

# UBA2014

## 600 V driver IC for HF fluorescent lamps

Rev. 04 — 16 October 2008

Product data sheet

### 1. General description

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The IC is a monolithic integrated circuit for driving electronically ballasted fluorescent lamps, with mains voltages up to 277 V (RMS) (nominal value).

The circuit is made in a 650 V Bipolar CMOS DMOS (BCD) power-logic process. It provides the drive function for the two discrete power MOSFETs.

Besides the drive function, the IC also includes the level-shift circuit, the oscillator function, a lamp voltage monitor, a current control function, a timer function and protections.

### 2. Features

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- Adjustable preheat time
- Adjustable preheat current
- Current controlled operating
- Single ignition attempt
- Adaptive non-overlap time control
- Integrated high-voltage level-shift function
- Power-down function
- Protection against lamp failures or lamp removal
- Capacitive mode protection

### 3. Applications

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- The circuit topology enables a broad range of ballast applications at different mains voltages for driving lamp types from T8, T5, PLC, T10, T12, PLL and PLT, for example.

## 4. Quick reference data

**Table 1. Quick reference data**

$V_{DD} = 13\text{ V}$ ;  $V_{FVDD} - V_{SH} = 13\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; all voltages are referenced to GND; see test circuit of [Figure 8](#); unless otherwise specified.

| Symbol                               | Parameter                          | Conditions   | Min  | Typ  | Max  | Unit             |
|--------------------------------------|------------------------------------|--|------|------|------|------------------|
| <b>Start-up state</b>                |                                    |  |      |      |      |                  |
| $V_{DD(\text{stop})}$                | oscillator stop supply voltage     |  | 8.6  | 9.1  | 9.6  | V                |
| $V_{DD(\text{start})}$               | oscillator start supply voltage    |  | 12.4 | 13.0 | 13.6 | V                |
| $I_{DD(\text{start})}$               | oscillator start-up supply current | $V_{DD} < V_{DD(\text{start})}$                              | -    | 170  | 200  | $\mu\text{A}$    |
| <b>High-voltage supply</b>           |                                    |  |      |      |      |                  |
| $V_{HS}$                             | high-side supply voltage           | $I_{HS} < 30\text{ }\mu\text{A}$                             | -    | -    | 570  | V                |
| <b>Reference voltage</b>             |                                    |  |      |      |      |                  |
| $V_{VREF}$                           | reference voltage                  | $I_L = 10\text{ }\mu\text{A}$                                | 2.86 | 2.95 | 3.04 | V                |
| <b>Voltage controlled oscillator</b> |                                    |  |      |      |      |                  |
| $f_{\text{max}}$                     | maximum bridge frequency           |  | 90   | 100  | 110  | kHz              |
| $f_{\text{min}}$                     | minimum bridge frequency           |  | 38.9 | 40.5 | 42.1 | kHz              |
| <b>High-side output driver</b>       |                                    |  |      |      |      |                  |
| $I_{O(\text{source})}$               | output source current              | $V_{GH} - V_{SH} = 0\text{ V}$                               | 135  | 180  | 235  | mA               |
| $I_{O(\text{sink})}$                 | output sink current                | $V_{GH} - V_{SH} = 13\text{ V}$                              | 265  | 330  | 415  | mA               |
| <b>Preheat current sensor</b>        |                                    |  |      |      |      |                  |
| $V_{ph}$                             | preheat voltage                    |  | 0.57 | 0.60 | 0.63 | V                |
| <b>Lamp voltage sensor</b>           |                                    |  |      |      |      |                  |
| $V_{\text{lamp}(\text{fail})}$       | lamp fail voltage                  |  | 0.77 | 0.81 | 0.85 | V                |
| $V_{\text{lamp}(\text{max})}$        | maximum lamp voltage               |  | 1.44 | 1.49 | 1.54 | V                |
| <b>Average current sensor</b>        |                                    |  |      |      |      |                  |
| $V_{\text{offset}}$                  | offset voltage                     | $V_{CSP} = V_{CSN} = 0\text{ V to }2.5\text{ V}$             | -2   | 0    | +2   | mV               |
| $g_m$                                | transconductance                   | $f = 1\text{ kHz}$   | 1900 | 3800 | 5700 | $\mu\text{A/mV}$ |
| <b>Preheat timer</b>                 |                                    |  |      |      |      |                  |
| $t_{ph}$                             | preheat time                       | $C_{CT} = 330\text{ nF}$ ;<br>$R_{IREF} = 33\text{ k}\Omega$ | 1.6  | 1.8  | 2.0  | s                |
| $V_{OL}$                             | LOW-level output voltage           |  | -    | 1.4  | -    | V                |
| $V_{OH}$                             | HIGH-level output voltage          |  | -    | 3.6  | -    | V                |

## 5. Ordering information

**Table 2. Ordering information**

| Type number | Package |   |          |
|-------------|---------|---|----------|
|             | Name    | Description   | Version  |
| UBA2014T    | SO16    | plastic small outline package; 16 leads; body width 3.9 mm  | SOT109-1 |
| UBA2014P    | DIP16   | plastic dual in-line package; 16 leads (300 mil); long body | SOT38-1  |

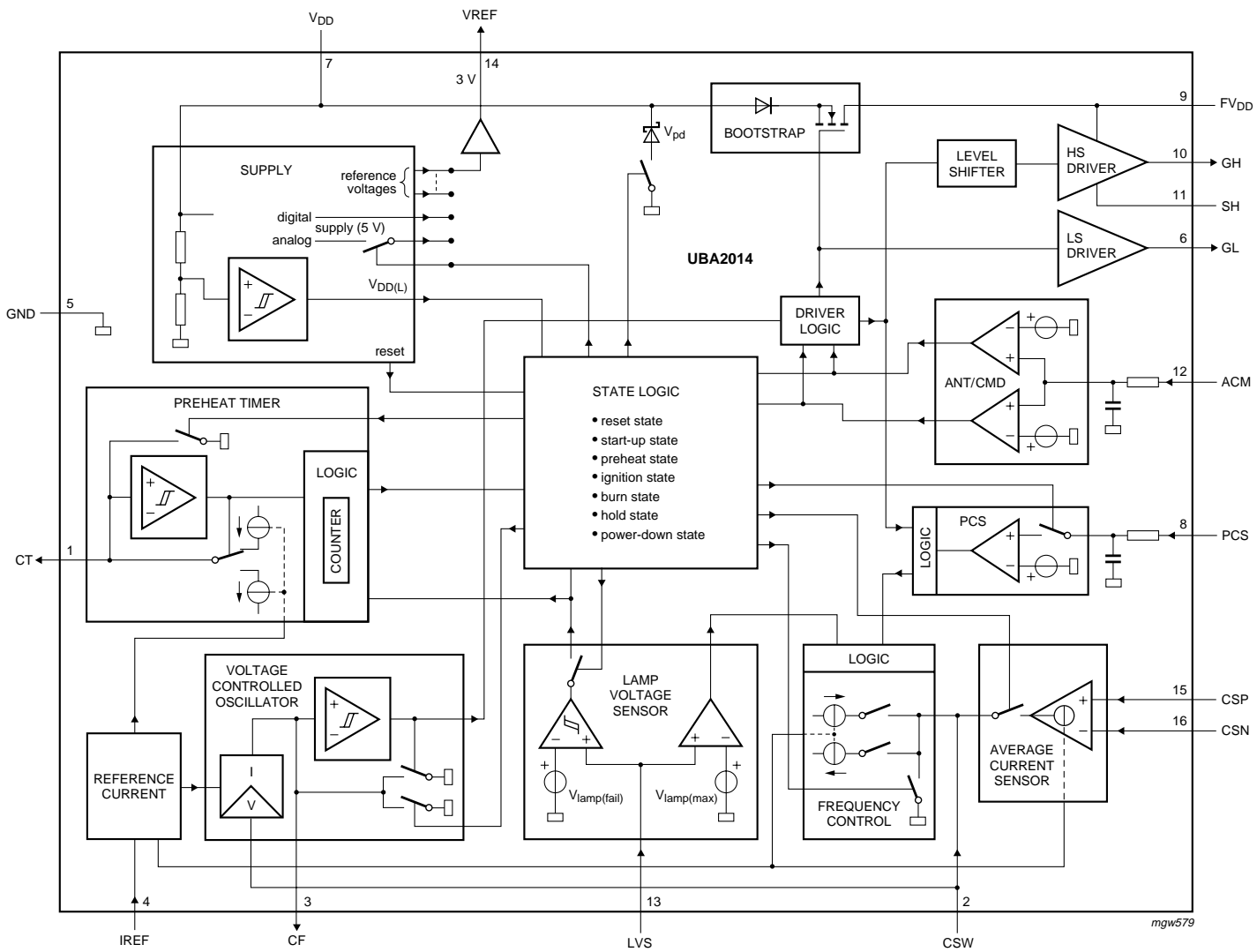


Fig 1. Block diagram

7. Pinning information

7.1 Pinning

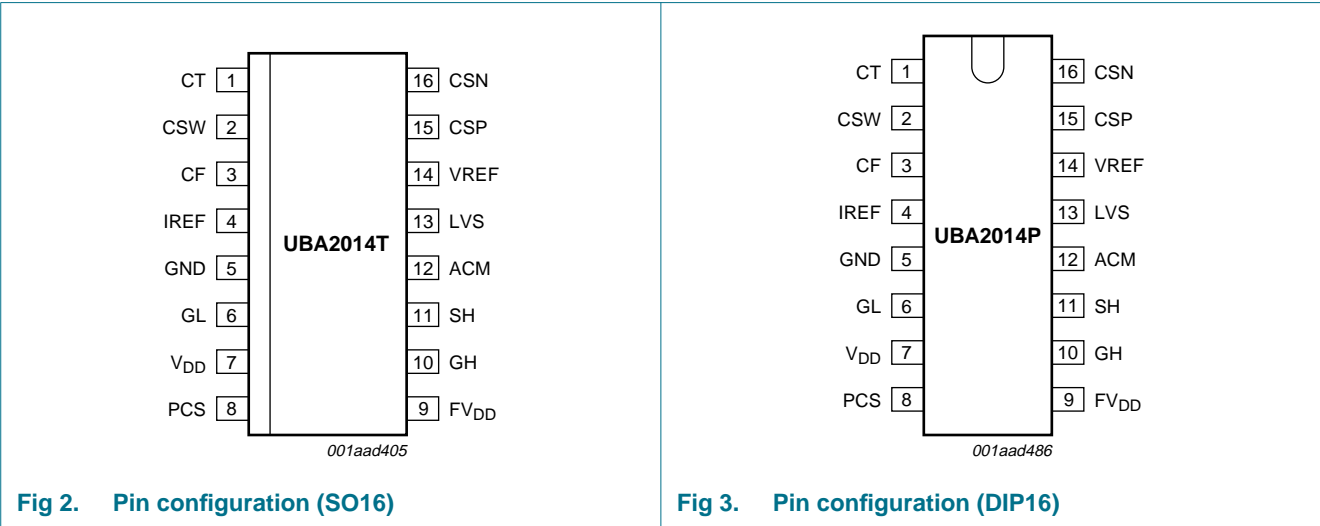


Fig 2. Pin configuration (SO16)

Fig 3. Pin configuration (DIP16)

7.2 Pin description

Table 3. Pin description

| Symbol           | Pin | Description  |
|------------------|-----|--|
| CT               | 1   | preheat timer output                                 |
| CSW              | 2   | input of voltage controlled oscillator               |
| CF               | 3   | voltage controlled oscillator output                 |
| IREF             | 4   | internal reference current input                     |
| GND              | 5   | ground   |
| GL               | 6   | gate output for the low-side switch                  |
| V <sub>DD</sub>  | 7   | low-voltage supply                                   |
| PCS              | 8   | preheat current sensor input                         |
| FV <sub>DD</sub> | 9   | floating supply voltage; supply for high-side switch |
| GH               | 10  | gate output for the high-side switch                 |
| SH               | 11  | source for the high-side switch                      |
| ACM              | 12  | capacitive mode input                                |
| LVS              | 13  | lamp voltage sensor input                            |
| VREF             | 14  | reference voltage output                             |
| CSP              | 15  | positive input for the average current sensor        |
| CSN              | 16  | negative input for the average current sensor        |

## 8. Functional description

### 8.1 Start-up state

Initial start-up can be achieved by charging the low-voltage supply capacitor C7 (see [Figure 8](#)) via an external start-up resistor. Start-up of the circuit is achieved under the condition that both half bridge transistors TR1 and TR2 are non-conductive. The circuit will be reset in the start-up state. If the low-voltage supply ( $V_{DD}$ ) reaches the value of  $V_{DD(start)}$  the circuit will start oscillating. A DC reset circuit is incorporated in the High-Side (HS) driver. Below the lockout voltage at the FV<sub>DD</sub> pin the output voltage ( $V_{GH} - V_{SH}$ ) is zero. The voltages at pins CF and CT are zero during the start-up state.

### 8.2 Oscillation

The internal oscillator is a Voltage Controlled Oscillator (VCO) circuit which generates a sawtooth waveform between the  $V_{CF(high)}$  level and 0 V. The frequency of the sawtooth is determined by capacitor  $C_{CF}$ , resistor  $R_{IREF}$ , and the voltage at pin CSW. The minimum and maximum switching frequencies are determined by  $R_{IREF}$  and  $C_{CF}$ ; their ratio is internally fixed. The sawtooth frequency is twice the half bridge frequency. The UBA2014 brings the transistors TR1 and TR2 into conduction alternately with a duty cycle of approximately 50 %. An overview of the oscillator signal and driver signals is illustrated in [Figure 4](#). The oscillator starts oscillating at  $f_{max}$ . During the first switching cycle the Low-Side (LS) transistor is switched on. The first conducting time is made extra long to enable the bootstrap capacitor to charge.

### 8.3 Adaptive non-overlap

The non-overlap time is realized with an Adaptive Non-overlap circuit (ANT). By using an adaptive non-overlap circuit, the application can determine the duration of the non-overlap time and make it optimum for each frequency; see [Figure 4](#). The non-overlap time is determined by the slope of the half bridge voltage, and is detected by the signal across resistor R16 which is connected directly to pin ACM. The minimum non-overlap time is internally fixed. The maximum non-overlap time is internally fixed at approximately 25 % of the bridge period time. An internal filter of 30 ns is included at the ACM pin to increase the noise immunity.

### 8.4 Timing circuit

A timing circuit is included to determine the preheat time and the ignition time. The circuit consists of a clock generator and a counter.

The preheat time is defined by  $C_{CT}$  and  $R_{IREF}$  and consists of 7 pulses at  $C_{CT}$ ; the maximum ignition time is 1 pulse at  $C_{CT}$ . The timing circuit starts operating after the start-up state, as soon as the low supply voltage ( $V_{DD}$ ) has reached  $V_{DD(start)}$  or when a critical value of the lamp voltage ( $V_{lamp(fail)}$ ) is exceeded. When the timer is not operating  $C_{CT}$  is discharged to 0 V at 1 mA.

## 8.5 Preheat state

After starting at  $f_{\max}$ , the frequency decreases until the momentary value of the voltage across sense resistor R14 reaches the internally fixed preheat voltage level (pin PCS). At crossing the preheat voltage level, the output current of the Preheat Current Sensor (PCS) circuit discharges the capacitor  $C_{\text{CSW}}$ , thus raising the frequency. The preheat time begins at the moment that the circuit starts oscillating. During the preheat time the Average Current Sensor (ACS) circuit is disabled. An internal filter of 30 ns is included at pin PCS to increase the noise immunity.

## 8.6 Ignition state

After the preheat time the ignition state is entered and the frequency will sweep down due to charging of the capacitor at pin CSW with an internally fixed current; see [Figure 5](#). During this continuous decrease in frequency, the circuit approaches the resonant frequency of the load. This will cause a high voltage across the load, which normally ignites the lamp. The ignition voltage of a lamp is designed above the  $V_{\text{lamp(fail)}}$  level. If the lamp voltage exceeds the  $V_{\text{lamp(fail)}}$  level the ignition timer is started.

## 8.7 Burn state

If the lamp voltage does not exceed the  $V_{\text{lamp(max)}}$  level the voltage at pin CSW will continue to increase until the clamp level at pin CSW is reached; see [Figure 5](#). 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 and the circuit will enter the burn state. The ACS circuit will be enabled. As soon as the averaged voltage across sense resistor R14, measured at pin CSN, reaches the reference level at pin CSP, the average current sensor circuit will take over the control of the lamp current. The average current through R14 is transferred to a voltage at the voltage controlled oscillator and regulates the frequency and, as a result, the lamp current.

## 8.8 Lamp failure mode

### 8.8.1 During ignition state

If the lamp does not ignite, the voltage level increases. When the lamp voltage exceeds the  $V_{\text{lamp(max)}}$  level, the voltage will be regulated at the  $V_{\text{lamp(max)}}$  level; see [Figure 6](#). When the  $V_{\text{lamp(fail)}}$  level is crossed the ignition timer has already started. If the voltage at pin LVS is above the  $V_{\text{lamp(fail)}}$  level at the end of the ignition time the circuit stops oscillating and is forced into the Power-down mode. The circuit will be reset only when the supply voltage is powered down.

### 8.8.2 During burn state

If the lamp fails during normal operation, the voltage across the lamp will increase and the lamp voltage will exceed the  $V_{\text{lamp(fail)}}$  level; see [Figure 7](#). At that moment the ignition timer is started. If the lamp voltage increases further it will reach the  $V_{\text{lamp(max)}}$  level. This forces the circuit to reenter 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 the circuit will enter the Power-down mode.

## 8.9 Power-down mode

The Power-down mode will be entered if, at the end of the ignition time, the voltage at pin LVS is above  $V_{\text{lamp(fail)}}$ . In the Power-down mode the oscillator will be stopped and both TR1 and TR2 will be non-conductive. The  $V_{\text{DD}}$  supply is internally clamped. The circuit is released from the Power-down mode by lowering the low-voltage supply below  $V_{\text{DD(reset)}}$ .

## 8.10 Capacitive mode protection

The signal across R16 also gives information about the switching behavior of the half bridge. If, after the preheat state, the voltage across the ACM resistor (R16) does not exceed the  $V_{\text{CMD}}$  level during the non-overlap time, the Capacitive Mode Detection (CMD) circuit assumes that the circuit is in the capacitive mode of operation. As a consequence the frequency will directly be increased to  $f_{\text{max}}$ . The frequency behavior is decoupled from the voltage at pin CSW until  $C_{\text{CSW}}$  has been discharged to zero.

## 8.11 Charge coupling

Due to parasitic capacitive coupling to the high voltage circuitry all pins are burdened with a repetitive charge injection. Given the typical application the pins IREF and CF are sensitive to this charge injection. For charge coupling of approximately 8 pC, a safe functional operation of the IC is guaranteed, independent of the current level.

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

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

## 8.12 Design equations

The following design equations are used to calculate the desired preheat time, the maximum ignition time, and the minimum and the maximum switching frequency.

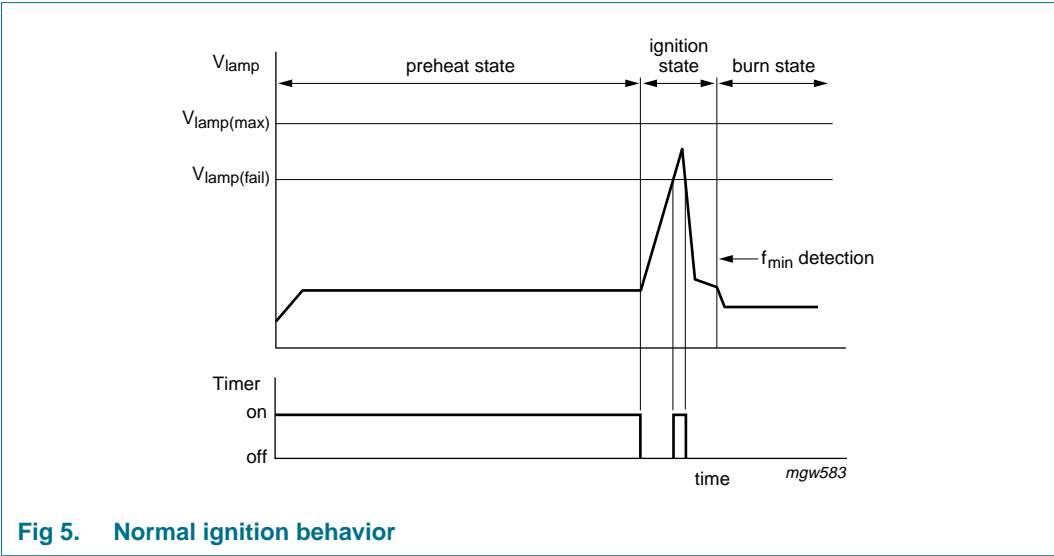
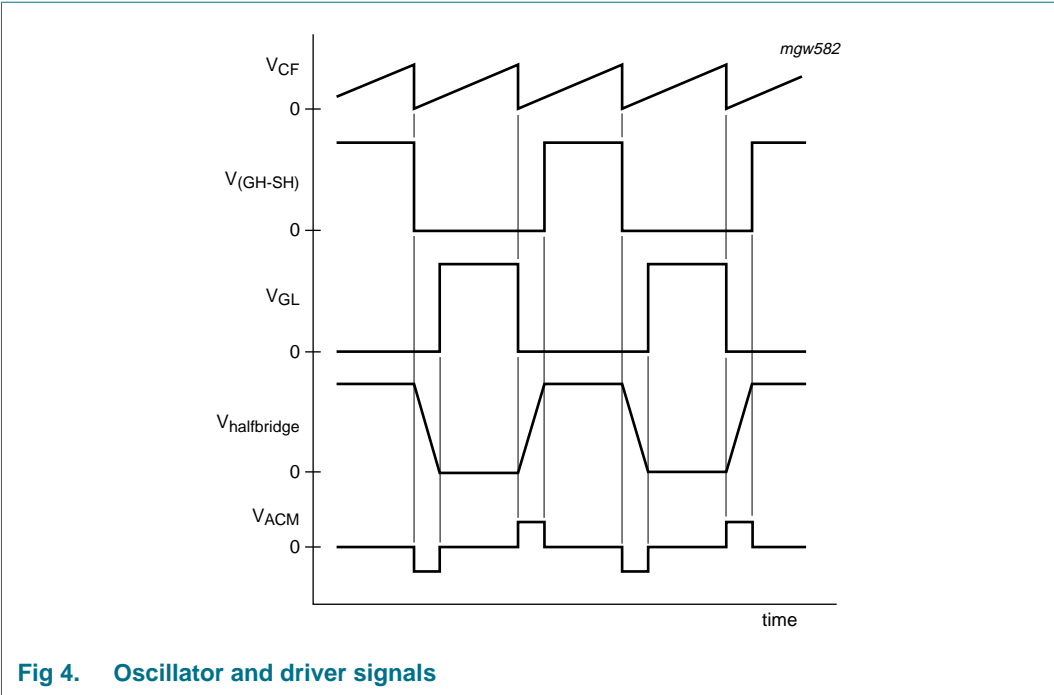
$$t_{ph} = 1.8 \times \frac{C_{CT}}{330 \times 10^{-9}} \times \frac{R_{IREF}}{33 \times 10^3} \quad (1)$$

$$t_{ign} = 0.26 \times \frac{C_{CT}}{330 \times 10^{-9}} \times \frac{R_{IREF}}{33 \times 10^3} \quad (2)$$

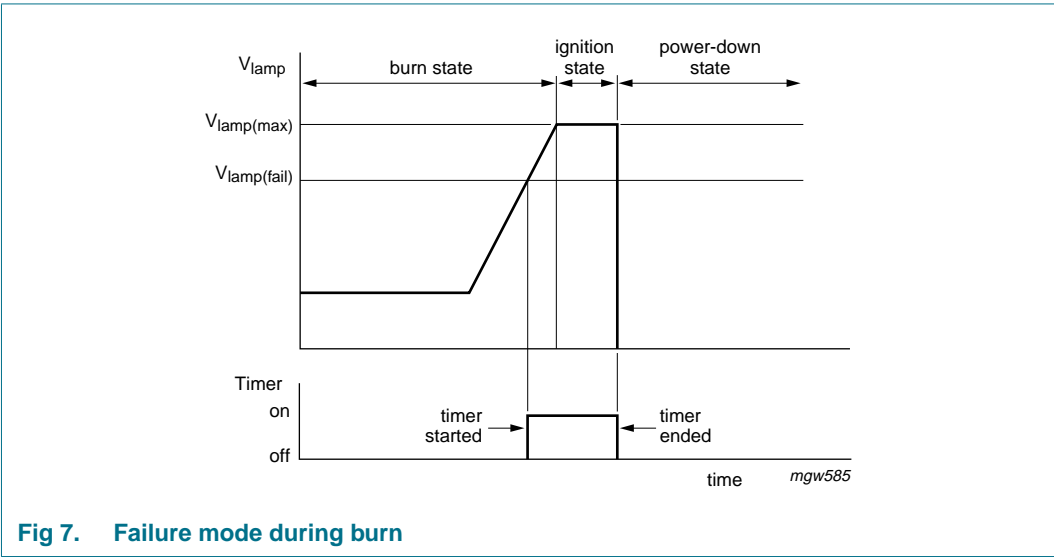
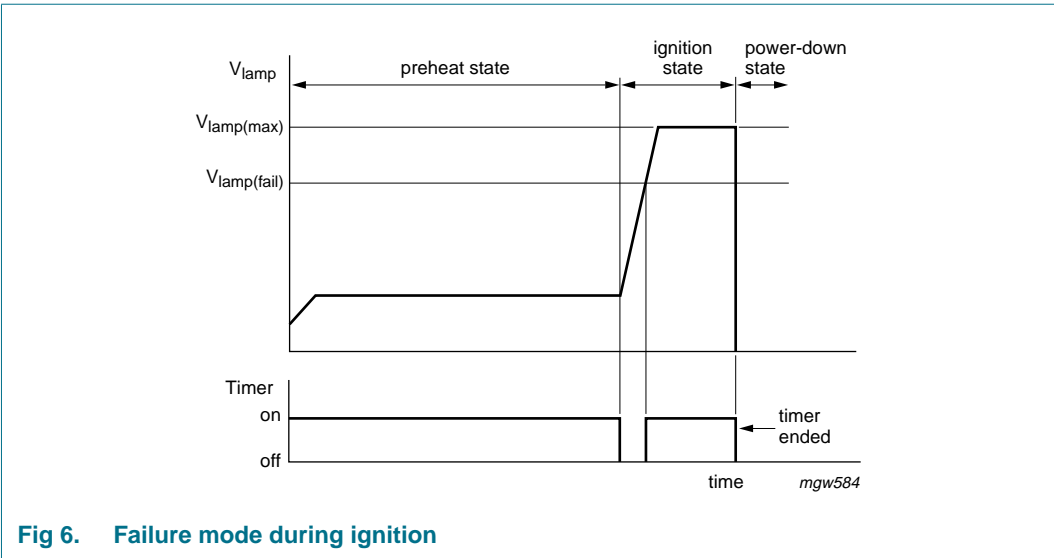
$$f_{min} = 40.5 \times 10^3 \times \frac{100 \times 10^{-12}}{C_{CF}} \times \frac{33 \times 10^3}{R_{IREF}} \quad (3)$$

$$f_{max} = 2.5 \times f_{min} \quad (4)$$

Start of ignition is defined as the moment at which the measured lamp voltage crosses the  $V_{\text{lamp(fail)}}$  level; see [Section 8.8](#).







## 9. Limiting values

**Table 4. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages referenced to GND.

| Symbol    | Parameter   | Conditions                        | Min       | Max   | Unit |
|-----------|---|-----------------------------------|-----------|-------|------|
| $V_{HS}$  | high-side supply voltage  | $I_{HS} < 30\ \mu A$ ; $t < 1\ s$ | -         | 600   | V    |
|           |   | $I_{HS} < 30\ \mu A$              | -         | 570   | V    |
| $V_{DD}$  | voltage at pin $V_{DD}$   |                                   | -         | 14    | V    |
| $V_{ACM}$ | voltage at pin ACM  |                                   | -5        | +5    | V    |
| $V_{PCS}$ | voltage at pin PCS  |                                   | -5        | +5    | V    |
| $V_{LVS}$ | voltage at pin LVS  |                                   | 0         | 5     | V    |
| $V_{CSP}$ | voltage at pin CSP  |                                   | 0         | 5     | V    |
| $V_{CSN}$ | voltage at pin CSN  |                                   | -0.3      | +5    | V    |
| $V_{CSW}$ | voltage at 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   |                                   |           |       |      |
|           | pins $FV_{DD}$ , GH and SH  |                                   | [1] -1000 | +1000 | V    |
|           | pins CT, CSW, CF, IREF, GL, $V_{DD}$ , PCS, CSN, CSP, VREF, LVS and ACM |                                   | [1] -2500 | +2500 | V    |

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

## 10. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol          | Parameter                                   | Conditions  | Typ | Unit |
|-----------------|---|-------------|-----|------|
| $R_{th(j-a)}$   | thermal resistance from junction to ambient | in free air |     |      |
|                 | SO16  |             | 100 | K/W  |
|                 | DIP16                                       |             | 60  | K/W  |
| $R_{th(j-pin)}$ | thermal resistance from junction to pin     | in free air |     |      |
|                 | SO16  |             | 50  | K/W  |
|                 | DIP16                                       |             | 30  | K/W  |

## 11. Characteristics

**Table 6. Characteristics**

$V_{DD} = 13\text{ V}$ ;  $V_{FVDD} - V_{SH} = 13\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; all voltages referenced to GND; see test circuit of [Figure 8](#); unless otherwise specified.

| Symbol   | Parameter                            | Conditions   | Min   | Typ   | Max  | Unit          |
|--|--------------------------------------|--|-------|-------|------|---------------|
| <b>Start-up state: pin <math>V_{DD}</math></b>                   |                                      |  |       |       |      |               |
| $V_{DD}$   | supply voltage                       | TR1 = off; TR2 = off   | -     | -     | 6    | V             |
| $V_{DD(reset)}$  | reset supply voltage                 | TR1 = off; TR2 = off   | 4.5   | 5.5   | 7.0  | V             |
| $V_{DD(stop)}$   | oscillator stop supply voltage       |  | 8.6   | 9.1   | 9.6  | V             |
| $V_{DD(start)}$  | oscillator start supply voltage      |  | 12.4  | 13.0  | 13.6 | V             |
| $V_{DD(hys)}$  | start-stop hysteresis supply voltage |  | 3.5   | 3.9   | 4.4  | V             |
| $V_{DD(clamp)}$  | clamp supply voltage                 | Power-down mode  | 10    | 11    | 12   | V             |
| $I_{DD(start)}$  | start-up supply current              | $V_{DD} < V_{DD(start)}$   | -     | 170   | 200  | $\mu\text{A}$ |
| $I_{DD(pd)}$   | power-down supply current            | $V_{DD} = 9\text{ V}$  | -     | 170   | 200  | $\mu\text{A}$ |
| $I_{DD}$   | supply current                       | $f_{bridge} = 40\text{ kHz}$ without gate drive                              | -     | 1.5   | 2.2  | mA            |
| <b>High-voltage supply: pins GH, SH and <math>FV_{DD}</math></b> |                                      |  |       |       |      |               |
| $I_L$  | latching current                     | 600 V at high-voltage pins   | -     | -     | 30   | $\mu\text{A}$ |
| <b>Reference voltage: pin <math>V_{REF}</math></b>               |                                      |  |       |       |      |               |
| $V_{ref}$  | reference voltage                    | $I_L = 10\text{ }\mu\text{A}$  | 2.86  | 2.95  | 3.04 | V             |
| $\Delta V_{VREF}$  | reference voltage stability          | $I_L = 10\text{ }\mu\text{A}$ ;<br>$T_{amb} = 25\text{ °C to }150\text{ °C}$ | -     | -0.64 | -    | %             |
| $I_{source}$   | source current                       |  | 1     | -     | -    | mA            |
| $I_{sink}$   | sink current                         |  | 1     | -     | -    | mA            |
| $Z_o$  | output impedance                     | $I_L = 1\text{ mA source}$   | -     | 3.0   | -    | $\Omega$      |
| <b>Current supply: pin <math>I_{REF}</math></b>                  |                                      |  |       |       |      |               |
| $V_I$  | input voltage                        |  | -     | 2.5   | -    | V             |
| $I_I$  | input current                        |  | 65    | -     | 95   | $\mu\text{A}$ |
| <b>Voltage controlled oscillator</b>                             |                                      |  |       |       |      |               |
| <b>Output: pin CSW</b>   |                                      |  |       |       |      |               |
| $V_o$  | output control voltage               |  | 2.7   | 3.0   | 3.3  | V             |
| $V_{clamp}$  | clamp voltage                        | burn state   | 2.8   | 3.1   | 3.4  | V             |
| <b>Voltage controlled oscillator output: pin CF</b>              |                                      |  |       |       |      |               |
| $f_{max}$  | maximum frequency                    |  | 90    | 100   | 110  | kHz           |
| $f_{min}$  | minimum frequency                    |  | 38.9  | 40.5  | 42.1 | kHz           |
| $\Delta f_{stab}$  | frequency stability                  | $T_{amb} = -20\text{ °C to }+80\text{ °C}$                                   | -     | 1.3   | -    | %             |
| $t_{start}$  | first output oscillator stroke time  |  | -     | 50    | -    | $\mu\text{s}$ |
| $t_{no(min)}$  | minimum non-overlap time             | GH to GL   | 0.68  | 0.90  | 1.13 | $\mu\text{s}$ |
|  |                                      | GL to GH   | 0.75  | 1.00  | 1.25 | $\mu\text{s}$ |
| $t_{no(max)}$  | maximum non-overlap time             | $f_{bridge} = 40\text{ kHz}$   | [1] - | 7.5   | -    | $\mu\text{s}$ |
| $V_{CF(high)}$   | high-level oscillator output voltage | $f = f_{min}$  | -     | 2.5   | -    | V             |

**Table 6. Characteristics ...continued**

$V_{DD} = 13\text{ V}$ ;  $V_{FVDD} - V_{SH} = 13\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; all voltages referenced to GND; see test circuit of [Figure 8](#); unless otherwise specified.

| Symbol                | Parameter                         | Conditions              | Min | Typ | Max | Unit          |
|-----------------------|-----------------------------------|-------------------------|-----|-----|-----|---------------|
| $I_{O(\text{start})}$ | oscillator output start current   | $V_{CF} = 1.5\text{ V}$ | 3.8 | 4.5 | 5.2 | $\mu\text{A}$ |
| $I_{O(\text{min})}$   | minimum oscillator output current | $V_{CF} = 1.5\text{ V}$ | -   | 21  | -   | $\mu\text{A}$ |
| $I_{O(\text{max})}$   | maximum oscillator output current | $V_{CF} = 1.5\text{ V}$ | -   | 54  | -   | $\mu\text{A}$ |

**Output drivers****High-side driver output: pin GH**

|                        |                           |                                 |      |     |     |          |
|------------------------|---------------------------|---------------------------------|------|-----|-----|----------|
| $V_{OH}$               | HIGH-level output voltage | $I_o = 10\text{ mA}$            | 12.5 | -   | -   | V        |
| $V_{OL}$               | LOW-level output voltage  | $I_o = 10\text{ mA}$            | -    | -   | 0.5 | V        |
| $I_{O(\text{source})}$ | output source current     | $V_{GH} - V_{SH} = 0\text{ V}$  | 135  | 180 | 235 | mA       |
| $I_{O(\text{sink})}$   | output sink current       | $V_{GH} - V_{SH} = 13\text{ V}$ | 265  | 330 | 415 | mA       |
| $R_{on}$               | on resistance             | $I_o = 10\text{ mA}$            | 32   | 39  | 45  | $\Omega$ |
| $R_{off}$              | off resistance            | $I_o = 10\text{ mA}$            | 16   | 21  | 26  | $\Omega$ |

**Low-side driver output: pin GL**

|                        |                           |                        |      |     |     |          |
|------------------------|---------------------------|------------------------|------|-----|-----|----------|
| $V_{OH}$               | HIGH-level output voltage | $I_o = 10\text{ mA}$   | 12.5 | -   | -   | V        |
| $V_{OL}$               | LOW-level output voltage  | $I_o = 10\text{ mA}$   | -    | -   | 0.5 | V        |
| $I_{O(\text{source})}$ | output source current     | $V_{GL} = 0$           | 135  | 200 | 235 | mA       |
| $I_{O(\text{sink})}$   | output sink current       | $V_{GL} = 13\text{ V}$ | 265  | 330 | 415 | mA       |
| $R_{on}$               | on resistance             | $I_o = 10\text{ mA}$   | 32   | 39  | 45  | $\Omega$ |
| $R_{off}$              | off resistance            | $I_o = 10\text{ mA}$   | 16   | 21  | 26  | $\Omega$ |

**Floating supply voltage: pin FV<sub>DD</sub>**

|            |                              |  |     |     |     |               |
|------------|------------------------------|--|-----|-----|-----|---------------|
| $V_{FVDD}$ | lockout voltage              |  | 2.8 | 3.5 | 4.2 | V             |
| $I_{FVDD}$ | floating well supply current | DC level at<br>$V_{GH} - V_{SH} = 13\text{ V}$ | -   | 35  | -   | $\mu\text{A}$ |

**Bootstrap diode**

|            |                                      |                   |     |     |     |   |
|------------|--------------------------------------|-------------------|-----|-----|-----|---|
| $V_{boot}$ | bootstrap diode forward drop voltage | $I = 5\text{ mA}$ | 1.3 | 1.7 | 2.1 | V |
|------------|--------------------------------------|-------------------|-----|-----|-----|---|

**Preheat current sensor****Input: pin PCS**

|          |                 |                          |      |      |      |               |
|----------|-----------------|--------------------------|------|------|------|---------------|
| $I_i$    | input current   | $V_{PCS} = 0.6\text{ V}$ | -    | -    | 1    | $\mu\text{A}$ |
| $V_{ph}$ | preheat voltage |                          | 0.57 | 0.60 | 0.63 | V             |

**Output: pin CSW**

|                        |                       |                          |     |    |    |               |
|------------------------|-----------------------|--------------------------|-----|----|----|---------------|
| $I_{O(\text{source})}$ | output source current | $V_{CSW} = 2.0\text{ V}$ | 9.0 | 10 | 11 | $\mu\text{A}$ |
| $I_{O(\text{sink})}$   | output sink current   | $V_{CSW} = 2.0\text{ V}$ | -   | 10 | -  | $\mu\text{A}$ |

**Adaptive non-overlap and capacitive mode detection; pin ACM**

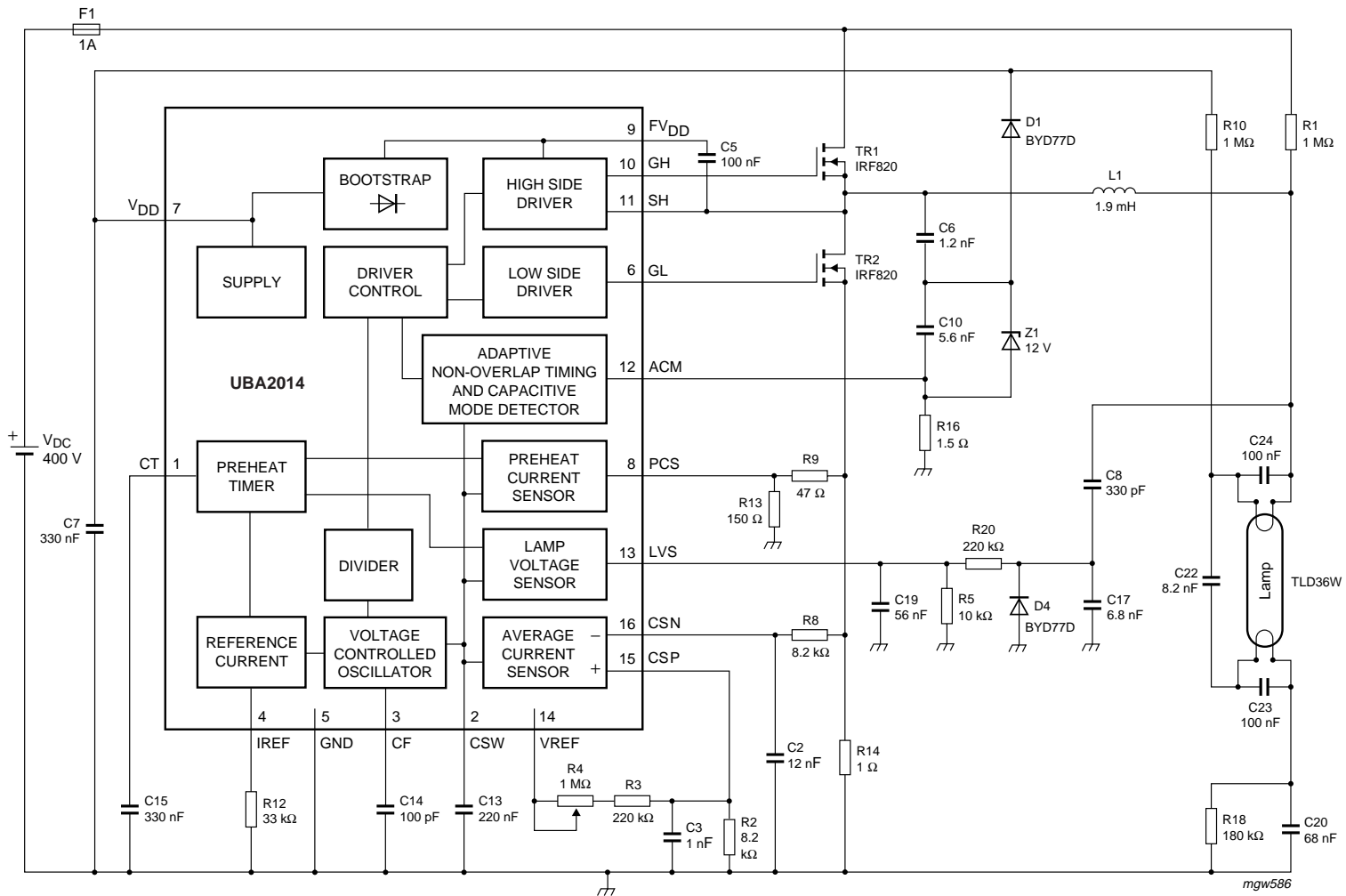
|            |  |                          |     |     |      |               |
|------------|--|--------------------------|-----|-----|------|---------------|
| $I_i$      | input current                              | $V_{ACM} = 0.6\text{ V}$ | -   | -   | 1    | $\mu\text{A}$ |
| $V_{CMDP}$ | positive capacitive mode detection voltage |                          | 80  | 100 | 120  | mV            |
| $V_{CMDN}$ | negative capacitive mode detection voltage |                          | -68 | -85 | -102 | mV            |

**Table 6. Characteristics ...continued**

$V_{DD} = 13\text{ V}$ ;  $V_{FVDD} - V_{SH} = 13\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; all voltages referenced to GND; see test circuit of [Figure 8](#); unless otherwise specified.

| Symbol                        | Parameter                      | Conditions   | Min  | Typ  | Max  | Unit             |
|-------------------------------|--------------------------------|--|------|------|------|------------------|
| <b>Lamp voltage sensor</b>    |                                |  |      |      |      |                  |
| Input: pin LVS                |                                |  |      |      |      |                  |
| $I_i$                         | input current                  | $V_{LVS} = 0.81\text{ V}$                                    | -    | -    | 1    | $\mu\text{A}$    |
| $V_{lamp(fail)}$              | lamp fail voltage              |  | 0.77 | 0.81 | 0.85 | V                |
| $V_{lamp(fail)(hys)}$         | lamp fail hysteresis voltage   |  | 119  | 144  | 169  | mV               |
| $V_{lamp(max)}$               | maximum lamp voltage           |  | 1.44 | 1.49 | 1.54 | V                |
| Output: pin CT                |                                |  |      |      |      |                  |
| $I_{o(sink)}$                 | output sink current            | $V_{CSW} = 2.0\text{ V}$                                     | 27   | 30   | 33   | $\mu\text{A}$    |
| $I_{o(source)}$               | ignition output source current | $V_{CSW} = 2.0\text{ V}$                                     | 9.0  | 10   | 11   | $\mu\text{A}$    |
| <b>Average current sensor</b> |                                |  |      |      |      |                  |
| Input: pins CSP and CSN       |                                |  |      |      |      |                  |
| $I_i$                         | input current                  | $V_{CS} = 0\text{ V}$  | -    | -    | 1    | $\mu\text{A}$    |
| $V_{offset}$                  | offset voltage                 | $V_{CSP} = V_{CSN} = 0\text{ V to } 2.5\text{ V}$            | -2   | 0    | +2   | mV               |
| $g_m$                         | transconductance               | $f = 1\text{ kHz}$   | 1900 | 3800 | 5700 | $\mu\text{A/mV}$ |
| Output: pin CSW               |                                |  |      |      |      |                  |
| $I_o$                         | output current                 | source and sink; $V_{CSW} = 2\text{ V}$                      | 85   | 95   | 105  | $\mu\text{A}$    |
| <b>Preheat timer; pin CT</b>  |                                |  |      |      |      |                  |
| $t_{ph}$                      | preheat time                   | $C_{CT} = 330\text{ nF}$ ;<br>$R_{IREF} = 33\text{ k}\Omega$ | 1.6  | 1.8  | 2.0  | s                |
| $t_{ign}$                     | ignition time                  | $C_{CT} = 330\text{ nF}$ ;<br>$R_{IREF} = 33\text{ k}\Omega$ | -    | 0.32 | -    | s                |
| $I_o$                         | 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                |
| $V_{hys}$                     | hysteresis voltage             |  | 2.05 | 2.20 | 2.35 | V                |

- [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, resulting in a maximum non-overlap time of 7.5  $\mu\text{s}$  at a bridge frequency of 40 kHz.



**Fig 8. Test and application circuit**

13. Package outline

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

SOT109-1

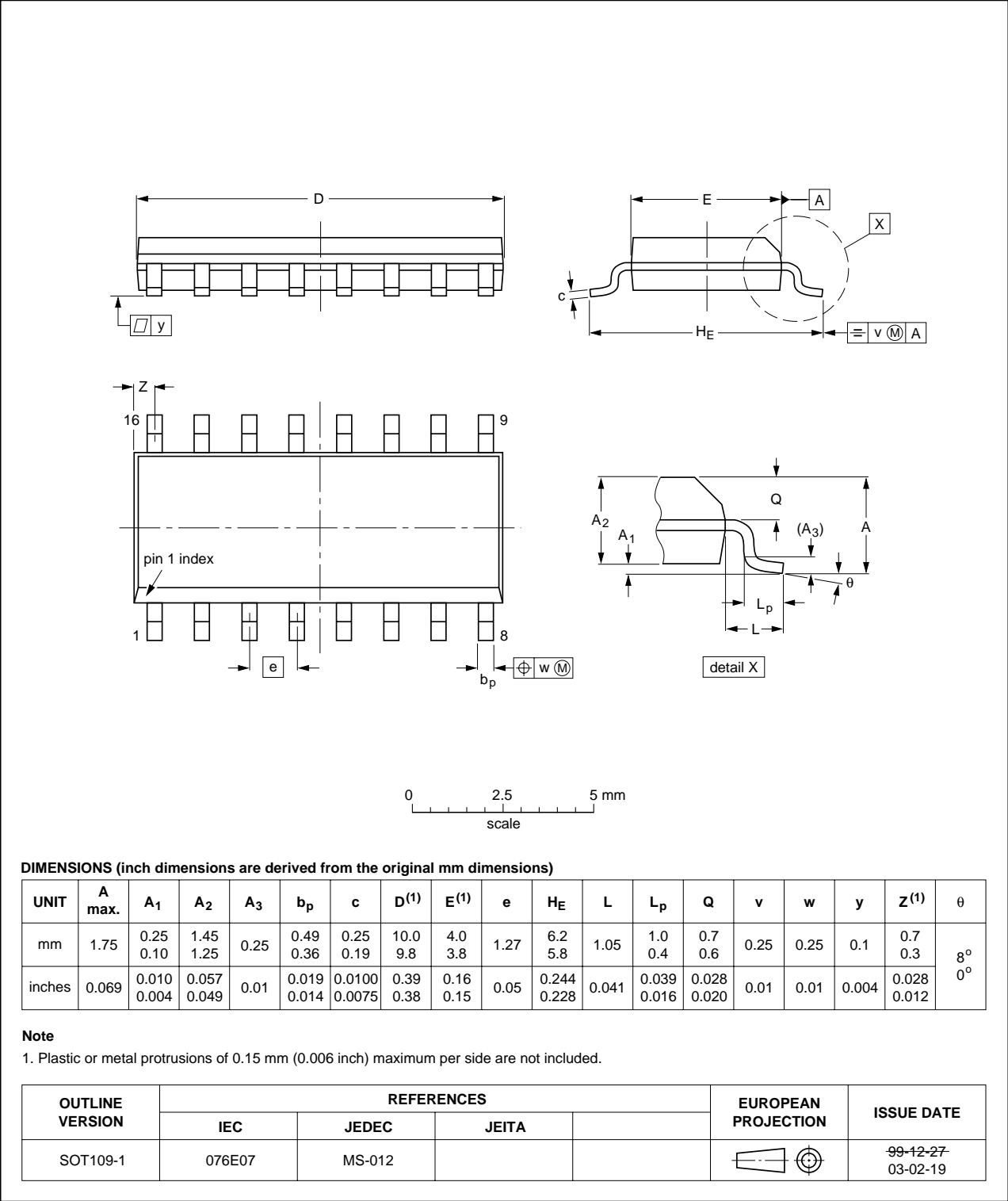
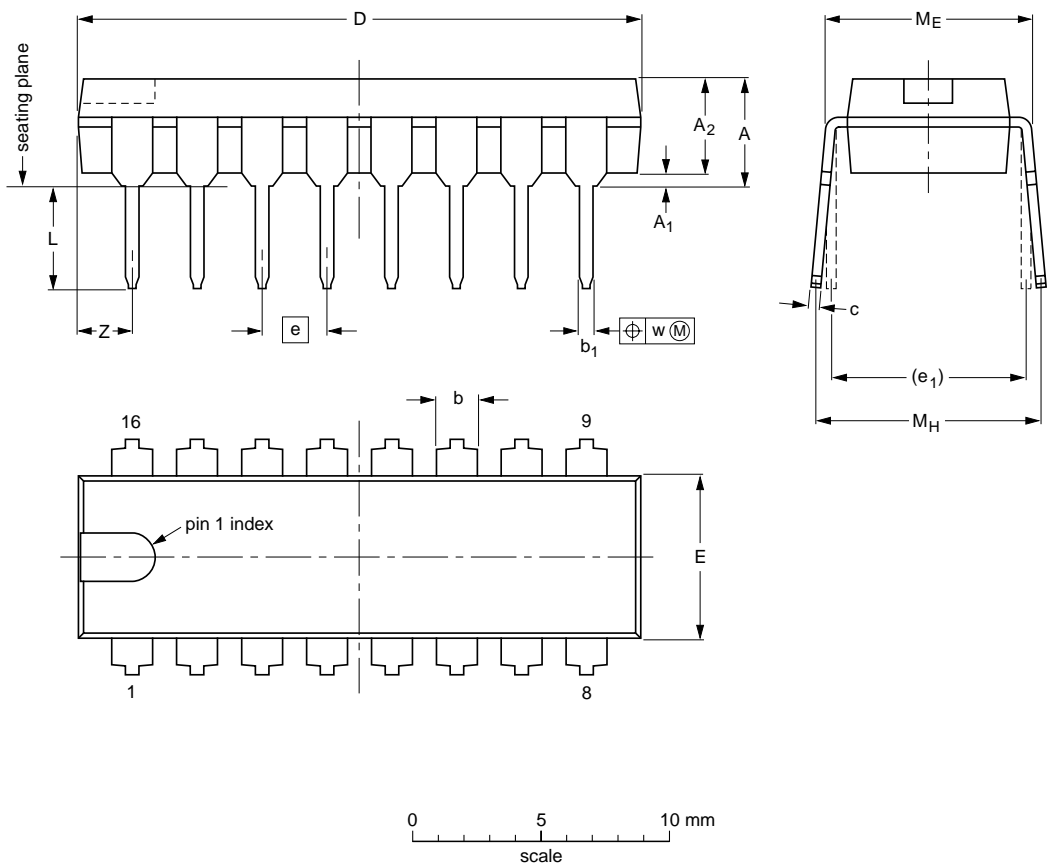


Fig 9. Package outline SOT109-1 (SO16)

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      | 0.02                   | 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     | 0.1  | 0.3            | 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 (0.01 inch) maximum per side are not included.

| OUTLINE<br>VERSION | REFERENCES |        |           |  | EUROPEAN<br>PROJECTION | ISSUE DATE           |
|--------------------|------------|--------|-----------|--|------------------------|----------------------|
|                    | IEC        | JEDEC  | JEITA     |  |                        |                      |
| SOT38-1            | 050G09     | MO-001 | SC-503-16 |  |                        | 99-12-27<br>03-02-13 |

Fig 10. Package outline SOT38-1 (DIP16)



## 14. Revision history

Table 7. Revision history

| Document ID    | Release date  | Data sheet status     | Change notice | Supersedes |
|----------------|---|-----------------------|---------------|------------|
| UBA2014_4      | 20081016  | Product data sheet    | -             | UBA2014_3  |
| Modifications: | <ul style="list-style-type: none"><li>• Max value for <math>V_{HS}</math> in <a href="#">Table 1</a> updated.</li><li>• Max value for <math>V_{HS}</math> in <a href="#">Table 4</a> updated.</li></ul> |                       |               |            |
| UBA2014_3      | 20080815  | Product data sheet    | -             | UBA2014_2  |
| UBA2014_2      | 20050912  | Product data sheet    | -             | UBA2014_1  |
| UBA2014_1      | 20020516  | Product specification | -             | -          |

## 15. Legal information

### 15.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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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