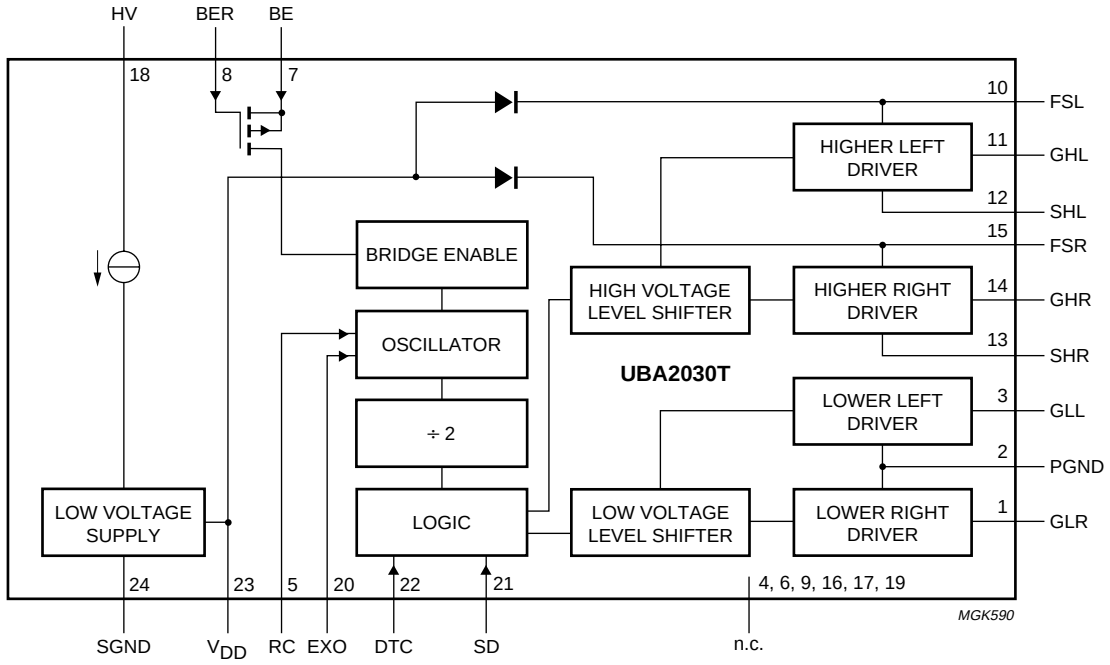


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
GLR	1	gate of lower right MOSFET
PGND	2	power ground for sources of lower left and right MOSFETs
GLL	3	gate of lower left MOSFET
n.c.	4	not connected
RC	5	RC input for internal oscillator
n.c.	6	not connected
BE	7	bridge enable control input
BER	8	bridge enable reference input
n.c.	9	not connected
FSL	10	floating supply voltage left output
GHL	11	gate of higher left MOSFET
SHL	12	source of higher left MOSFET
SHR	13	source of higher right MOSFET
GHR	14	gate of higher right MOSFET
FSR	15	floating supply voltage right output
n.c.	16	not connected
n.c.	17	not connected
HV	18	high voltage supply input
n.c.	19	not connected
EXO	20	external oscillator input
SD	21	shut-down input
DTC	22	‘dead time’ control input
V_{DD}	23	internal (low voltage) supply
SGND	24	signal ground

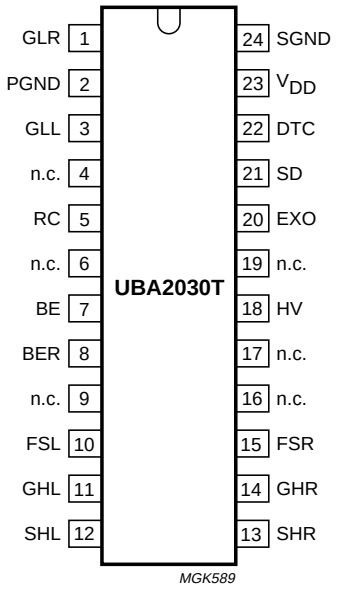


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

Supply voltage

The UBA2030T is powered by a single supply voltage connected to the HV pin (the full bridge supply could be used, for example). The IC generates its own low voltage supply for driving the internal circuitry and the MOSFETs in the full bridge, removing the need for an additional low voltage supply. A capacitor must be connected between the V_{DD} pin and SGND to obtain a ripple-free internal supply voltage.

Start-up

When the power is turned on, the UBA2030T enters a start-up phase; the high side MOSFETs are switched off and the low side MOSFETs switched on. During start-up, the bootstrap capacitors are charged and the bridge output current is zero.

Oscillation

At the point where the supply voltage at the HV pin crosses the ‘start oscillating threshold’, the bridge begins commutating between the following two defined states:

Higher left and lower right MOSFETs on, higher right and lower left MOSFETs off

Higher left and lower right MOSFETs off, higher right and lower left MOSFETs on.

When the internal oscillator is used, the bridge commutating frequency is determined by the values of an external resistor and capacitor. In this mode, the EXO pin must be connected to SGND.

When an external oscillator is used, its output must be connected to the EXO pin; the internal oscillator must be disabled by connecting the RC pin to SGND. The bridge commutating frequency is half the oscillator frequency due to a ÷2 circuit which guarantees an accurate 50% duty factor.

The time between turning off the conducting pair of MOSFETs and turning on the other pair, the ‘dead time’, can be adjusted using an external resistor. If the supply voltage at the HV pin falls below the ‘stop oscillating threshold’, the UBA2030T re-enters the start-up phase.

Bridge enable

The bridge enable function allows the bridge to be held in its current state. When active, it connects the RC pin to SGND, disabling the internal oscillator. If the bridge enable function is activated during ‘dead time’, the bridge is allowed to enter the next conducting state before being held. Oscillations resume the instant the bridge enable function is turned off. A timing diagram is shown in Fig.3.

To hold the bridge, an external control circuit is required to provide a source current to the bridge enable control input (pin BE), and to supply a reference voltage to pin BER, (see Fig.6).

Shut-down

The active HIGH shut-down input (pin SD) can be used at any time to turn off all four MOSFETs. However, if the supply voltage drops below the ‘stop oscillating threshold’, the bridge re-enters the start-up phase even if the shut-down function is active.

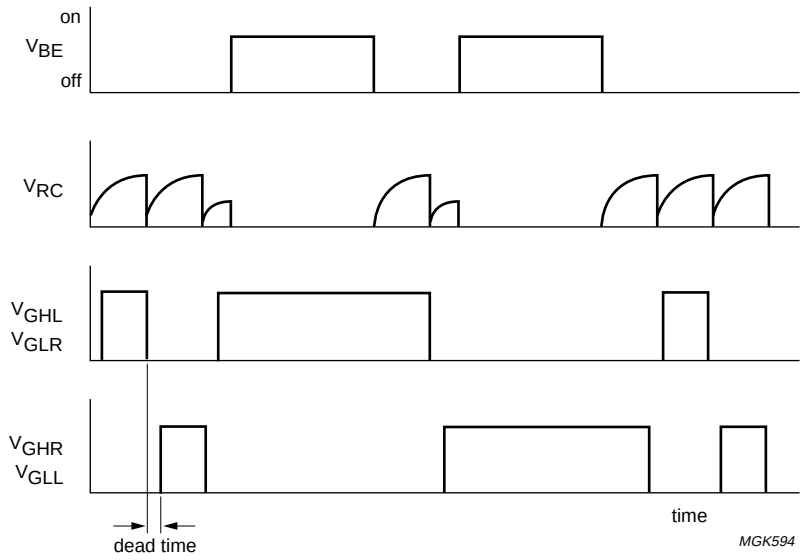


Fig.3 Timing diagram.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DD}	supply voltage (low voltage)		0	18	V
V_{HV}	supply voltage (high voltage)	note 1	0	570	V
V_{FSL}; V_{FSR}	floating supply voltage	$V_{SHL} = V_{SHR}$ = 570 V, note 1	570	588	V
		$V_{SHL} = V_{SHR}$ = 0 V	0	18	V
V_{SHL}; V_{SHR}	source voltage for higher right and left MOSFETs	with reference to PGND and SGND	–10	+570	V
V_{PGND}	power ground voltage	with reference to SGND	–7	+10	V
$V_{i(BER)}$	bridge enable reference input voltage		0	570	V
$V_{i(BE)}$	bridge enable control input voltage	$V_{i(BER)}$ = 570 V	570	580	V
		$V_{i(BER)}$ = 0 V	0	10	V
$I_{i(BE)}$	bridge enable control input current		0	700	μA
$V_{i(EXO)}$	input voltage from external oscillator on pin EXO		0	V_{DD}	V
V_{SD}	shut-down input voltage on pin SD		0	V_{DD}	V
SR	slew rate at output pins	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_{es}	electrostatic handling	note 2			
	pin HV		–	±1250	V
	pins BE, BER, FSL, GHL, SHL, SHR, GHR and FSR		–	±1500	V

Notes

1. This value is guaranteed down to T_j = –25 °C. From T_j = –25 to –40 °C, the voltage on pin HV is limited to 530 V and the floating supply voltage (V_{FSL}, V_{FSR}) is limited to a maximum value of 548 V.
2. In accordance with the human body model: equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	70	K/W

QUALITY SPECIFICATION

In accordance with *"SNW-FQ-611 part E"*. The numbers of the quality specification can be found in the *"Quality Reference Handbook"*.

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
High voltage						
V_{HV}	high voltage supply		0	–	570	V
I_L	leakage current	with HV = 570 V applied to pins BER, SHR and SHL	–	–	5	μA
$V_{PGND(float)}$; $V_{SGND(float)}$	floating ground voltage		0	–	5	V
Start-up, powered via the HV pin; note 1						
I_{strtu}	start-up current		–	0.7	1.0	mA
V_{strtu}	start-up voltage	high left and right MOSFETs off; low left and right MOSFETs on	–	6	–	V
$V_{th(osc\ strt)}$	start oscillating threshold voltage	f_{bridge} = 500 Hz; no load	14.0	15.5	17.0	V
$V_{th(osc\ stp)}$	stop oscillating threshold voltage		11.5	13.0	14.5	V
V_{hys}	hysteresis voltage	between oscillation start and stop levels	2.0	2.5	3.0	V
I_{HV}	supply current	f_{bridge} = 500 Hz; no load; V_{HV} = 50 V	0.3	0.5	0.7	mA
V_{DD}	internal supply voltage (low voltage)	f_{bridge} = 500 Hz; no load; V_{HV} = 50 V	14.0	15.3	16.5	V
		f_{bridge} = 500 Hz; no load; at start oscillating threshold	10.5	11	11.5	V
		f_{bridge} = 500 Hz; no load; at stop oscillating threshold	8.0	8.5	9.0	V
Output drivers						
$V_{o(GHL,GHR)}$	output voltage on pins GHL and GHR for gates of higher right and left MOSFETs	at power-up; no load; V_{HV} = 50 V; f_{bridge} = 500 Hz;	13.2	14.5	16.5	V
$V_{o(GLL,GLR)}$	output voltage on pins GLL and GLR for gates of lower right and left MOSFETs		14.0	15.3	16.5	V
Δt	time difference between diagonally placed output drivers		0	–	100	ns
R_{onH}	higher MOSFETs on resistance	V_{FSR} = V_{FSL} = 15 V; I_{source} = 50 mA	33	39	46	Ω
R_{offH}	higher MOSFETs off resistance	V_{FSR} = V_{FSL} = 15 V; I_{sink} = 50 mA	11	14	17	Ω
R_{onL}	lower MOSFETs on resistance	V_{DD} = 15 V; I_{source} = 50 mA	33	39	46	Ω
R_{offL}	lower MOSFETs off resistance	V_{DD} = 15 V; I_{sink} = 50 mA	11	14	17	Ω
V_{diode}	bootstrap diode voltage drop	I_{diode} = 1 mA	0.8	1.0	1.2	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{o(source)}$	output source current	$V_{DD} = V_{FSL} = V_{FSR} = 15$ V; $V_{GHR} = V_{GHL} = V_{GLR} = V_{GLL} = 0$ V	140	190	240	mA
$I_{o(sink)}$	output sink current	$V_{DD} = V_{FSL} = V_{FSR} = 15$ V; $V_{GHR} = V_{GHL} = V_{GLR} = V_{GLL} = 15$ V	200	260	320	mA
$I_{FSL(float)}$; $I_{FSR(float)}$	floating supply current	$V_{FSR} = V_{FSL} = 15$ V	–	15	–	µA
Internal oscillator; notes 2 and 3						
f_{bridge}	bridge oscillating frequency	EXO pin connected to SGND	50	–	50000	Hz
$\Delta f_{osc}/\Delta T$	oscillator frequency dependency with respect to temperature	fixed RC; $\Delta T = -40$ °C to +150 °C	0	–	10	%
$\Delta f_{osc}/\Delta V_{DD}$	oscillator frequency dependency with respect to V_{DD}	fixed RC; $\Delta V_{DD} = 12$ to 16 V	0	–	10	%
k_H	HIGH-level trip point	$V_{RCH} = k_H \times V_{DD}$	0.67	0.71	0.75	
k_L	LOW-level trip point	$V_{RCL} = k_L \times V_{DD}$	–	0.01	–	
k_{osc}	oscillator constant	$f_{bridge} = \frac{1}{(k_{osc} \times R_{osc} \times C_{osc})}$	2.34	2.49	2.64	
External oscillator; note 2						
$f_{osc(ext)}$	external oscillator frequency	RC pin connected to SGND; $f_{bridge} = \frac{f_{osc(ext)}}{2}$	100	–	100000	Hz
V_{IH}	HIGH-level input voltage	$\left\|\frac{\Delta V_{EXO}}{\Delta t}\right\| > 5$ V/ms	4.5	–	V_{DD}	V
V_{IL}	LOW-level input voltage	$\left\|\frac{\Delta V_{EXO}}{\Delta t}\right\| > 5$ V/ms	0	–	0.5	V
$I_{i(EXO)}$	input current		0	–	50	µA
Dead time control; notes 2 and 4						
t_{dead}	dead time control range (adjusted externally)		0.4	–	4	µs
k_{DT}	dead time variable	$R_{DT} = k_{DT} \times t_{dead} - 70$ kΩ	180	270	380	kΩ/µs
Bridge enable; notes 2 and 5						
I_{IH}	HIGH-level input current; note 6	bridge enable active	100	–	700	µA
		$V_{BE} - V_{BER} = 5$ V	–	1.1	–	mA
I_{IL}	LOW-level input current	bridge enable not active	0	–	20	µA
$V_{BE} - V_{BER}$	threshold voltage	$I_{IH} = 100$ µA				
	with reference to HV		2.1	2.6	3.0	V
	with reference to PGND		3.5	5.5	7.5	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Shut-down; note 2						
V_{IH}	HIGH-level input voltage	shut-down active; $\left\|\frac{\Delta V_{SD}}{\Delta t}\right\| > 5$ V/ms	4.5	–	V_{DD}	V
V_{IL}	LOW-level input voltage	shut-down not active; $\left\|\frac{\Delta V_{SD}}{\Delta t}\right\| > 5$ V/ms	0	–	0.5	V
$I_{i(SD)}$	input current		0	–	50	μA

Notes

1. The current into pin HV is internally limited to 15 mA at T_j = 25 °C and to 10 mA at T_j = 150 °C.
2. V_{DD} = 15 V.
3. The bridge frequency can be calculated using Equation (1).
4. The ‘dead time’ is adjusted using an external resistor; see Equation (2).
5. This function is disabled when using an external oscillator.
6. I_{IH} < 2.1 mA when the condition is $V_{BE} - V_{BER}$ = 5 V at T_j = 150 °C.

Design equations

BRIDGE COMMUTATION FREQUENCY

The internal ÷2 circuit requires the frequency of the internal or external oscillator to be twice the bridge frequency. When the internal oscillator is used, the bridge frequency can be adjusted using an external resistor and capacitor:

$$f_{bridge} = \frac{1}{2.8 \times R_{osc} \times C_{osc}} \quad (1)$$

Where:

$R_{osc(min)}$ = 200 kΩ

$R_{osc(max)}$ = 2 MΩ (with low leakage current).

DEAD TIME

$$R_{DT} = 270 \times t_{dead} - 70 \quad (2)$$

The ‘dead time’ (t_{dead}) can be adjusted using an external resistor (R_{DT}) connected between DTC and SGND:

Units are kΩ for R_{DT} and μs for t_{dead}.

Where:

$R_{DT(min)}$ = 50 kΩ

$R_{DT(max)}$ = 1 MΩ.

APPLICATION INFORMATION

Basic application

A basic full bridge configuration with an HID lamp is shown in Fig.4. The bridge enable and shut-down functions are not used in this application. The EXO, BE, BER and SD pins are connected to system ground. The IC is powered by the high voltage supply.

When the internal oscillator is used; the bridge commutating frequency is determined by the values of R_{osc} and C_{osc}. The bridge starts oscillating when the HV supply voltage exceeds the 'start oscillating threshold' (typically 15.5 V). If the supply voltage at the HV pin falls below the 'stop oscillating threshold' (typically 13 V), the UBA2030T enters the start-up state.

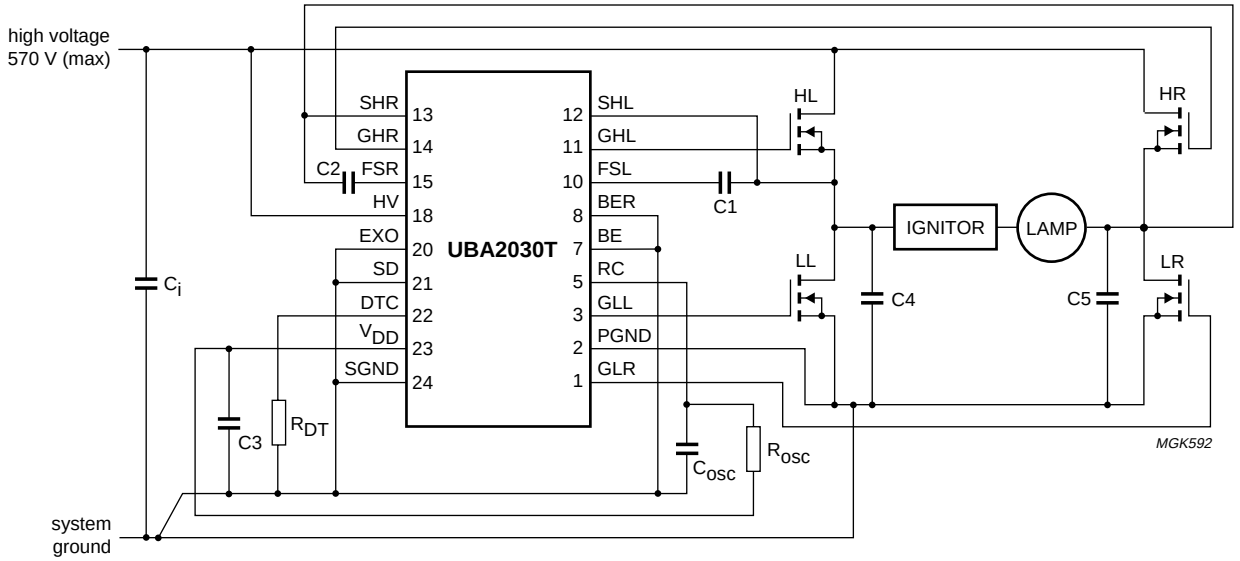


Fig.4 Basic configuration.

Application with external control

Figure 5 shows an application containing an external oscillator control circuit referenced to system ground. The RC, BER and BE pins are connected to system ground. The bridge commutation frequency is determined by the external oscillator. The shut-down input (pin SD) can be used to quickly turn off all four MOSFETs in the full bridge.

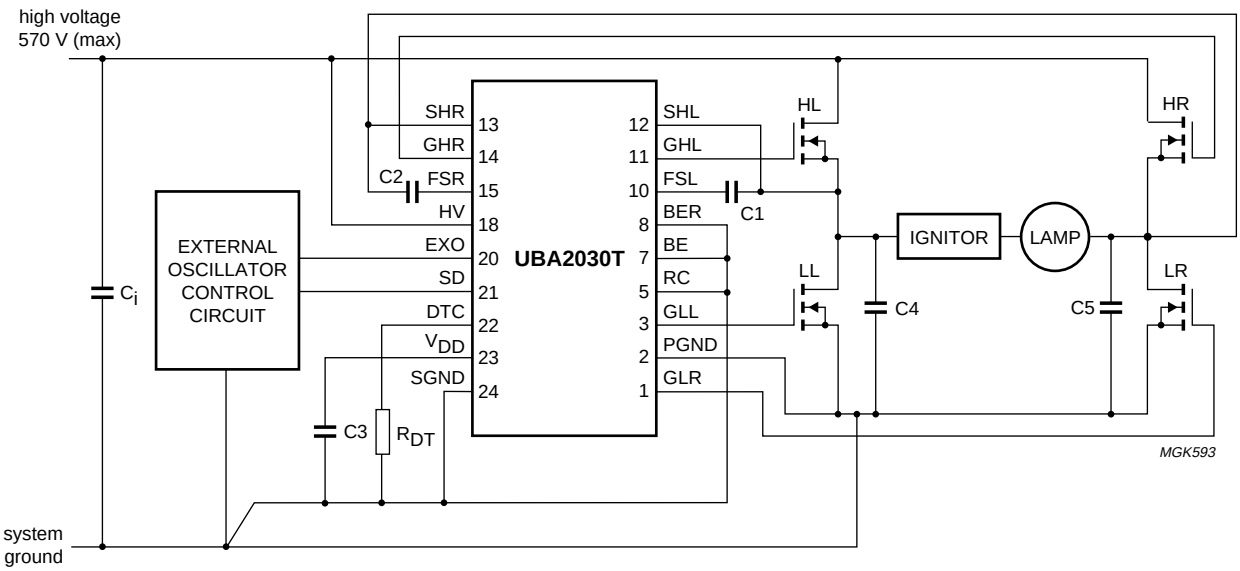


Fig.5 External control configuration.

Automotive application

The life of an HID lamp depends on the rate of sodium migration through its quartz wall. To minimize this, the lamp must be operated negative with respect to system ground.

Figure 6 shows a full bridge with an HID lamp in an automotive environment, and a control circuit referenced to the high side of the bridge. The BER and HV pins are connected to system ground. The bridge can be held in its current state using the BE pin. See the timing diagram in Fig.3.

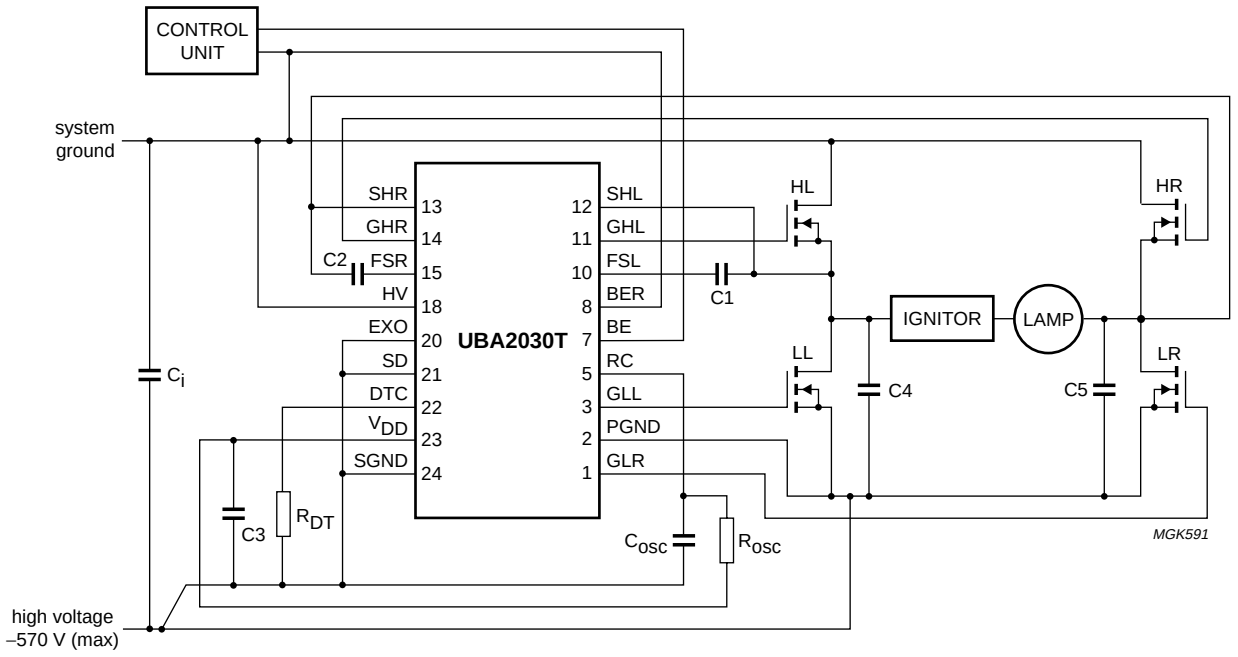


Fig.6 Automotive configuration (example 1).

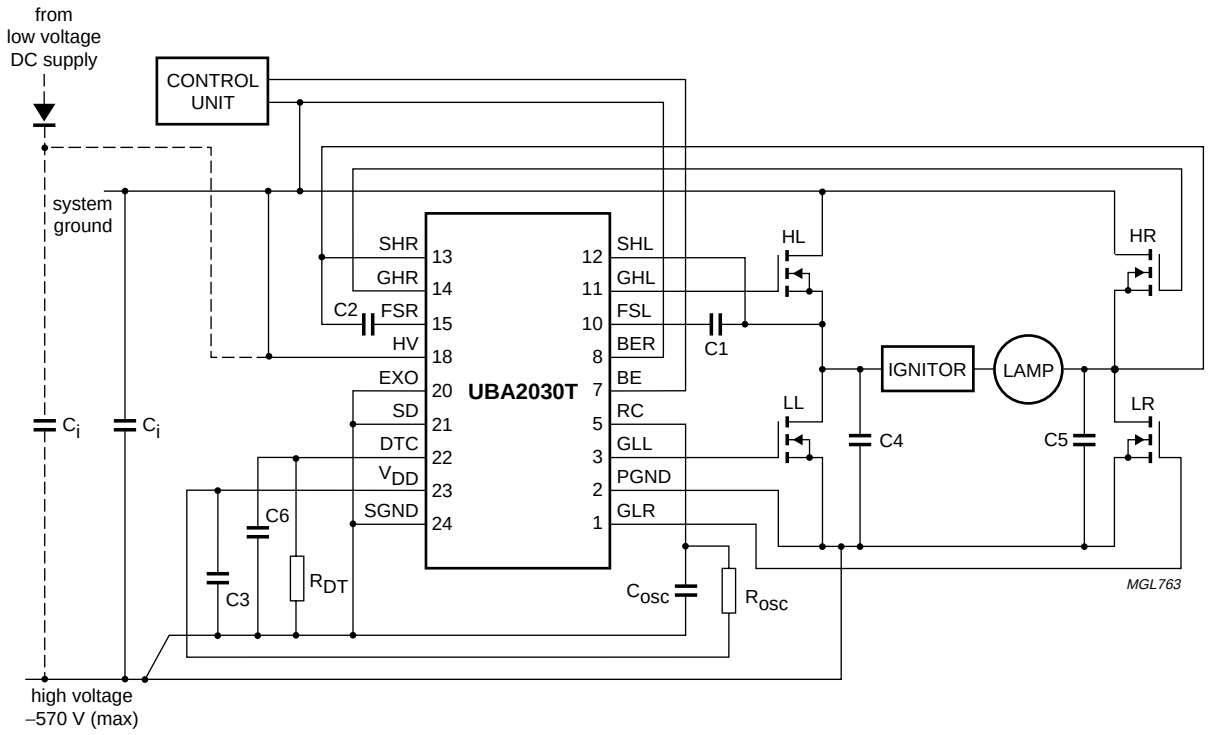
Additional application information

The UBA2030T is the commutator part in a complete system for driving an HID lamp. The life of the HID lamp can depend on the amount of sodium that migrates through its quartz wall. To minimize this migration, the lamp must be operated negative with respect to system ground.

Figure 7 shows a full bridge with an HID lamp in a typical automotive configuration using a control unit referenced to the high side of the bridge. Pin BER is connected to system ground. The bridge can be held in its current state by pin BE. The supply current to the internal low voltage circuit is fed to pin HV which can be connected to either system ground or to a low voltage DC supply, such as a battery, as indicated by the dotted lines in Fig.7.

The diode in series with the supply to pin HV prevents C_i being discharged if the lamp is shorted during the ignition phase. C6 should be positioned as close as possible to pin DTC. The control unit drives the MOSFETs relatively hard which can cause radiation. To prevent switching the MOSFETs hard, a resistor can be connected in series with each gate.

In all applications, the voltage on pin HV must not be allowed to become lower than the voltage at pin V_{DD} during the start-up phase or during normal operation, otherwise the full bridge will not operate correctly. During the start-up phase, pin EXO and pin SD should both be LOW. The voltage as a function of time at pin EXO and pin SD should be >5 V/ms.

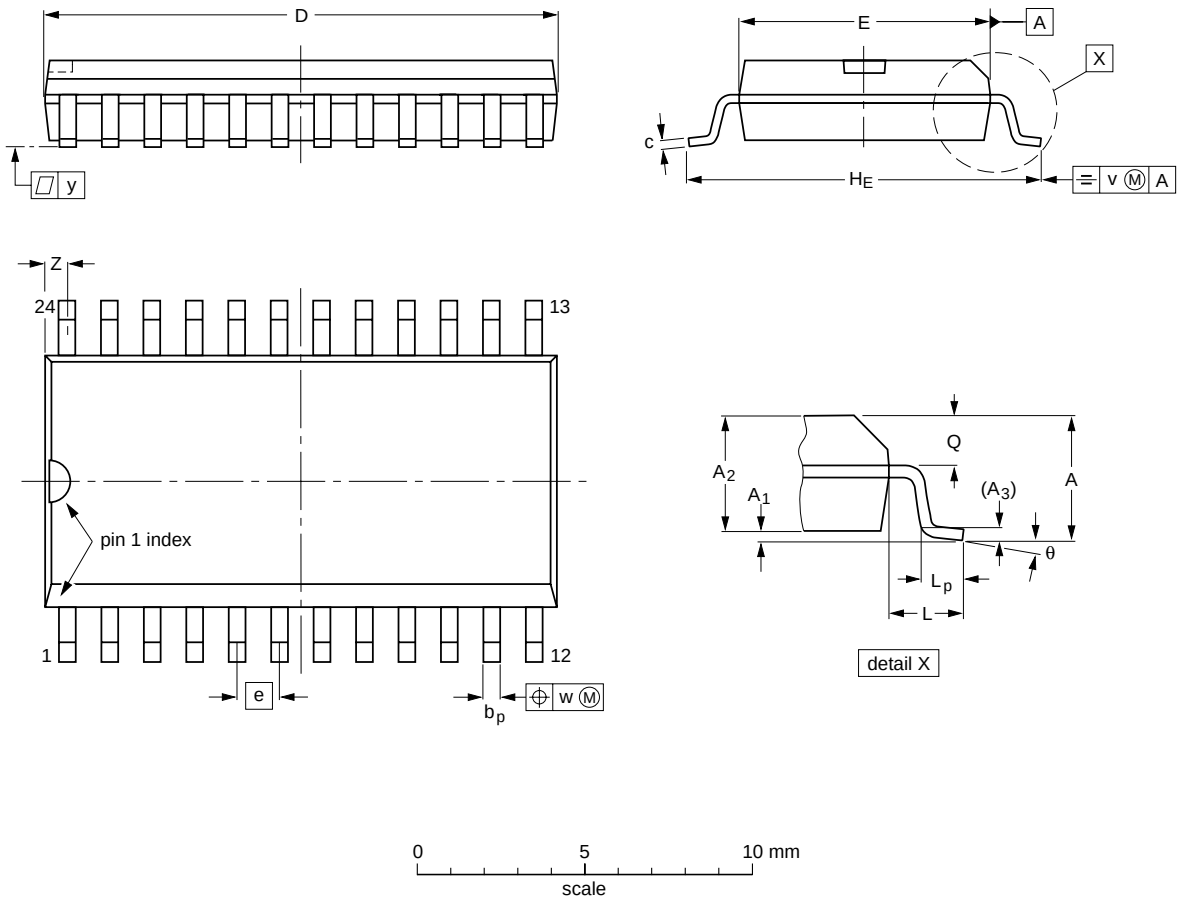


C1 = 150 nF.
C2 = 150 nF.
C3 = 220 nF.
C6 = 100 pF.
C_{osc} = 10 nF.
R_{osc} = 147 kΩ.
R_{DT} = 50 to 1000 kΩ (220 kΩ = a 'dead time' of 1 μs).

Fig.7 Automotive configuration (example 2).

PACKAGE OUTLINE

SO24: plastic small outline package; 24 leads; body width 7.5 mm **SOT137-1**



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	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	15.6 15.2	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8^o 0^o
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.61 0.60	0.30 0.29	0.050	0.419 0.394	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT137-1	075E05	MS-013AD				~~95-01-24~~ 97-05-22

SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.
A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW(1)
BGA, SQFP	not suitable	suitable
HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable(2)	suitable
PLCC(3), SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended(3)(4)	suitable
SSOP, TSSOP, VSO	not recommended(5)	suitable

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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