AN11187

UBA2015/UBA2017 saturating inductor support during ignition

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Document information

Info	Content
Keywords	UBA2015, UBA2017, saturating resonant tank inductor support
Abstract	This application note describes how to use a UBA2015/UBA2017 or in combination with a resonant tank inductor that saturates during lamp ignition. This application note also applies to the UBA2017 half-bridge controller IC without a PFC.

Revision history

Rev	Date	Description
v.1	20120816	first issue

Contact information

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1. Introduction

This application note describes how to use a UBA2015/UBA2017 in combination with a resonant tank inductor that saturates during lamp ignition.

The ignition voltage V_{ign} is applied to the lamp for time t_{ign} to ignite a fluorescent lamp. The V_{ign} voltage is much higher than the nominal operating voltage of the lamp.

Most lamp ballasts apply an open lamp voltage to the lamp connector during the ignition state. The open lamp voltage is applied for between 100 ms and 200 ms to ensure old and cold lamps ignite.

Some lamp ballasts use a saturating inductor during the ignition state to reduce the size and cost of this inductor.

The UBA2015/UBA2017 circuitry only supports saturation protection. The IC reduces the on-time of the low-side half-bridge transistor when the inductor saturates. However, the high voltage is not maintained over the total programmable ignition time-out period.

The UBA2015/UBA2017 can also be used to control inductor saturation during the ignition time-out period. The saturation is controlled during the programmable ignition time-out period. This function requires an extra circuit that connects to the CF pin capacitor. This extra circuit is explained in this application note.

Remark: Unless otherwise stated, all voltages are typical values.

1.1 Features

- Operating the resonant tank inductor in saturation
- Regulation is adjustable for several saturation levels

2. Circuit Diagram

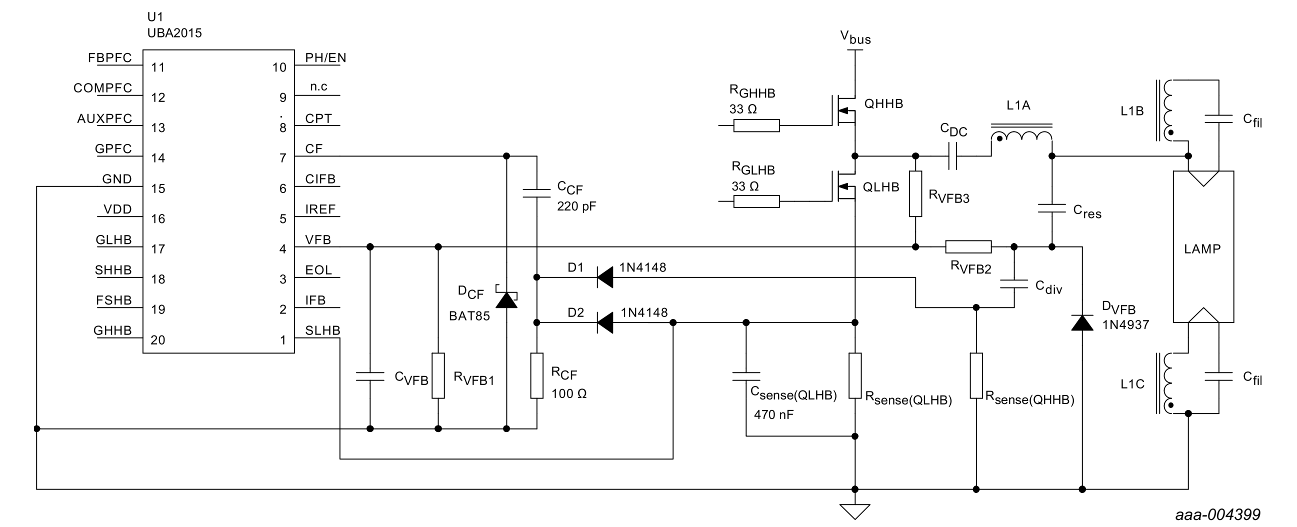

Fig 1. Circuit to support inductor saturation

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The additional parts for inductor saturation regulation are: D_{CF}, D1, D2, R_{CF}, $R_{sense(QLHB)}$ and $C_{sense(QLHB)}$. To reduce the sense resistor values, Schottky diodes can be used on positions D1 and D2.

2.1 Extended Bill of Materials

Table 1. Extended Bill of Materials

Part reference	Description
C_{CF}	UBA2015/UBA2017 oscillator frequency setting
C_{DC}	DC blocking capacitor
C_{div}	capacitive lamp voltage divider
$C_{sense(QLHB)}$	filter capacitor to remove hard switching spikes
C_{res}	resonance capacitor
D1	increases V_{CF} when the L1A inductor saturates and QHHB is on
D2	increases V_{CF} when the L1A inductor saturates and QLHB is on
D_{CF}	CF pin protection against negative voltages
D_{VFB}	clamping diode to ground
L1A	resonant tank inductor
L1B; L1C	inductor L1 windings for heating the filaments
R_{CF}	provide impedance to lift V_{CF}
R_{GHHB}; R_{GLHB}	MOSFET gate damping resistors
$R_{sense(QHHB)}$	inductor current sense resistor when QHHB is on
$R_{sense(QLHB)}$	inductor current sense resistor when QLHB is on
R_{VFB1}; R_{VFB2}	resistor divider VFB pin voltage
R_{VFB3}	VFB pin voltage offset

3. Operation and Performance

At the end of the preheat state, the half-bridge frequency is swept down by increasing the voltage on the VCO input (pin CIFB). The current in the inductor increases during the sweep and the inductor starts to saturate.

Figure 2 shows the first ignition attempt and a small part of the second and final ignition attempt. The resonance capacitor C_{res} integrates the current waveform to generate the ignition voltage.

Figure 2 shows the CF pin voltage on channel C4. When saturation pulses are present, the CF pin voltage is increased because of the signal injected by diodes D1 or D2. Each time the CF pin reaches 2.5 V, the active MOSFET is switched off.

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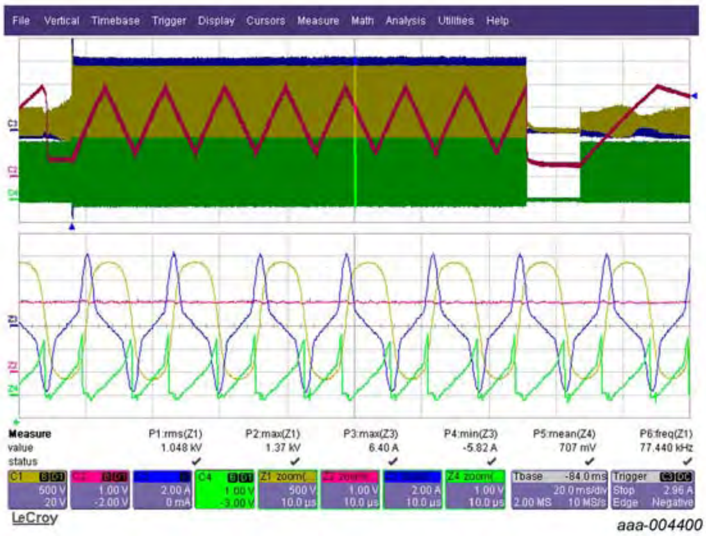

(1) C1=V_{Cres}.

(1) C2 = V_{CPT}.

(1) C3 = I_{L1A}.

(1) C4 = V_{CF}.

Fig 2. First ignition attempt: lamp voltage, inductor current, CPT timer, CF pin voltage

Figure 2 shows the fault timer counting on channel C2. The VFB pin activates counting and is necessary to shut down the ballast in case no lamp is present.

The fault timer is activated using the VFB pin under the following circumstances:

- In the ignition state: when the VFB voltage is > $V_{th(ov)(VFB)}$ = 2.5 V and < $V_{th(ovextra)(VFB)}$ = 3.35 V.
- In burn state after flow detection = V_{CIFB} = 3.0 V: when the VFB voltage > $V_{th(oveol)(VFB)}$ > 880 mV (DIM pin left open, UBA2015A only) and < $V_{th(ovextra)(VFB)}$ = 3.35 V

In addition, the voltage feedback stabilizes the voltage increase on the CIFB pin. Figure 3 shows the CIFB pin voltage on channel 4. The CIFB voltage sets the operating frequency. However during saturation, the operating frequency is higher than set because the MOSFET on-time is reduced by triggering the CF threshold voltage $V_{th(CF)}$ at 2.5 volts.

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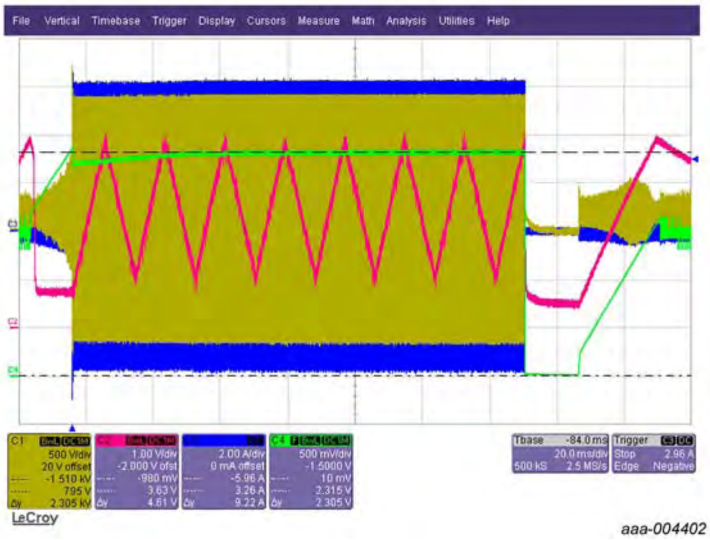

(1) C1=V_{Cres}.

(2) C2 = V_{CPT}.

(3) C3 = I_{L1A}.

(4) C4 = V_{CIFB}.

Fig 3. First ignition attempt: lamp voltage, inductor current, CPT timer, CIFB pin voltage

4. Step-by-step guide

The goal is to set the sense resistors for the correct open lamp voltage during an open lamp test.

1. Start with sense resistors $R_{sense(QHHB)}$ and $R_{sense(QLHB)}$ at 1 Ω. Keep $R_{sense(QHHB)}$ equal to $R_{sense(QLHB)}$).
2. Measure the open lamp voltage during ignition.
3. If the open lamp voltage is too low, reduce the value of $R_{sense(QHHB)}$ and $R_{sense(QLHB)}$. Then go to step 2.
4. If the open lamp voltage is too high, increase the value of $R_{sense(QHHB)}$ and $R_{sense(QLHB)}$. Then go to step 2.
5. Open lamp voltage is ok, $R_{sense(QHHB)}$ and $R_{sense(QLHB)}$. are correct.

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5. Simplified circuit

It is possible to operate a saturating inductor with a smaller circuit for some ballast (large CIFB capacitor, non-dimmable).

Remark: Test only using $R_{sense(QLHB)}$ for inductor saturation regulation, do not mount $R_{sense(QHHB)}$, D1 or D_{CF}. The $R_{sense(QLHB)}$ value obtained is higher compared to Figure 1.

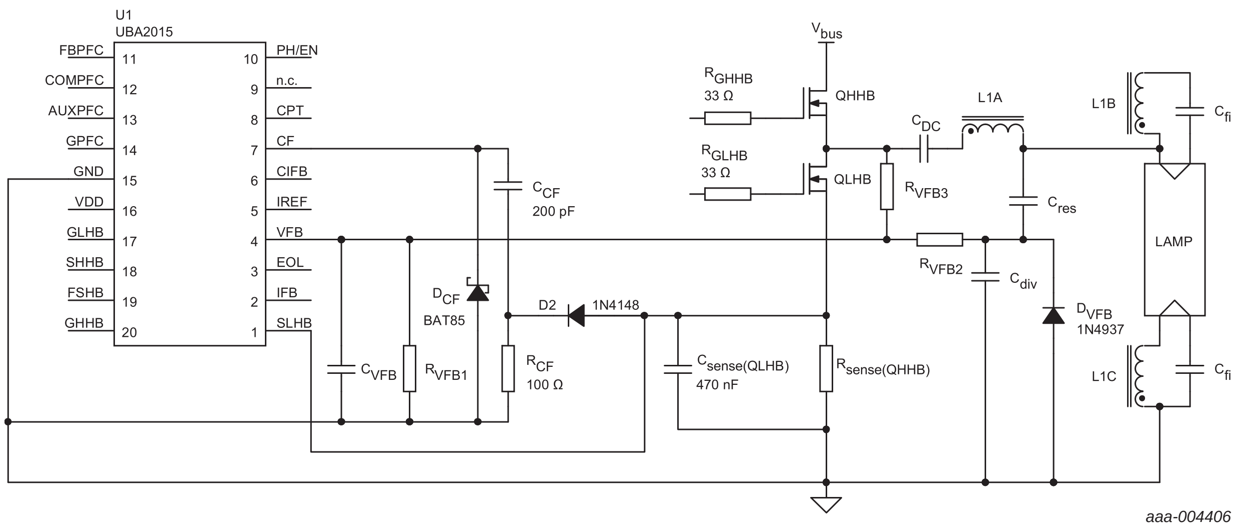

Fig 4. Simplified circuit to support inductor saturation

6. Star ground configuration

The UBA2015/UBA2017 is subjected to large disturbances because of the high peak current during saturation. These disturbances are caused when the half-bridge switching node has commuted to the bus voltage V_{bus}.

Place the star ground near the GND pin (15) of the UBA2015 to minimize the common impedance of the ground tracks.

Route the bus voltage next to the ground between the bus capacitor C11 and half-bridge MOSFETs to minimize the magnetic field of the high di/dt signal.

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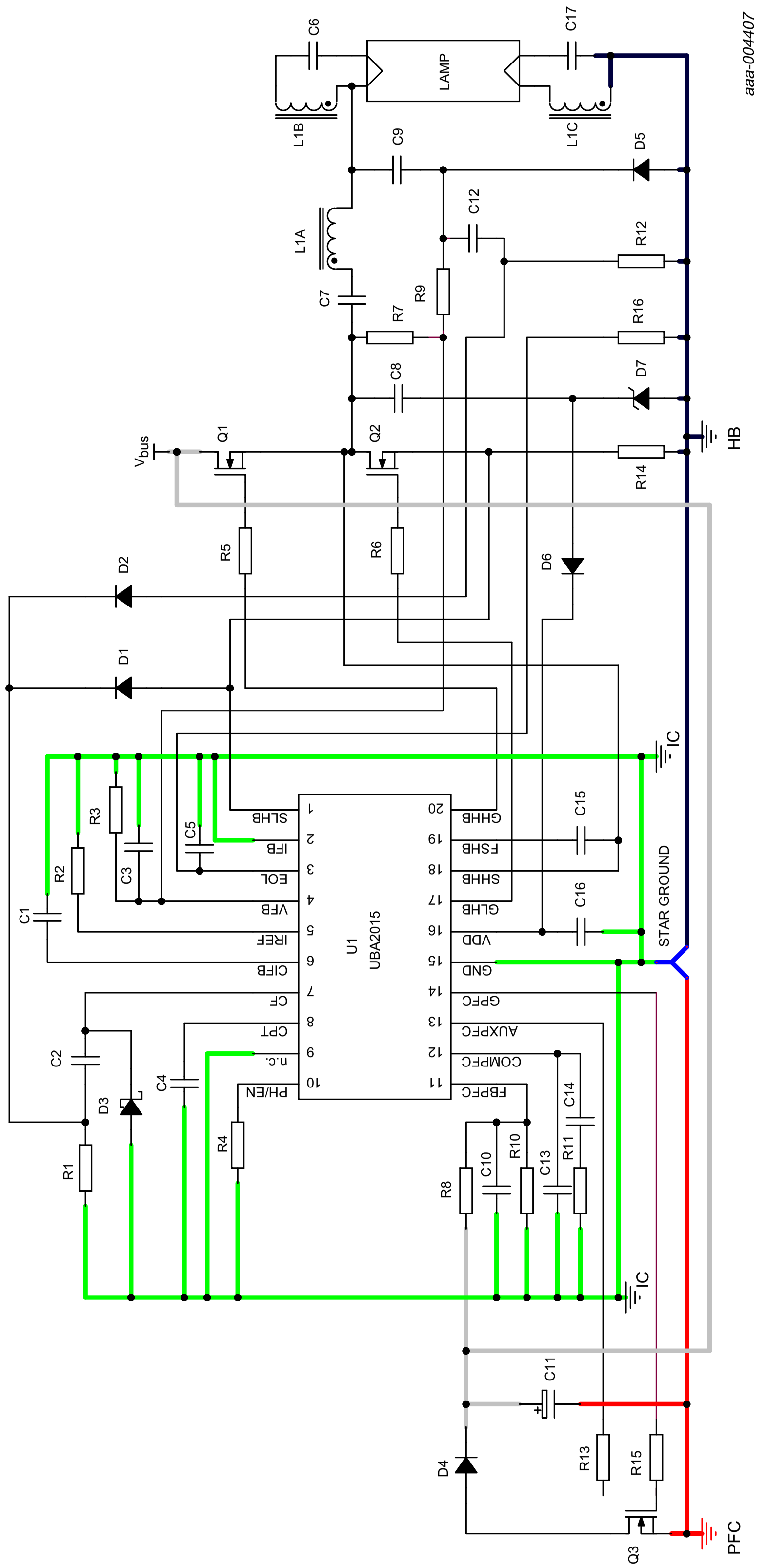

Fig 5. Star ground example to indicate board layout set-up

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7. References

[1] **UBA2016A/15/15A —** 600 V fluorescent lamp driver with PFC, linear dimming and boost function

[2] **UBA2017/UBA2017A —** 600 V fluorescent lamp driver with linear dimming function

[3] **AN10958 —** Fluorescent lamp driver with PFC using the UBA2015/16 family

[4] **UM10359 —** UBA2016AT demo board 1 × 28 W dim and boost

[5] **UM10438 —** UBA2015AP evaluation board 1 × 35 W T5 dimmable 120 V (AC)

[6] **UM10440 —** UBA2015AT reference design 2 × 35 W T5 dimmable 230 V (AC)

[7] **UM10466 —** UBA2015P reference design 2 × 35 W T5 non-dimmable 230 V (AC)

[8] **UM10486 —** UBA2015P reference design 2 × 35 W T5 non-dimmable 120 V (AC)

[9] **UM10561 —** UBA2017AT reference design for 420 V (DC)

[10] **UM10564 —** UBA2017DB1064 2 x 28 W T5 demo board

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