

# DATA SHEET

## **UBA2070** 600 V CCFL ballast driver IC

Product specification  
Supersedes data of 2001 Sep 27

2002 Oct 24

**600 V CCFL ballast driver IC****UBA2070****FEATURES**

- Current controlled operation
- Adaptive non-overlap time control
- Integrated high voltage level shift function
- Power-down function
- Protected against lamp failures or lamp removal
- Capacitive mode protection.

**APPLICATION**

- The circuit topology enables a broad range of backlight inverters.

**GENERAL DESCRIPTION**

The UBA2070 is a high voltage integrated circuit for driving electronically ballasted Cold Cathode Fluorescent Lamps (CCFL) at mains voltages up to 277 V (RMS) (nominal value). The circuit is made in a 650 V Bipolar CMOS DMOS (BCD) power logic process. The UBA2070 provides the drive function for the two discrete MOSFETs. Besides the drive function the UBA2070 also includes the level-shift circuit, the oscillator function, a lamp voltage monitor, a current control function, a timer function and protections.

**ORDERING INFORMATION**

| TYPE NUMBER | PACKAGE |                                                             |          |
|-------------|---------|-------------------------------------------------------------|----------|
|             | NAME    | DESCRIPTION                                                 | VERSION  |
| UBA2070T    | SO16    | plastic small outline package; 16 leads; body width 3.9 mm  | SOT109-1 |
| UBA2070P    | DIP16   | plastic dual in-line package; 16 leads (300 mil); long body | SOT38-1  |

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## QUICK REFERENCE DATA

| SYMBOL                                              | PARAMETER                 | CONDITION                                     | MIN. | TYP. | MAX. | UNIT       |
|-----------------------------------------------------|---------------------------|-----------------------------------------------|------|------|------|------------|
| <b>High voltage supply</b>                          |                           |                                               |      |      |      |            |
| $V_{hs}$                                            | high side supply voltage  | $I_{hs} < 30 \mu A$ ; $t < 1 s$               | –    | –    | 600  | V          |
| <b>Start-up state</b>                               |                           |                                               |      |      |      |            |
| $V_{DD(high)}$                                      | oscillator start voltage  |                                               | 12.4 | 13   | 13.6 | V          |
| $V_{DD(low)}$                                       | oscillator stop voltage   |                                               | 8.6  | 9.1  | 9.6  | V          |
| $I_{DD(start)}$                                     | start-up current          | $V_{DD} < V_{DD(high)}$                       | –    | 170  | 200  | $\mu A$    |
| <b>Reference voltage (pin <math>V_{REF}</math>)</b> |                           |                                               |      |      |      |            |
| $V_{ref}$                                           | reference voltage         | $I_L = 10 \mu A$                              | 2.86 | 2.95 | 3.04 | V          |
| <b>Voltage controlled oscillator</b>                |                           |                                               |      |      |      |            |
| $f_{bridge(max)}$                                   | maximum bridge frequency  |                                               | 90   | 100  | 110  | kHz        |
| $f_{bridge(min)}$                                   | minimum bridge frequency  |                                               | 38.9 | 40.5 | 42.1 | kHz        |
| <b>Output drivers (pins GH and GL)</b>              |                           |                                               |      |      |      |            |
| $I_{source}$                                        | source current            | $V_{GH} - V_{SH} = 0$ ; $V_{GL} = 0$          | 135  | 180  | 235  | mA         |
| $I_{sink}$                                          | sink current              | $V_{GH} - V_{SH} = 13 V$ ;<br>$V_{GL} = 13 V$ | 265  | 300  | 415  | mA         |
| <b>Lamp voltage sensor (pin LVS)</b>                |                           |                                               |      |      |      |            |
| $V_{LVS(fail)}$                                     | fail voltage level        |                                               | 1.19 | 1.25 | 1.31 | V          |
| $V_{LVS(max)}$                                      | maximum voltage level     |                                               | 1.67 | 1.76 | 1.85 | V          |
| <b>Average current sensor (pin CS)</b>              |                           |                                               |      |      |      |            |
| $V_{offset}$                                        | offset voltage            | $V_{CS} = 0$ to 2.5 V                         | –2   | 0    | +2   | mV         |
| $g_m$                                               | transconductance          | $f = 1 kHz$                                   | 100  | 200  | 400  | $\mu A/mV$ |
| <b>Ignition timer (pin CT)</b>                      |                           |                                               |      |      |      |            |
| $V_{OL}$                                            | LOW-level output voltage  |                                               | –    | 1.4  | –    | V          |
| $V_{OH}$                                            | HIGH-level output voltage |                                               | –    | 3.6  | –    | V          |

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## BLOCK DIAGRAM

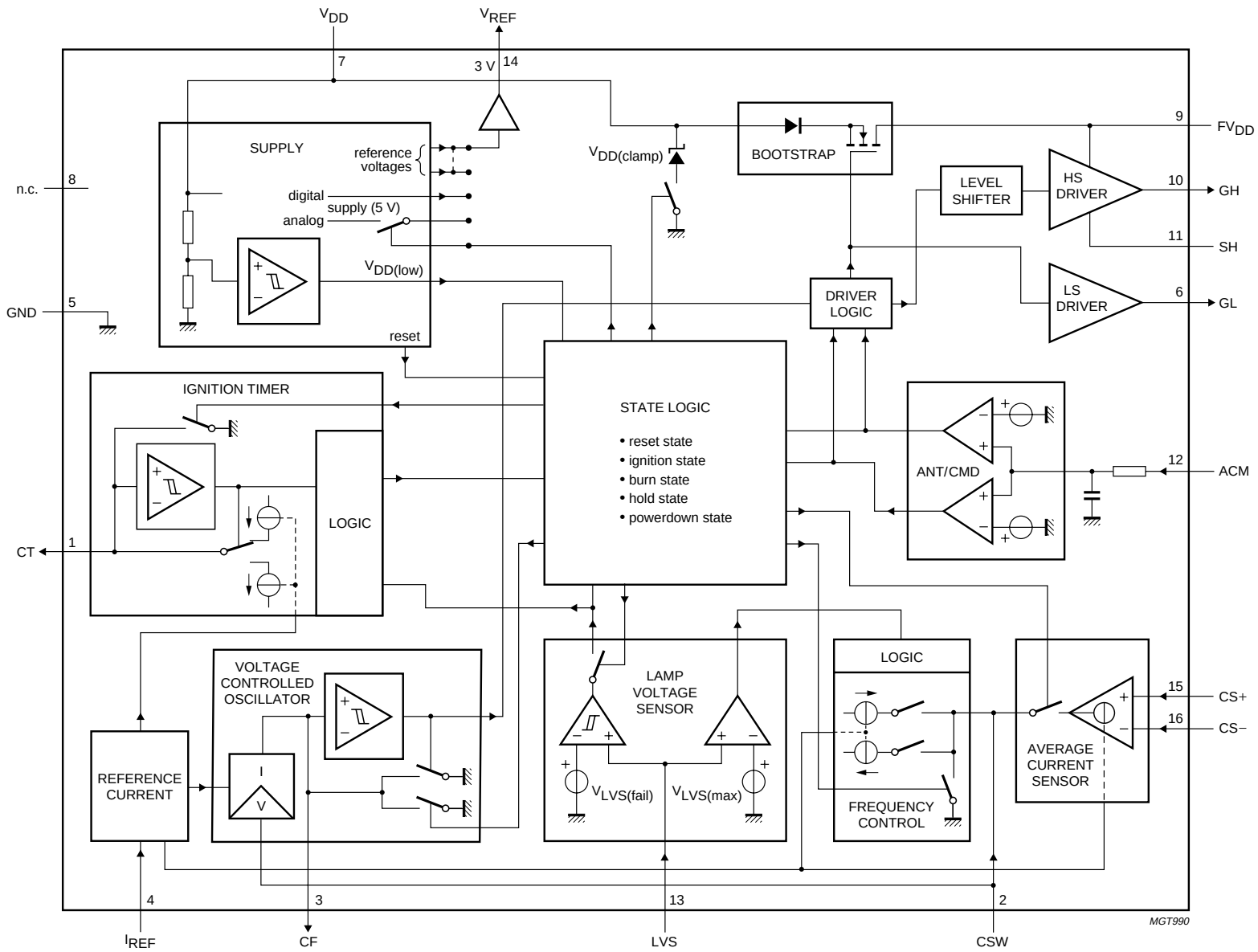


Fig.1 Block diagram.

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PINNING

| SYMBOL           | PIN | DESCRIPTION                                      |
|------------------|-----|--------------------------------------------------|
| CT               | 1   | ignition timer output                            |
| CSW              | 2   | voltage controlled oscillator input              |
| CF               | 3   | voltage controlled oscillator output             |
| I <sub>REF</sub> | 4   | internal reference current input                 |
| GND              | 5   | ground                                           |
| GL               | 6   | gate of the low side switch output               |
| V <sub>DD</sub>  | 7   | low voltage supply                               |
| n.c.             | 8   | not connected                                    |
| FV <sub>DD</sub> | 9   | floating supply; supply for the high side switch |
| GH               | 10  | gate of the high side switch output              |
| SH               | 11  | source of the high side switch                   |
| ACM              | 12  | capacitive mode input                            |
| LVS              | 13  | lamp voltage sensor input                        |
| V <sub>REF</sub> | 14  | reference voltage output                         |
| CS+              | 15  | average current sensor positive input            |
| CS-              | 16  | average current sensor negative input            |

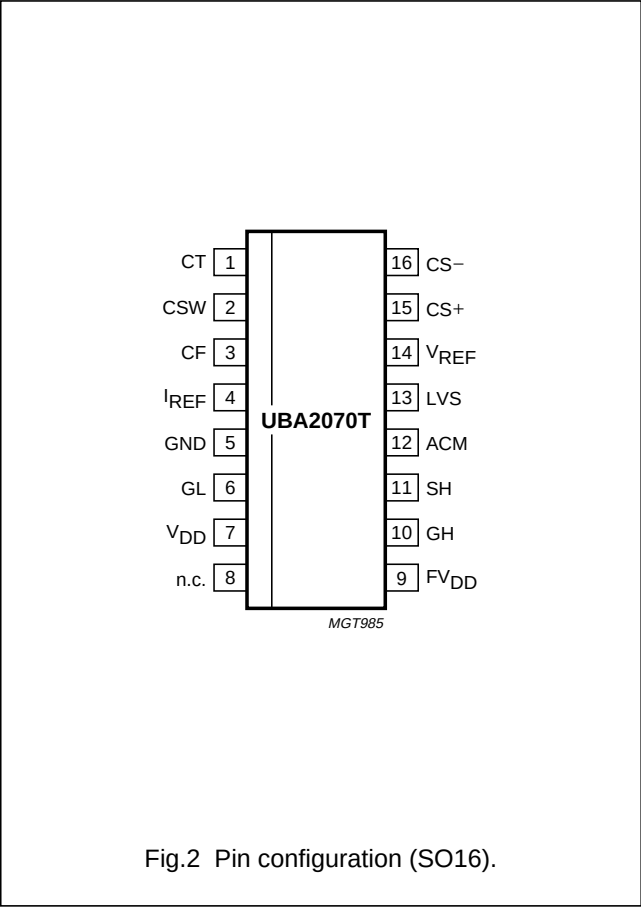


Fig.2 Pin configuration (SO16).

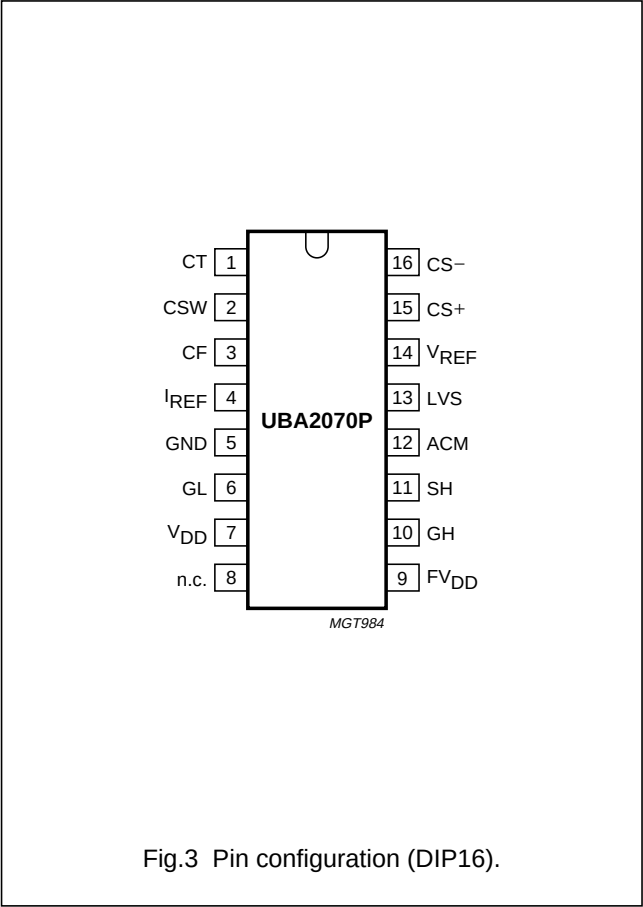


Fig.3 Pin configuration (DIP16).

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**FUNCTIONAL DESCRIPTION****Start-up state**

Initial start-up can be achieved by charging  $C_{VDD}$  using an external start-up resistor. The start-up of the circuit is such, that the MOSFETs  $T_{IS}$  and  $T_{HS}$  shall be non-conductive. The circuit will be reset in the start-up state. If the  $V_{DD}$  supply reaches the value of  $V_{DD(high)}$  the circuit starts oscillating. A DC reset circuit is incorporated in the high side (hs) driver. Below the lockout voltage at pin  $FV_{DD}$  the output voltage ( $V_{GH} - V_{SH}$ ) is zero. The voltages at pins CF and CT are zero during the start-up state.

**Oscillation**

The internal oscillator is a Voltage Controlled Oscillator circuit (VCO) which generates a sawtooth waveform between the high level at pin CF and 0 V (see Fig.4). The frequency of the sawtooth is determined by  $C_{CF}$ ,  $R_{IREF}$  and the voltage at pin CSW. The minimum and maximum frequencies are determined by  $C_{CF}$  and  $R_{IREF}$ . The minimum to maximum ratio is fixed internally. The sawtooth frequency is twice the half bridge frequency. The IC brings the MOSFETs  $T_{HS}$  and  $T_{IS}$  alternately into conduction with a duty factor of 50%. The oscillator starts oscillating at  $f_{max}$ . During the first switching cycle the MOSFET  $T_{IS}$  is switched on. To charge the bootstrap capacitor the first conduction time after the start-up state is made extra long. In all other cases the duty factor at the start is 50%.

**Non-overlap time**

The non-overlap time is realized with an Adaptive Non-Overlap circuit (ANT). By using this circuit, the application determines the duration of the non-overlap time (determined by the slope of the half bridge voltage and detected by the signal across  $R_{ACM}$ ) and makes the non-overlap time optimum for each frequency (see Fig.4). The minimum non-overlap time is internally fixed. The maximum non-overlap time is internally fixed at approximately 25% of the bridge period time.

**Timing circuit**

A timing circuit is included (a clock generator) to determine the maximum ignition time. The ignition time is defined as 1 pulse at pin CT; the lamp has to ignite within the duration of this pulse. The timer circuit starts operating when a critical value of the lamp voltage [ $V_{LVS(fail)}$ ] is exceeded. When the timer is not operating the capacitor at pin CT is discharged by 1 mA to 0 V.

**Ignition state**

After the start at  $f_{max}$  the frequency will decrease due to charging the capacitor at pin CSW with an internally fixed current. During this continuous decrease in frequency, the circuit approaches the resonant frequency of the lamp. This will cause a high voltage across the lamp, which ignites the lamp. The ignition voltage of the lamp is designed to be above the  $V_{LVS(fail)}$  level. If the lamp voltage exceeds this voltage level the ignition timer is started (see Fig.5).

**Burn state**

If the lamp voltage does not exceed the  $V_{LVS(max)}$  level the voltage at pin CSW will continue to increase until the clamp level at pin CSW is reached. As a consequence the frequency will decrease until the minimum frequency is reached. When the frequency reaches its minimum level it is assumed that the lamp has ignited, the circuit will enter the burn state and the Average Current Sensor (ACS) circuit will be enabled (see Fig.5). As soon as the average voltage across  $R_{sense}$  (measured at pin CS-) reaches the reference level at pin CS+, the average current sensor circuit will take over the control of the lamp current. The average current through  $R_{sense}$  is transferred to a voltage at the voltage controlled oscillator to regulate the frequency and, as a result, the lamp current.

**Lamp failure****DURING IGNITION STATE**

If the lamp fails to ignite, the voltage level increases. When the lamp voltage exceeds the  $V_{LVS(max)}$  level, the voltage will be regulated at that level. The ignition timer is started when the  $V_{LVS(fail)}$  level is exceeded. If the voltage at pin LVS is above the  $V_{LVS(fail)}$  level at the end of the ignition time the circuit stops oscillation and is forced into a Power-down state (see Fig.6). This state is terminated by switching off the  $V_{DD}$  supply.

**DURING BURN STATE**

If the lamp fails during normal operation, the voltage across the lamp will increase and the lamp voltage will exceed the  $V_{LVS(fail)}$  level. This forces the circuit to re-enter the ignition state and results in an attempt to re-ignite the lamp. If during restart the lamp still fails, the voltage remains high until the end of the ignition time. At the end of the ignition time the circuit stops oscillating and enters the Power-down state (see Fig.7).

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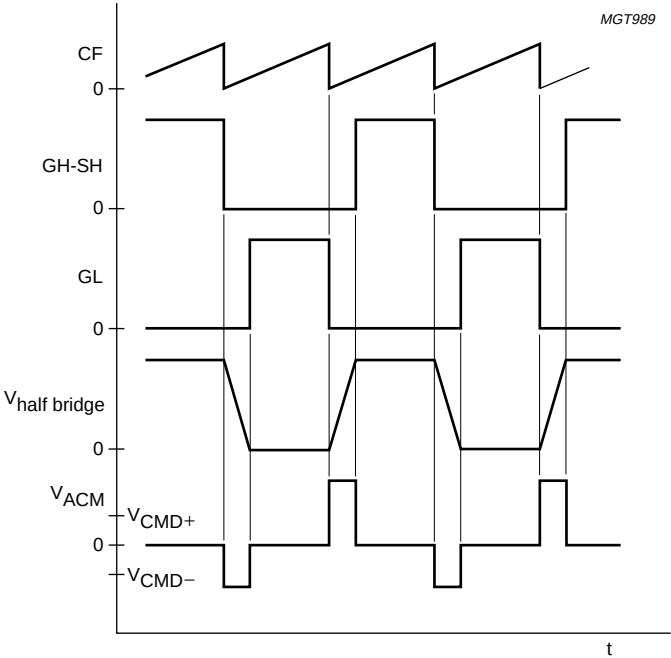


Fig.4 Oscillator and driver timing.

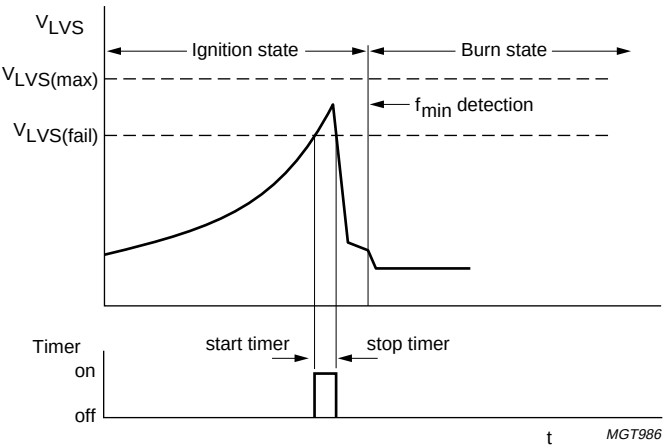


Fig.5 Normal ignition behaviour.

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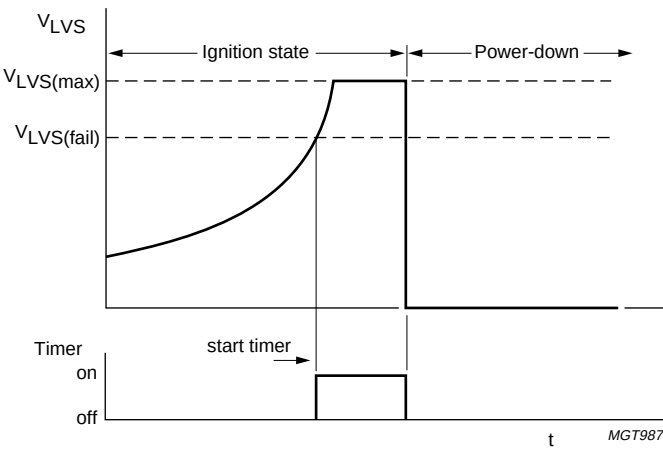


Fig.6 Lamp failure during ignition state.

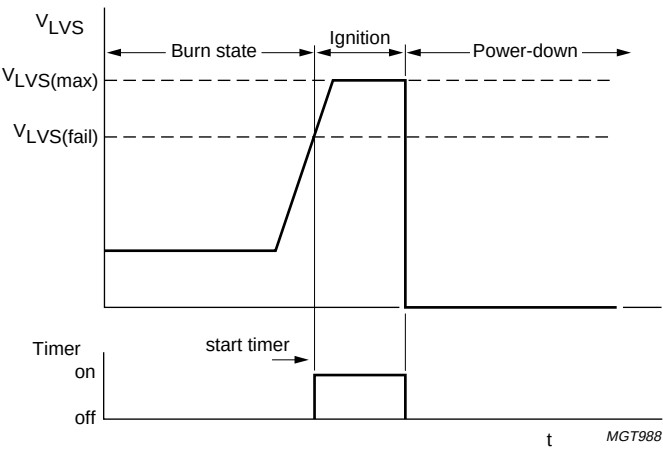


Fig.7 Lamp failure during burn state.

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**Power-down state**

The Power-down state will be entered if, at the end of the ignition time, the voltage at pin LVS is above  $V_{LVS(fail)}$ . In the Power-down state the oscillation will be stopped and MOSFETs  $T_{hs}$  and  $T_{ls}$  will be non-conductive. The  $V_{DD}$  supply is internally clamped. The circuit is released from the Power-down state by reducing the supply voltage to below  $V_{DD(reset)}$ .

**Capacitive mode protection**

The signal across  $R_{ACM}$  also gives information about the switching behaviour of the half bridge. If the voltage at  $R_{ACM}$  does not exceed the  $V_{CMD}$  level during the non-overlap time (see Fig.4), the Capacitive Mode Detection (CMD) circuit assumes that the circuit is in capacitive mode of operation. Consequently the frequency will be directly increased to  $f_{max}$ . In this event the frequency behaviour is decoupled from the voltage at pin CSW until the voltage is discharged to zero. An internal filter of 30 ns is included at pin ACM to increase the noise immunity.

**Charge coupling**

Due to parasitic capacitive coupling to the high voltage circuitry all pins are charged with a repetitive charge injection. Given the typical application the pins  $I_{REF}$  and CF are sensitive to this charge injection. For charge coupling of  $\pm 8$  pC, a safe functional operation of the IC is guaranteed, independent of the current level.

Charge coupling at current levels below 50  $\mu A$  will not interfere with the accuracy of the  $V_{CS}$  and  $V_{ACM}$  levels.

Charge coupling at current levels below 20  $\mu A$  will not interfere with the accuracy of any parameter.

**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 60134); all voltages referenced to ground.

| SYMBOL    | PARAMETER                                                                                                                                        | CONDITION                       | MIN.  | MAX.  | UNIT |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------|-------|------|
| $V_{hs}$  | high side supply voltage                                                                                                                         | $I_{hs} < 30 \mu A$ ; $t < 1$ s | –     | 600   | V    |
|           |                                                                                                                                                  | $I_{hs} < 30 \mu A$             | –     | 510   | V    |
| $V_{ACM}$ | voltage on pin ACM                                                                                                                               |                                 | –5    | +5    | V    |
| $V_{LVS}$ | voltage on pin LVS                                                                                                                               |                                 | 0     | 5     | V    |
| $V_{CS+}$ | voltage on pin CS+                                                                                                                               |                                 | 0     | 5     | V    |
| $V_{CS-}$ | voltage on pin CS–                                                                                                                               |                                 | –0.3  | +5    | V    |
| $V_{CSW}$ | voltage on pin CSW                                                                                                                               |                                 | 0     | 5     | V    |
| $T_{amb}$ | ambient temperature                                                                                                                              |                                 | –25   | +80   | °C   |
| $T_j$     | junction temperature                                                                                                                             |                                 | –25   | +150  | °C   |
| $T_{stg}$ | storage temperature                                                                                                                              |                                 | –55   | +150  | °C   |
| $V_{esd}$ | electrostatic discharge voltage<br>pins $FV_{DD}$ , GH, SH and $V_{DD}$<br>pins GL, ACM, CS+, CS–, CSW,<br>LVS, CF, $I_{REF}$ , CT and $V_{REF}$ | note 1                          | –1000 | +1000 | V    |
|           |                                                                                                                                                  |                                 | –2500 | +2500 | V    |

**Note**

1. In accordance with the human body model: equivalent to discharging a 100 pF capacitor through a 1.5 k $\Omega$  series resistor.

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## THERMAL CHARACTERISTICS

| SYMBOL        | PARAMETER                                     | DESCRIPTION | VALUE | UNIT |
|---------------|-----------------------------------------------|-------------|-------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient   | in free air |       |      |
|               | SO16                                          |             | 100   | K/W  |
|               | DIP16                                         |             | 60    | K/W  |
| $R_{th(j-t)}$ | thermal resistance from junction to tie-point |             |       |      |
|               | SO16                                          |             | 50    | K/W  |
|               | DIP16                                         |             | 30    | K/W  |

## QUALITY SPECIFICATION

In accordance with "SNW-FQ-611D".

## CHARACTERISTICS

$V_{DD} = 13\text{ V}$ ,  $V_{FVDD} - V_{SH} = 13\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; all voltages referenced to ground; see Fig.8; unless otherwise specified.

| SYMBOL                                              | PARAMETER                                   | CONDITION                                                                 | MIN. | TYP.  | MAX. | UNIT          |
|-----------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------|------|-------|------|---------------|
| <b>High voltage supply</b>                          |                                             |                                                                           |      |       |      |               |
| $I_L$                                               | leakage current on high voltage pins        | voltage at pins $FV_{DD}$ , GH and SH = 600 V                             | –    | –     | 30   | $\mu\text{A}$ |
| <b>Start-up state (pin <math>V_{DD}</math>)</b>     |                                             |                                                                           |      |       |      |               |
| $V_{DD}$                                            | supply voltage for defined driver output    | $T_{HS} = \text{off}$ ; $T_{LS} = \text{off}$                             | –    | –     | 6    | V             |
| $V_{DD(\text{high})}$                               | oscillator start voltage                    |                                                                           | 12.4 | 13    | 13.6 | V             |
| $V_{DD(\text{low})}$                                | oscillator stop voltage                     |                                                                           | 8.6  | 9.1   | 9.6  | V             |
| $V_{DD(\text{hys})}$                                | start-stop hysteresis voltage               |                                                                           | 3.5  | 3.9   | 4.4  | V             |
| $I_{DD(\text{start})}$                              | start-up current                            | $V_{DD} < V_{DD(\text{high})}$                                            | –    | 170   | 200  | $\mu\text{A}$ |
| $V_{DD(\text{clamp})}$                              | clamp voltage                               | Power-down mode                                                           | 10   | 11    | 12   | V             |
| $I_{DD(\text{pd})}$                                 | Power-down current                          | $V_{DD} = 9\text{ V}$                                                     | –    | 170   | 200  | $\mu\text{A}$ |
| $V_{DD(\text{reset})}$                              | reset voltage                               | $T_{HS} = \text{off}$ ; $T_{LS} = \text{off}$                             | 4.5  | 5.5   | 7    | V             |
| $I_{DD}$                                            | operating supply current                    | $f_{\text{bridge}} = 40\text{ kHz}$ without gate drive                    | –    | 1.5   | 2.2  | mA            |
| <b>Reference voltage (pin <math>V_{REF}</math>)</b> |                                             |                                                                           |      |       |      |               |
| $V_{\text{ref}}$                                    | reference voltage                           | $I_L = 10\text{ }\mu\text{A}$                                             | 2.86 | 2.95  | 3.04 | V             |
| $I_{\text{ref}}$                                    | reference current                           | source                                                                    | 1    | –     | –    | mA            |
|                                                     |                                             | sink                                                                      | 1    | –     | –    | mA            |
| $Z_o$                                               | output impedance                            | $I_L = 1\text{ mA}$ source                                                | –    | 3     | –    | $\Omega$      |
| $\Delta V_{\text{ref}}/\Delta T$                    | temperature coefficient of $V_{\text{ref}}$ | $I_L = 10\text{ }\mu\text{A}$ ;<br>$T_{amb} = 25\text{ to }150\text{ °C}$ | –    | –0.64 | –    | %/K           |
| <b>Current supply (pin <math>I_{REF}</math>)</b>    |                                             |                                                                           |      |       |      |               |
| $V_I$                                               | input voltage                               |                                                                           | –    | 2.5   | –    | V             |
| $I_I$                                               | input current                               |                                                                           | 65   | –     | 95   | $\mu\text{A}$ |

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| SYMBOL                                                                     | PARAMETER                                                   | CONDITION                                                                       | MIN. | TYP. | MAX. | UNIT          |
|----------------------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------|------|------|------|---------------|
| <b>Voltage controlled oscillator</b>                                       |                                                             |                                                                                 |      |      |      |               |
| $t_{\text{start}}$                                                         | first output oscillator stroke                              | after start-up state only                                                       | –    | 50   | –    | $\mu\text{s}$ |
| $f_{\text{bridge(max)}}$                                                   | maximum bridge frequency                                    |                                                                                 | 90   | 100  | 110  | kHz           |
| $f_{\text{bridge(min)}}$                                                   | minimum bridge frequency                                    |                                                                                 | 38.9 | 40.5 | 42.1 | kHz           |
| $\Delta f_{\text{stab}}$                                                   | frequency stability                                         | $T_{\text{amb}} = -20 \text{ to } +80 \text{ }^{\circ}\text{C}$                 | –    | 1.3  | –    | %             |
| $t_{\text{no(min)}}$                                                       | minimum non-overlap time                                    | GH to GL                                                                        | 0.68 | 0.90 | 1.13 | $\mu\text{s}$ |
|                                                                            |                                                             | GL to GH                                                                        | 0.75 | 1    | 1.25 | $\mu\text{s}$ |
| $t_{\text{no(max)}}$                                                       | maximum non-overlap time                                    | at $f_{\text{bridge}} = 40 \text{ kHz}$ ; note 1                                | –    | 6.7  | –    | $\mu\text{s}$ |
| <b>PIN CSW</b>                                                             |                                                             |                                                                                 |      |      |      |               |
| $V_i$                                                                      | input voltage                                               |                                                                                 | 2.7  | 3    | 3.3  | V             |
| $V_{\text{clamp}}$                                                         | clamp voltage                                               | burn state                                                                      | 2.8  | 3.1  | 3.4  | V             |
| <b>PIN CF</b>                                                              |                                                             |                                                                                 |      |      |      |               |
| $I_{\text{start}}$                                                         | start current                                               | $V_{\text{CF}} = 1.5 \text{ V}$                                                 | 3.8  | 4.5  | 5.2  | $\mu\text{A}$ |
| $I_{\text{min}}$                                                           | minimum current                                             | $V_{\text{CF}} = 1.5 \text{ V}$                                                 | –    | 21   | –    | $\mu\text{A}$ |
| $I_{\text{max}}$                                                           | maximum current                                             | $V_{\text{CF}} = 1.5 \text{ V}$                                                 | –    | 54   | –    | $\mu\text{A}$ |
| $V_{\text{OH}}$                                                            | HIGH-level output voltage                                   | $f = f_{\text{min}}$                                                            | –    | 2.5  | –    | V             |
| <b>Output drivers</b>                                                      |                                                             |                                                                                 |      |      |      |               |
| $V_{\text{boot}}$                                                          | bootstrap diode forward drop                                | $I = 5 \text{ mA}$                                                              | 1.3  | 1.7  | 2.1  | V             |
| $V_{\text{FVDD}}$                                                          | lockout voltage on pin $\text{FV}_{\text{DD}}$              |                                                                                 | 2.8  | 3.5  | 4.2  | V             |
| $I_{\text{FVDD}}$                                                          | floating well supply current on pin $\text{FV}_{\text{DD}}$ | DC level at $V_{\text{GH}} - V_{\text{SH}} = 13 \text{ V}$                      | –    | 35   | –    | $\mu\text{A}$ |
| <b>PINS GH AND GL</b>                                                      |                                                             |                                                                                 |      |      |      |               |
| $I_{\text{source}}$                                                        | source current                                              | $V_{\text{GH}} - V_{\text{SH}} = 0$ ; $V_{\text{GL}} = 0$                       | 135  | 180  | 235  | mA            |
| $I_{\text{sink}}$                                                          | sink current                                                | $V_{\text{GH}} - V_{\text{SH}} = 13 \text{ V}$ ; $V_{\text{GL}} = 13 \text{ V}$ | 265  | 300  | 415  | mA            |
| $V_{\text{OH}}$                                                            | HIGH-level output voltage                                   | $I_o = 10 \text{ mA}$                                                           | 12.5 | –    | –    | V             |
| $V_{\text{OL}}$                                                            | LOW-level output voltage                                    | $I_o = 10 \text{ mA}$                                                           | –    | –    | 0.5  | V             |
| <b>HIGH SIDE AND LOW SIDE</b>                                              |                                                             |                                                                                 |      |      |      |               |
| $R_{\text{on}}$                                                            | on resistance                                               | $I_o = 10 \text{ mA}$                                                           | 32   | 39   | 45   | $\Omega$      |
| $R_{\text{off}}$                                                           | off resistance                                              | $I_o = 10 \text{ mA}$                                                           | 16   | 21   | 26   | $\Omega$      |
| <b>Adaptive non-overlap timing and capacitive mode detection (pin ACM)</b> |                                                             |                                                                                 |      |      |      |               |
| $I_i$                                                                      | input current                                               | $V_{\text{ACM}} = 1.25 \text{ V}$                                               | –    | –    | 1    | $\mu\text{A}$ |
| $V_{\text{det}}$                                                           | capacitive mode detection voltage                           | positive                                                                        | 80   | 100  | 120  | mV            |
|                                                                            |                                                             | negative                                                                        | –68  | –85  | –102 | mV            |

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| SYMBOL                                             | PARAMETER                          | CONDITION                              | MIN. | TYP.  | MAX. | UNIT             |
|----------------------------------------------------|------------------------------------|----------------------------------------|------|-------|------|------------------|
| <b>Lamp voltage sensor (pin LVS)</b>               |                                    |                                        |      |       |      |                  |
| $I_i$                                              | input current                      | $V_{LVS} = 1.25 \text{ V}$             | –    | –     | 1    | $\mu\text{A}$    |
| $V_{LVS(\text{fail})}$                             | fail voltage                       |                                        | 1.19 | 1.25  | 1.31 | V                |
| $V_{LVS(\text{fail})(\text{hys})}$                 | fail voltage hysteresis            |                                        | 112  | 140   | 168  | mV               |
| $\Delta V_{LVS(\text{fail})(\text{hys})}/\Delta T$ | temperature coefficient hysteresis |                                        | –    | 0.65  | –    | mV/K             |
| $V_{LVS(\text{max})}$                              | maximum voltage                    |                                        | 1.67 | 1.76  | 1.85 | V                |
| $I_{o(\text{sink})}$                               | output sink current                | $V_{CSW} = 2 \text{ V}$                | 2.8  | 3.2   | 3.6  | $\mu\text{A}$    |
| $I_{o(\text{source})(\text{ign})}$                 | ignition output source current     | $V_{CSW} = 2 \text{ V}$                | 9.0  | 10    | 11   | $\mu\text{A}$    |
| <b>Average current sensor (pins CS+ and CS–)</b>   |                                    |                                        |      |       |      |                  |
| $I_i$                                              | input current                      | $V_{CS} = 0 \text{ V}$                 | –    | –     | 1    | $\mu\text{A}$    |
| $V_{\text{offset}}$                                | offset voltage                     | $V_{CS} = 0 \text{ to } 2.5 \text{ V}$ | –2   | 0     | +2   | mV               |
| $I_{o(\text{source})}$                             | output source current              | $V_{CSW} = 2.0 \text{ V}$              | 9.0  | 10    | 11   | $\mu\text{A}$    |
| $I_{o(\text{sink})}$                               | output sink current                | $V_{CSW} = 2.0 \text{ V}$              | 9.0  | 10    | 11   | $\mu\text{A}$    |
| $g_m$                                              | transconductance                   | $f = 1 \text{ kHz}$                    | 100  | 200   | 400  | $\mu\text{A/mV}$ |
| <b>Ignition timer (pin CT)</b>                     |                                    |                                        |      |       |      |                  |
| $I_o$                                              | output current                     | $V_{CT} = 2.5 \text{ V}$               | 5.5  | 5.9   | 6.3  | $\mu\text{A}$    |
| $V_{OL}$                                           | LOW-level output voltage           |                                        | –    | 1.4   | –    | V                |
| $V_{OH}$                                           | HIGH-level output voltage          |                                        | –    | 3.6   | –    | V                |
| $V_{\text{hys}}$                                   | output hysteresis                  |                                        | 2.05 | 2.20  | 2.35 | V                |
| $t_{\text{ign}}$                                   | ignition time                      |                                        | –    | 0.257 | –    | s                |

**Note**

1. The maximum non-overlap time is determined by the level of the CF signal. If this signal exceeds a level of 1.25 V the non-overlap will end. This equals a maximum non-overlap time of 6.7  $\mu\text{s}$  at a bridge frequency of 40 kHz.

# 600 V CCFL ballast driver IC

## UBA2070

## APPLICATION AND TEST INFORMATION

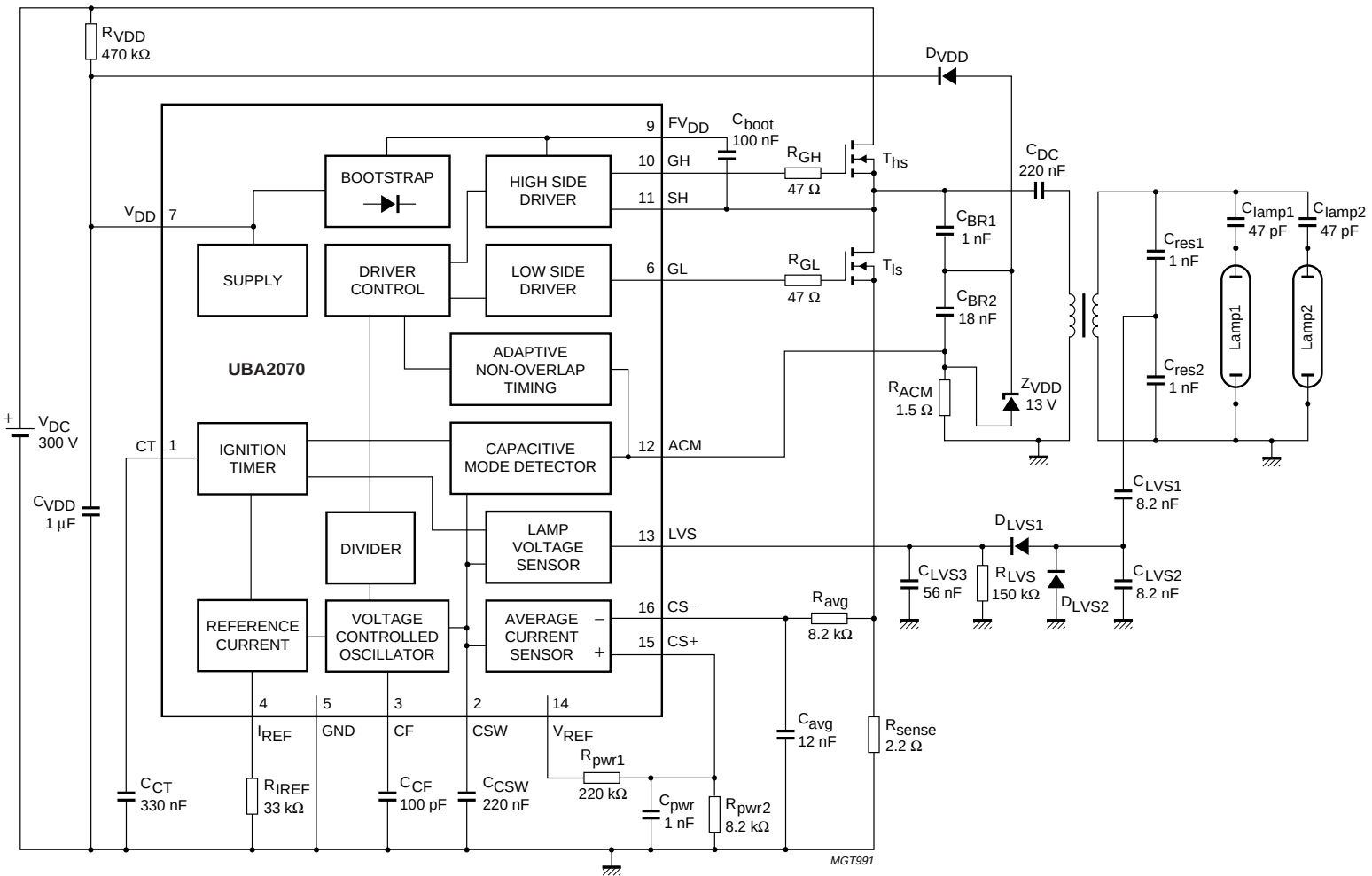


Fig.8 Test application circuit.

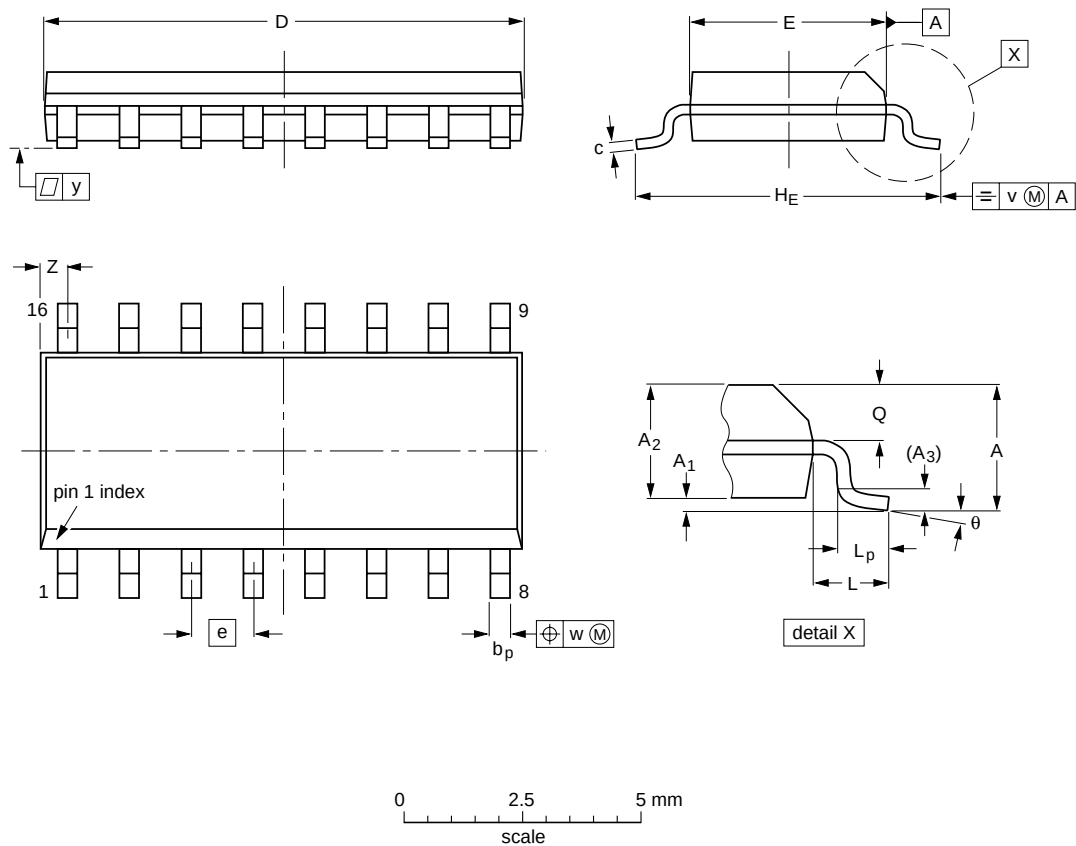
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PACKAGE OUTLINES

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



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

| UNIT   | A<br>max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c                | D <sup>(1)</sup> | E <sup>(1)</sup> | e     | H <sub>E</sub> | L     | L <sub>p</sub> | Q              | v    | w    | y     | z <sup>(1)</sup> | θ        |
|--------|-----------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm     | 1.75      | 0.25<br>0.10   | 1.45<br>1.25   | 0.25           | 0.49<br>0.36   | 0.25<br>0.19     | 10.0<br>9.8      | 4.0<br>3.8       | 1.27  | 6.2<br>5.8     | 1.05  | 1.0<br>0.4     | 0.7<br>0.6     | 0.25 | 0.25 | 0.1   | 0.7<br>0.3       | 8°<br>0° |
| inches | 0.069     | 0.010<br>0.004 | 0.057<br>0.049 | 0.01           | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.39<br>0.38     | 0.16<br>0.15     | 0.050 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.020 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012   |          |

Note

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

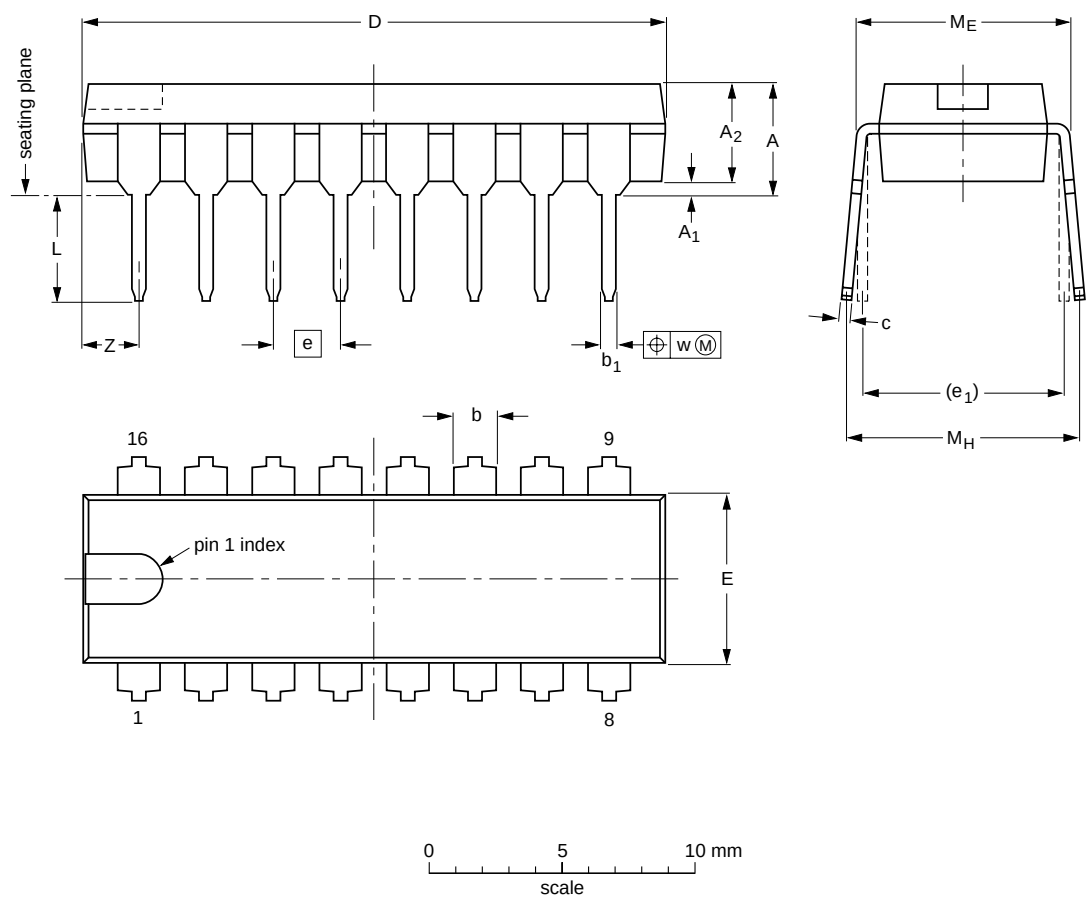
| OUTLINE<br>VERSION | REFERENCES |        |      |  | EUROPEAN<br>PROJECTION | ISSUE DATE            |
|--------------------|------------|--------|------|--|------------------------|-----------------------|
|                    | IEC        | JEDEC  | EIAJ |  |                        |                       |
| SOT109-1           | 076E07     | MS-012 |      |  |                        | 97-05-22-<br>99-12-27 |

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DIP16: plastic dual in-line package; 16 leads (300 mil); long body

SOT38-1



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

| UNIT   | A<br>max. | A <sub>1</sub><br>min. | A <sub>2</sub><br>max. | b              | b <sub>1</sub> | c              | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | e <sub>1</sub> | L            | M <sub>E</sub> | M <sub>H</sub> | w     | Z <sup>(1)</sup><br>max. |
|--------|-----------|------------------------|------------------------|----------------|----------------|----------------|------------------|------------------|------|----------------|--------------|----------------|----------------|-------|--------------------------|
| mm     | 4.7       | 0.51                   | 3.7                    | 1.40<br>1.14   | 0.53<br>0.38   | 0.32<br>0.23   | 21.8<br>21.4     | 6.48<br>6.20     | 2.54 | 7.62           | 3.9<br>3.4   | 8.25<br>7.80   | 9.5<br>8.3     | 0.254 | 2.2                      |
| inches | 0.19      | 0.020                  | 0.15                   | 0.055<br>0.045 | 0.021<br>0.015 | 0.013<br>0.009 | 0.86<br>0.84     | 0.26<br>0.24     | 0.10 | 0.30           | 0.15<br>0.13 | 0.32<br>0.31   | 0.37<br>0.33   | 0.01  | 0.087                    |

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE<br>VERSION | REFERENCES |        |           |  | EUROPEAN<br>PROJECTION | ISSUE DATE           |
|--------------------|------------|--------|-----------|--|------------------------|----------------------|
|                    | IEC        | JEDEC  | EIAJ      |  |                        |                      |
| SOT38-1            | 050G09     | MO-001 | SC-503-16 |  |                        | 95-01-19<br>99-12-27 |

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### SOLDERING

#### Introduction

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 IC packages. Wave soldering is often preferred when through-hole and surface mount components are mixed on one printed-circuit board. Wave soldering can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

#### Through-hole mount packages

##### SOLDERING BY DIPPING OR BY SOLDER WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joints for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ( $T_{stg(max)}$ ). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

##### MANUAL SOLDERING

Apply the soldering iron (24 V or less) to the lead(s) of the package, either below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

#### Surface mount packages

##### 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, convection or convection/infrared 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 preferably be kept below 220 °C for thick/large packages, and below 235 °C for small/thin packages.

##### 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.

## 600 V CCFL ballast driver IC

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## Suitability of IC packages for wave, reflow and dipping soldering methods

| MOUNTING           | PACKAGE <sup>(1)</sup>                                           | SOLDERING METHOD                  |                       |          |
|--------------------|------------------------------------------------------------------|-----------------------------------|-----------------------|----------|
|                    |                                                                  | WAVE                              | REFLOW <sup>(2)</sup> | DIPPING  |
| Through-hole mount | DBS, DIP, HDIP, SDIP, SIL                                        | suitable <sup>(3)</sup>           | –                     | suitable |
| Surface mount      | BGA, LBGA, LFBGA, SQFP, TFBGA, VFBGA                             | not suitable                      | suitable              | –        |
|                    | HBCC, HBGA, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, HVSON, SMS | not suitable <sup>(4)</sup>       | suitable              | –        |
|                    | PLCC <sup>(5)</sup> , SO, SOJ                                    | suitable                          | suitable              | –        |
|                    | LQFP, QFP, TQFP                                                  | not recommended <sup>(5)(6)</sup> | suitable              | –        |
|                    | SSOP, TSSOP, VSO                                                 | not recommended <sup>(7)</sup>    | suitable              | –        |

## Notes

- For more detailed information on the BGA packages refer to the “(LF)BGA Application Note” (AN01026); order a copy from your Philips Semiconductors sales office.
- 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”.
- For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.
- These packages are not suitable for wave soldering. On versions with the heatsink on the bottom side, the solder cannot penetrate between the printed-circuit board and the heatsink. On versions with the heatsink on the top side, the solder might be deposited on the heatsink surface.
- 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.
- Wave soldering is suitable for LQFP, QFP and TQFP packages with a pitch (e) larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is 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.

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## DATA SHEET STATUS

| LEVEL | DATA SHEET STATUS <sup>(1)</sup> | PRODUCT STATUS <sup>(2)(3)</sup> | DEFINITION                                                                                                                                                                                                                                                                                     |
|-------|----------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I     | Objective data                   | Development                      | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.                                                                                                    |
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3. For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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.

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**NOTES**

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