UM10504

UBA2213 demo board for 230 V 7 W CFL

Rev. 1 — 9 February 2012 **User manual**

Document information

Info	Content
Keywords	UBA2213, Demo board, CFL, Boost
Abstract	The UBA2213 family of integrated circuits is a range of high-voltage monolithic ICs for driving Compact Fluorescent Lamps (CFL) in half-bridge configuration.

Revision history

Rev	Date	Description
v.1	20120209	draft

Contact information

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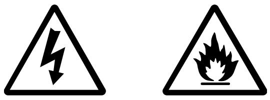
1. Introduction

WARNING

Lethal voltage and fire ignition hazard



The non-insulated high voltages that are present when operating this product, constitute a risk of electric shock, personal injury, death and/or ignition of fire.

This product is intended for evaluation purposes only. It shall be operated in a designated test area by personnel qualified according to local requirements and labor laws to work with non-insulated mains voltages and high-voltage circuits. This product shall never be operated unattended.

The UBA2213 family of integrated circuits is a range of high-voltage monolithic ICs for driving Compact Fluorescent Lamps (CFL) in half-bridge configuration. It derived from UBA2211 with boost feature, which could boost the lamp current in a certain time after ignition and results in a fast warm-up.

Run-up time is one of the key requirements for CFL. Run-up is the time measurement from lamp-on until the 80 % light output is reached. If high temperature amalgam burners are used, or the lamp is ignited in cold-weather run-up time are long. The UBA2213 is designed for both indoor and outdoor applications.

In addition to the boost feature, the UBA2213 has integrated other features for a CFL including:

- Preheat current control
- RMS current control
- Saturation Current Protection (SCP)
- OverTemperature Protection (OTP)
- Capacitor Mode Protection (CMP)

This user manual is intended for 230 V applications of a 7 W demo board based on UBA2213AT. Ref. 1 provides additional information on the UBA2213.

2. Specification

The UBA2213B demo boards are set up to drive a 7 W burner. The specification is as follows:

Mains Input:

- AC line input voltage: 170 V (AC) to 254 V (AC)

Remark: Board optimized for 230 V (AC) 50 Hz.

Steady state:

- Lamp voltage: 56 V
- Lamp current: 100 mA
- Working frequency: 42 kHz
- Power Factor (PF): > 0.58

Remark: Values measured at 230 V (AC) mains, Baishi T2 7 W burner. See Table 1

Preheat state:

- Preheat current: 340 mA
- Preheat time: 1.1 s

Remark: constant preheat current at 170 V (AC) to 230 V (AC). See Table 1.

Boost state:

- Lamp current: 160 mA
- Boost time: 50 s
- Transition time (boost > RMS): 0.5 s

Remark: Measured at 230 V (AC) mains. see Figure 5 and Table 1

3. Circuit diagram

Figure 1 shows a typical application circuit diagram.

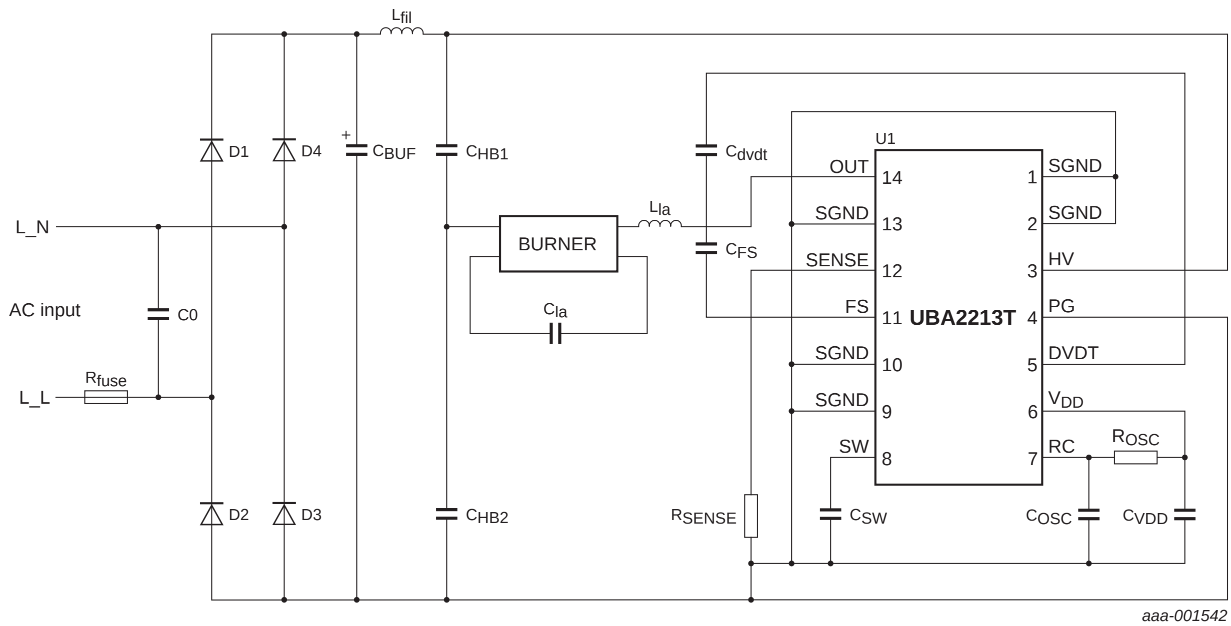


Fig 1. Typical UBA2213 application circuit for a CFL

4. Applications

Figure 2 shows a typical 7 W CFL application using the UBA2213

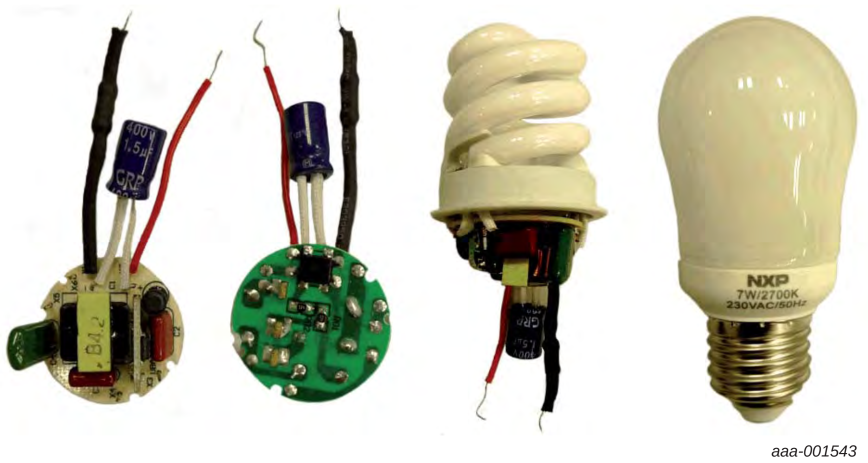


Fig 2. 7 W UBA2213 CFL application

5. Circuit description

The 7 W demo board is based on the UBA2213 IC. The demo board has all the necessary functions to operate CFL lamps efficiently including preheat, ignition, boost and on-state operation. Several protection features safeguard the correct functioning of the CFL and controller. Figure 3 shows the typical timing of the system. Each phase is identical as for the UBA2211 except for the inserted boost state.

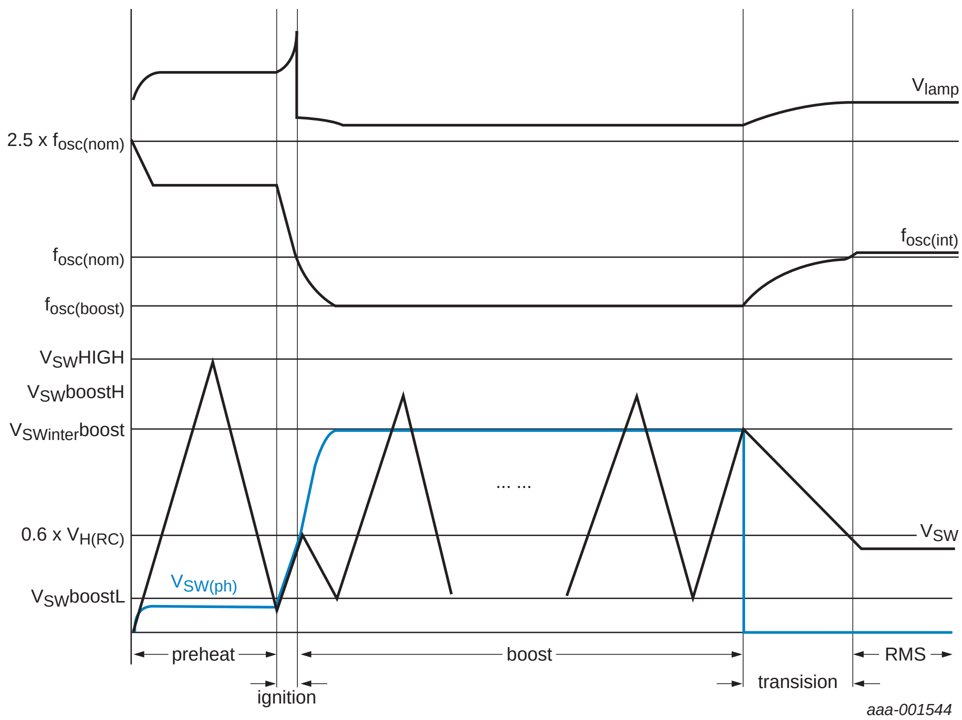


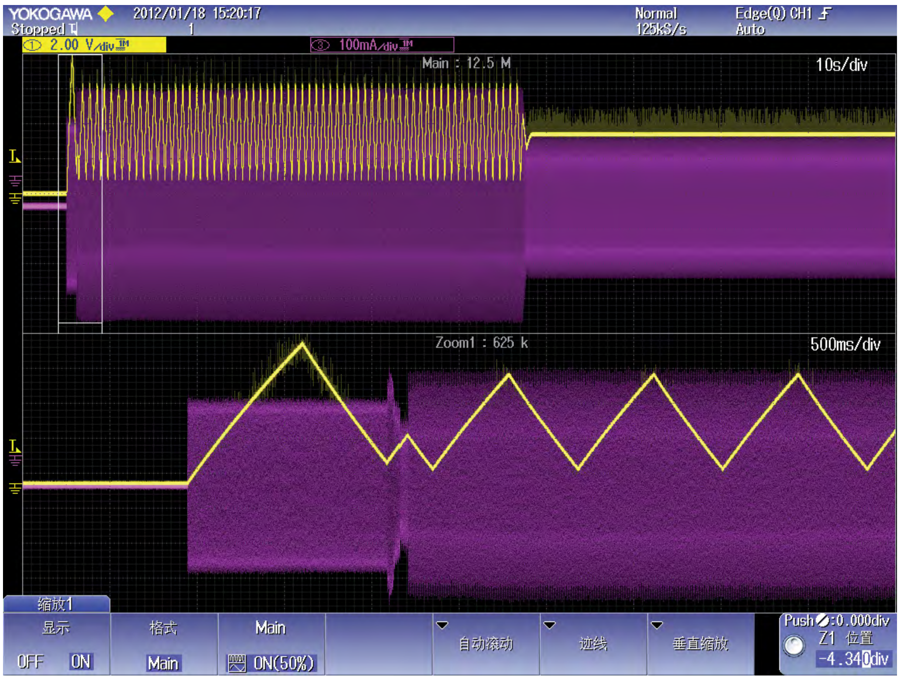
Fig 3. Application timing sequence

During preheat, SW sweeps for preheat timing, when preheat time ends SW and preheat-out are short together and lift to 0.6 × VH(RC). As a result, frequency sweeping crosses the resonant frequency and ignites the lamp. After ignition, the SW voltage sweeps up and down for boost timing, boost ends after 63 cycles of SW sweeping. SW then sweeps down to 3 V for RMS frequency control.

Boost time and transition time are related to preheat time, this means C_{SW} determines preheat time, boost time and transition time. The current source for charging/discharging SW for boost timing is 1.4 mA and 300 nA for discharging SW during transition. Preheat-out voltage, $V_{SW(ph)}$ see Figure 3 determines the preheat and boost frequency separately for preheat and boost stages.

6. Measured results

Figure 4 and Figure 5 show the measured results using a typical 7 W lamp. The results show that the boost effect is clearly visible when the light is on. This state is true for the same lamp types without the boost feature. Figure 4 and Figure 5 waveforms show the states after power-on. where preheat, ignition, boost, transition and RMS stage can be seen. The preheat and transition stages are zoomed (lower trace) for clarity.



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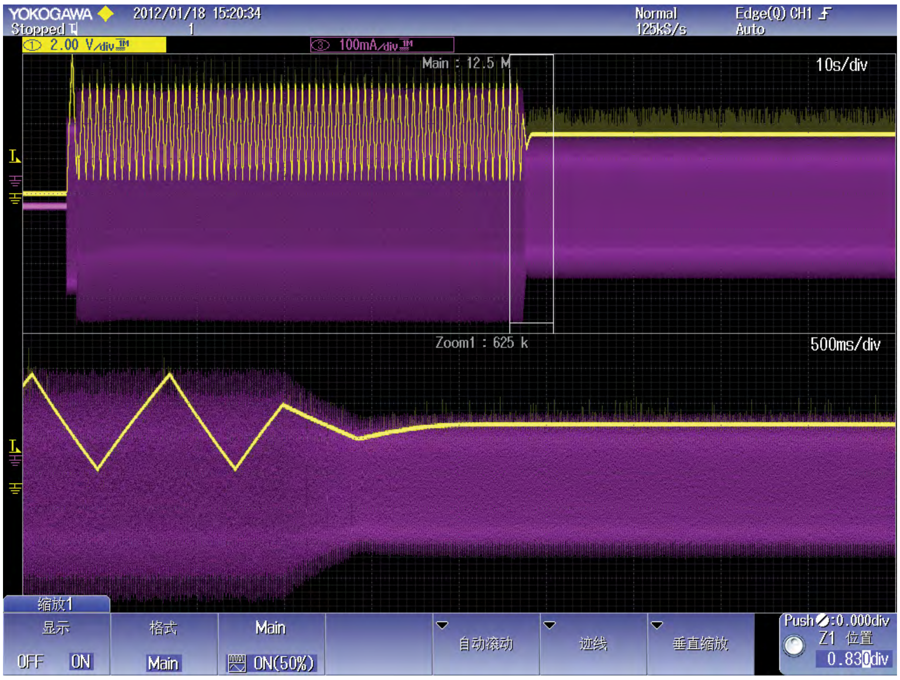
(1) Green: SW signal timing for preheat, boost and transition

(2) Dark blue: HB current, also preheat current at preheat stage

Fig 4. Time sequence for a boost lamp with preheat stage (zoomed out)



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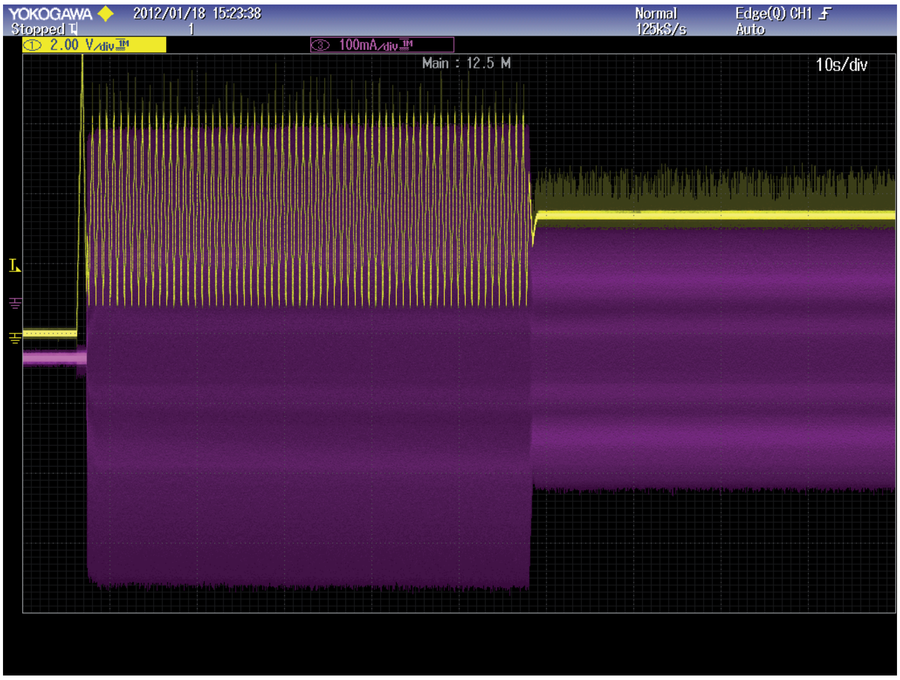
(1) Green: SW signal timing for preheat, boost and transition

(2) Dark blue: HB current, also preheat current at preheat stage

Fig 5. Time sequence for a boost lamp with boost to RMS transition (zoomed out)

Figure 6 shows the lamp discharge current and the boost lamp current. During normal operation, the boost current is 1.8 × the lamp current. The light output measurement shown in Figure 7 proves the effectiveness of the boost. A 7 W amalgam lamp was used for the measurements.



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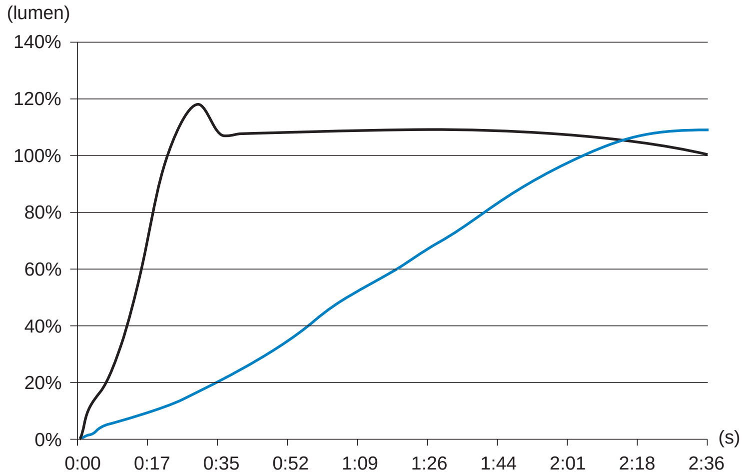
(1) Green: SW signal

(2) Dark blue: Lamp current

Fig 6. Boost lamp current measurement

Figure 7 shows the measured light output versus time, boost and non-boost based on 12 W amalgam lamp. Figure 7 shows that lumen run-up is faster with boost then without.



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(1) Dark curve: Lumen run-up with boost (boost ratio 1.8)

(2) Blue curve: Non-boost (boost ratio 1)

Fig 7. Lumen output versus time, boost and non-boost

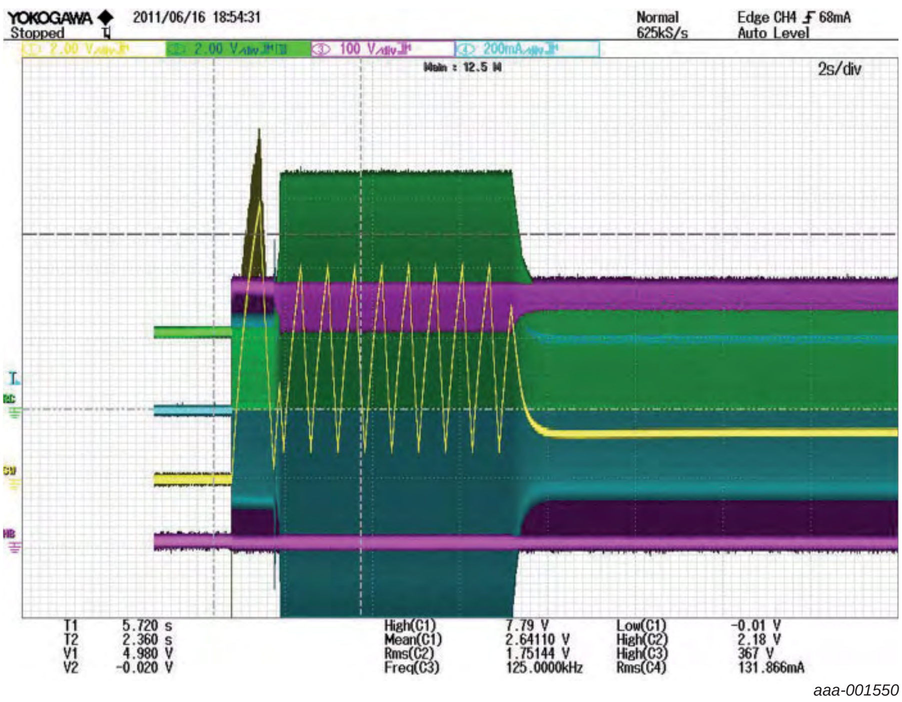
Electrical parameters measured are listed in Table 1

Table 1. Electric parameters 7 W boost lamp (UBA2213AT)

Pin (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)
6.3	0.609	56	100	90	139	5.6	42	1.1	340
8.4	0.645	45	160	70	185	7.2	27	-	-

The boost feature helps to reach a fast run-up time. When a hot lamp is used, boost is not normally required however, under some circumstances boost is required for a short duration. Considering the working temperature of most amalgam lamps and the UBA2213, set the boost overtemperature ($T_{boost(OTP)}$). The IC detects the die temperature and ends the boost state when the temperature is above the trigger. The lamp then switches directly to the RMS stage.

Figure 8 shows the results of measurements where the lamps remained burning for long periods where a high mains input of 270 V was used. Switching the lamp off and on quickly showed that the lamp transition to RMS took about 5 s of boost because of triggering the boost OTP. From the measured waveform in Figure 8, SW took 8 cycles where normally SW sweeps 63 cycles if no OTP occurs.



(1) Yellow: SW signal

(2) Green: RC signal

(3) Dark blue: HB current

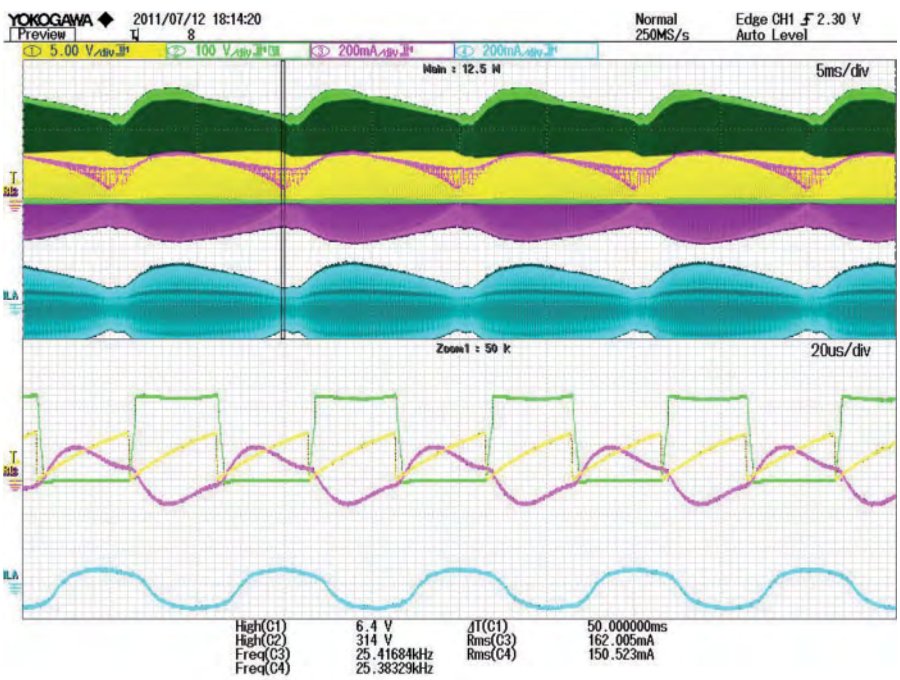
(4) Purple: HB voltage

Fig 8. Boost OTP triggered

7. Boost lamp with high lamp voltage

Lamps consume more power during the boost stage, as a result the half-bridge voltage valley value is pulled low and capacitive mode/hard-switch is started. This condition is true when a lamp with a high lamp voltage used for low mains input. The UBA2213 detects switch operation through an internal active Zero-Voltage Switching (ZVS) control circuit to prevent stress on MOSFETs.

In capacitive mode, the internal current source discharges the internal capacitor. As a result, the preheat-out voltage is lower and the preheat-out controlled boost frequency voltage increases. This condition continues until the system moves to the border of ZVS. Figure 9 shows the CMP response at boost stage.



(1) Yellow: RC signal

(2) Green: half-bridge voltage

(3) Blue: lamp current

(4) Purple: half-bridge current

Fig 9. Capacitor mode at boost stage

Figure 9 shows that the RC peak value decreases (frequency increase) at the lowest half-bridge voltage valley and increases at a higher half-bridge voltage. In addition, due to CMP, the boost frequency is not at the lowest boost frequency. As a consequence the boost ratio, boosted lamp current to RMS lamp current is lower.

Where a significant boost effect is required some system parameters need adjusted. For example, a bigger lamp capacitor alleviates capacitive mode resulting in a higher boost ratio. However, this leads to a large filament current which leads to low-power efficiency and a narrower RMS operation range.

8. Ratio of preheat current and RMS current

Resistor R_{SENSE} set the preheat current and steady state half-bridge (lamp) currents. The result is the ratio between these two currents is fixed at 1.2 which is ideal for most burners. However, for an extended burner, adding resistor (R_{SW}) across C_{SW} extends the ratio. Table 2 lists the typical settings. To prevent malfunctioning of the preheat timer, do not use a resistor smaller than 10 MΩ.

A resistor connected between V_{DD} and SW would result in a smaller ratio between preheat current and RMS current.

Table 2. Typical ratio setting of $I_{preheat}/I_{RMS}$

R_{SW} (MΩ)	I_{ph}/I_{RMS}
none	1.2
25	1.3
20	1.4
15	1.5
11	1.7

However, R_{SW} has impact on boost and transition time, for instance when R_{SW} shunt with C_{SW}:

For preheat and boost time: T with R_{SW} / T without R_{SW} = $1 / (1-\times^2)$

Where × equals to the ratio of external current source and internal current source, external current source is roughly:

$I_{external} = (V_{high}+V_{low})/(2 \times R_{SW})$

Where, V_{high} and V_{low} are the high and low limit of the sawtooth signal.

For transition time: T with R_{SW} / T without R_{SW} = $1 / (1+\times)$

Where, C_{SW} = 100 nF and R_{SW} is 10 MΩ, preheat time is increased from 1.6 s to 2.47 s. In addition, boost time increases from 1.11 s/cycles to 1.37 s/cycles. Transition time is decreased from 1.08 s to 0.42 s.

9. OverTemperature Protection (OTP)

OTP is active in all states. When the die temperature has reached the OTP trigger level, the oscillator is stopped. As a result, LS switch remains in the on-state and HS switch remains off.

Inductor energy can now resonate and damp out gradually. As the oscillator is stopped, the dV/dt supply current is not generated. The V_{DD} voltage now gradually decreases and the start-up state is entered when $V_{DD} < V_{DD(stop)}$. The OTP is reset when $T < OTP_{reset}$.

(1) V_{HB}

(2) I_l

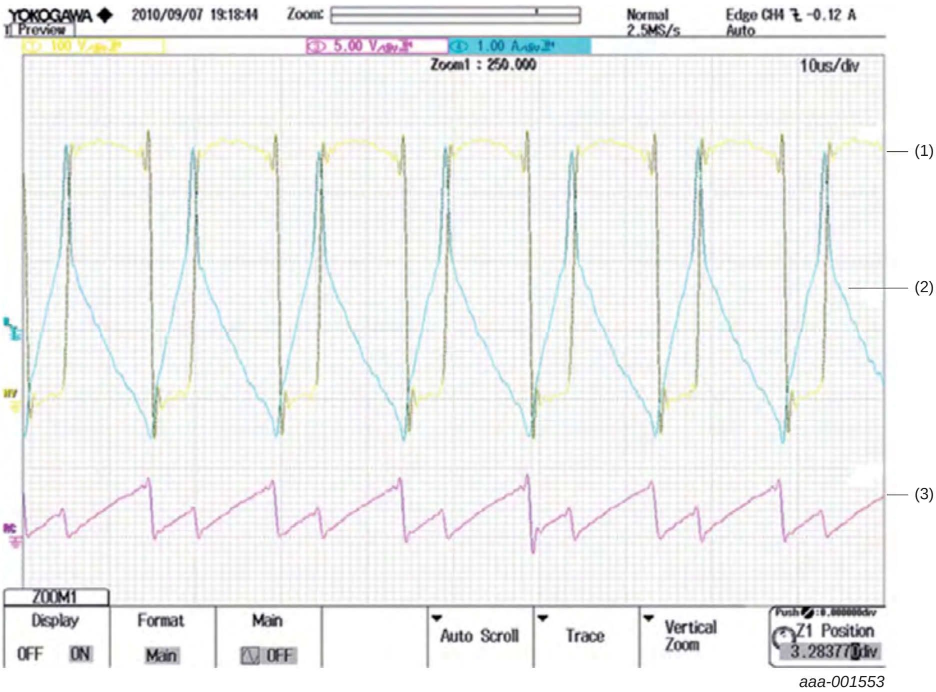
(3) V_{RC}

Fig 10. OTP function

10. Saturation Current Protection (SCP)

A critical parameter in the design of the lamp inductor is its saturation current. Saturation of the lamp inductor occurs in cost effective and miniaturized CFLs. The UBA2213 internally monitors the power transistor current. When this current exceeds the capability of the internal half-bridge power transistors, their conduction time is reduced. As a result, the application balances itself on the edge of the current capability of the internal power switches.

Figure 11 shows the SCP in a real application using a saturated inductor. Due to this saturation control the burner can ignite despite the inductor saturating effect. However, when the same parameters were setup with an IC without this protection function the IC failed during the ignition.



(1) V_{HB}
(2) I_{l}
(3) V_{RC}

Fig 11. IC results with saturated inductor at ignition

11. Capacitive Mode Protection (CMP)

UBA2213 detects switch operation through an internal active ZVS control circuit and prevents stress on MOSFETs.

When capacitive mode is detected, the C_{SW} capacitor is discharged and the frequency is increased. The system moves to the border of ZVS. CMP is active in the ignition and steady state (see Figure 12).

(1) V_{HB}

(2) I_l

(3) V_{RC}

Fig 12. CMP at RMS state

12. Bill of Materials (BOM)

The BOM for the 230 V reference board is shown in Table 3

Table 3. BOM UBA2213 demo board (SO14)

Reference	Component	Package	Remarks
R_{fuse}			
D1, D2, D3, D4	M7		
C1	2.7 μF; 400 V; 105 °C; 10 × 16		C_{BUF}
C5	10 nF; 50 V; 0805		C_{FS}
C6	100 nF; 50 V; 0805		C_{SW}
C7	220 pF; 50 V; 0805		C_{osc}
C8	100 nF; 50 V; 0805		C_{VDD}
C9	220 pF; 500 V: 0805		C_{dvdt}
C0, C2, C3	100 nF; 400 V: CL21		C0, C_{HB1}, C_{HB2}
C4	2.2 nF; 1 KV; CBB28		C_{la}
L1	LGB 3 mH		L_{fil}
L2	3 mH; EE13; PC40		L_{la}
R1	100 kΩ; 1 %; 0805		R_{OSC}

Table 3. BOM UBA2213 demo board (SO14)

Reference	Component	Package	Remarks
R2	1.8 Ω;1 W; 1 %		R_{SENSE}
PCB	UBA2213-1; UBA2213-8		
IC	UBA2213BT		
Burner	3U-12W; 2700 k		

13. PCB layout

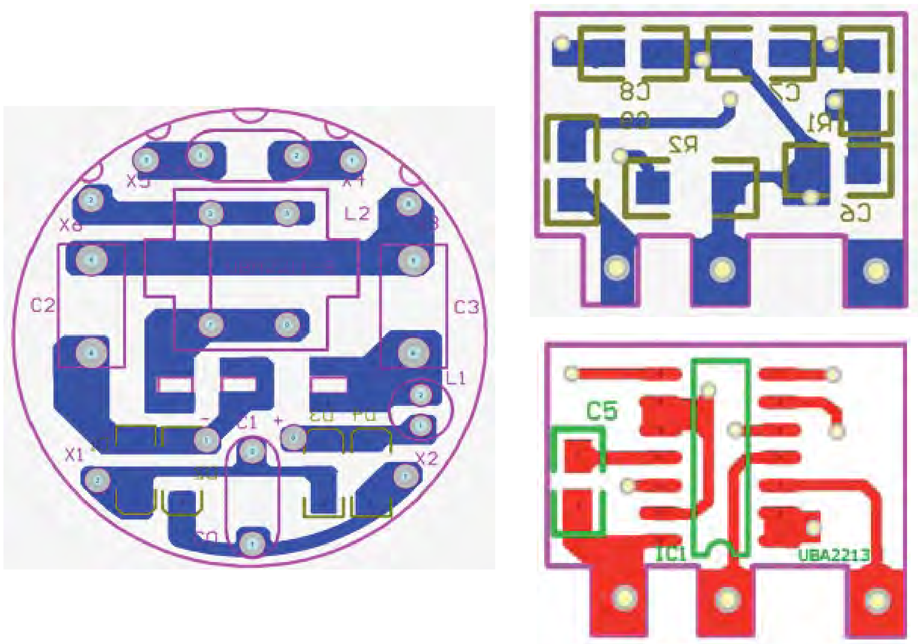


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Fig 13. Mother and daughter PCB boards

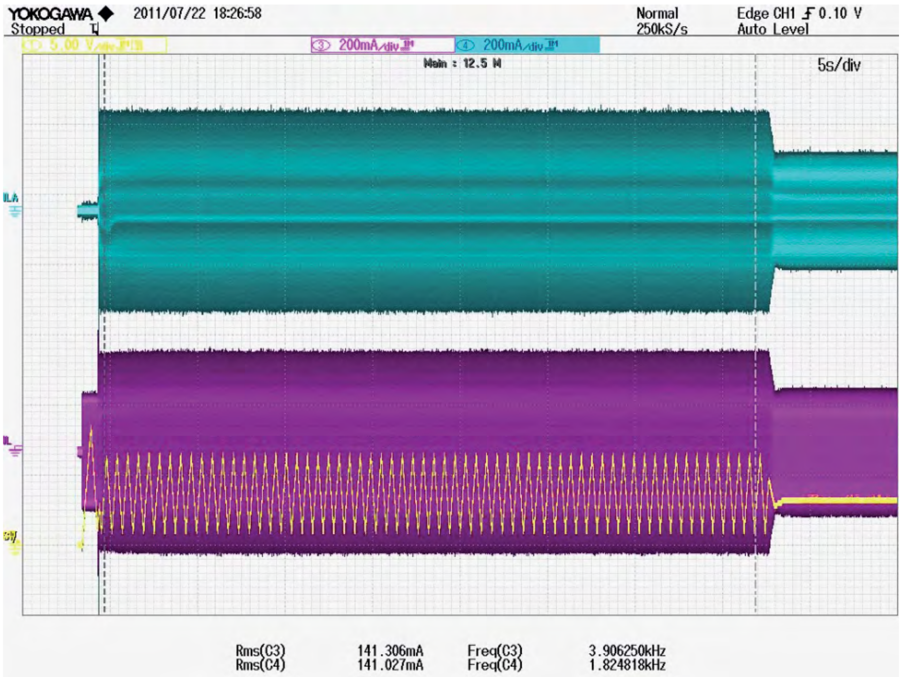
14. Lamp measurements

Other amalgam lamps were measured in the laboratory including 5 W, 8 W, 11 W, 15 W and 20 W. The results of these measurements including the component lists, start-up-to-burn scope graphic and electrical parameters are detailed in Section 14.1 to Section 14.10.

14.1 5 W Spiral lamp

Table 4. 5 W Spiral lamp (UBA2213AT N1B)

V_{IN} (V)	I_l (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	32	5	0.66	49	90	30	95	4.3	43	0.8	102		
	42	6.8	0.68	42	142	18	142	5.6	27	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 14. 5 W Spiral lamp measurements

Table 5. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	3.0 Ω	1
8	C_{lamp}	2.2 nF	1
9	L_{lamp}	5 mH	1
10	C_{HB}	100 nF	2

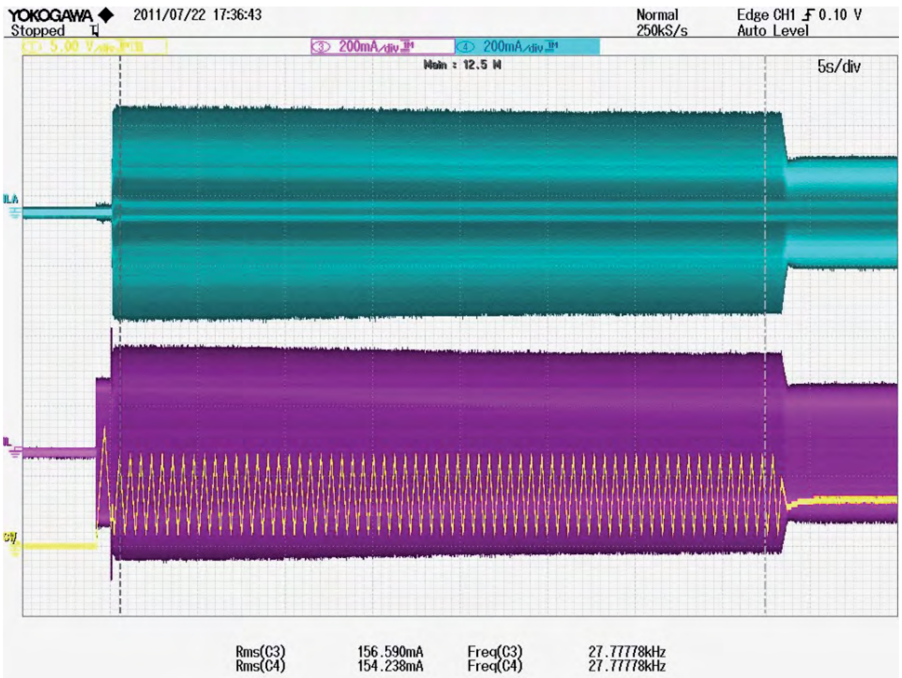
Table 5. Component list

No	Part	Value	Remarks
11	E_{lcap}	1 µF	1
12	R_{fuse}	10 Ω	1
13	Burner	5 W, spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213AT	1
16	Connector		2

14.2 8 W Spiral lamp

Table 6. 8 W Spiral lamp (UBA2213BT N1B)

V_{IN} (V)	I_l (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	58	8.6	0.63	77	96	57	114	7.3	43.2	0.8	129		
	66	10	0.65	54.5	158	30	160	8.2	27	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 15. 8 W Spiral lamp measurements

Table 7. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	2.4 Ω	1
8	C_{lamp}	2.7 nF	1
9	L_{lamp}	4.5 mH	1
10	C_{HB}	100 nF	2
11	E_{lcap}	2.2 µF	1
12	R_{fuse}	10 Ω	1
13	Burner	8 W, spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213BT	1
16	Connector		2

14.3 11 W 3U lamp

Table 8. 11 W 3U lamp (UBA2213BT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	74	11.5	0.67	86.7	119	64	139	10.2	43.5	0.8	187		
	85	13.5	0.68	66.8	187	34	192	11.8	27	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		

(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 16. 11 W 3U lamp measurements

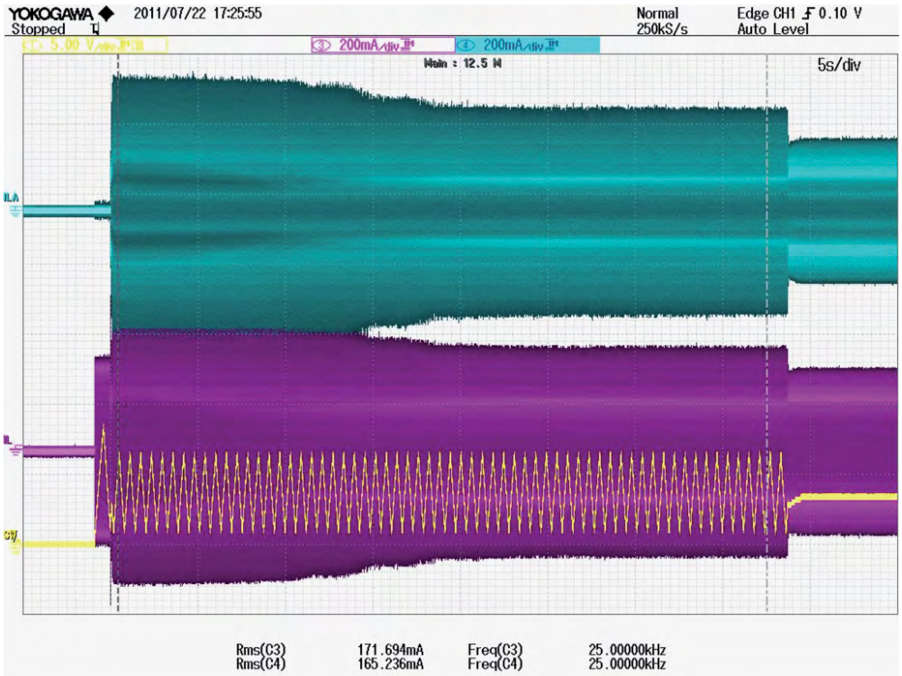
Table 9. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.8 Ω	1
8	C_{lamp}	2.7 nF	1
9	L_{lamp}	3.5 mH	1
10	C_{HB}	100 nF	2
11	E_{lcap}	2.2 μF	1
12	R_{fuse}	10 Ω	1
13	Burner	11 W, 3U	1
14	L_{fil}	1 mH	1
15	IC	UBA2213BT	1
16	Connector		2

14.4 12 W Spiral lamp

Table 10. 12 W Spiral lamp (UBA2213BT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	76	11.7	0.67	89	119	65	137	10.3	43	0.8	165		
	85	13.5	0.68	75	174	41	179	11.9	28	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 17. 12 W Spiral lamp measurements

Table 11. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.8 Ω	1
8	C_{lamp}	2.7 nF	1
9	L_{lamp}	3.5 mH	1
10	C_{HB}	100 nF	2

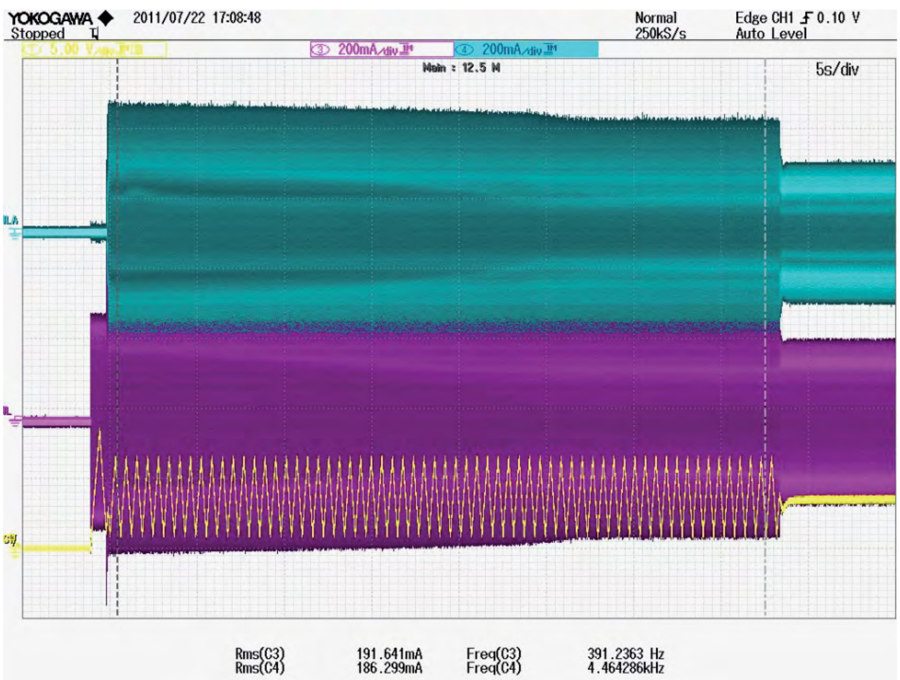
Table 11. Component list

No	Part	Value	Remarks
11	E_{lcap}	2.2 μF	1
12	R_{fuse}	10 Ω	1
13	Burner	12 W, spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213BT	1
16	Connector		2

14.5 14 W Spiral lamp

Table 12. 14 W Spiral lamp (UBA2213BT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	92	13.6	0.64	98	123	73	147	11.9	43	0.8	187		
	106	16.3	0.66	64	185	41	191	14.2	27	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 18. 14 W Spiral lamp measurements

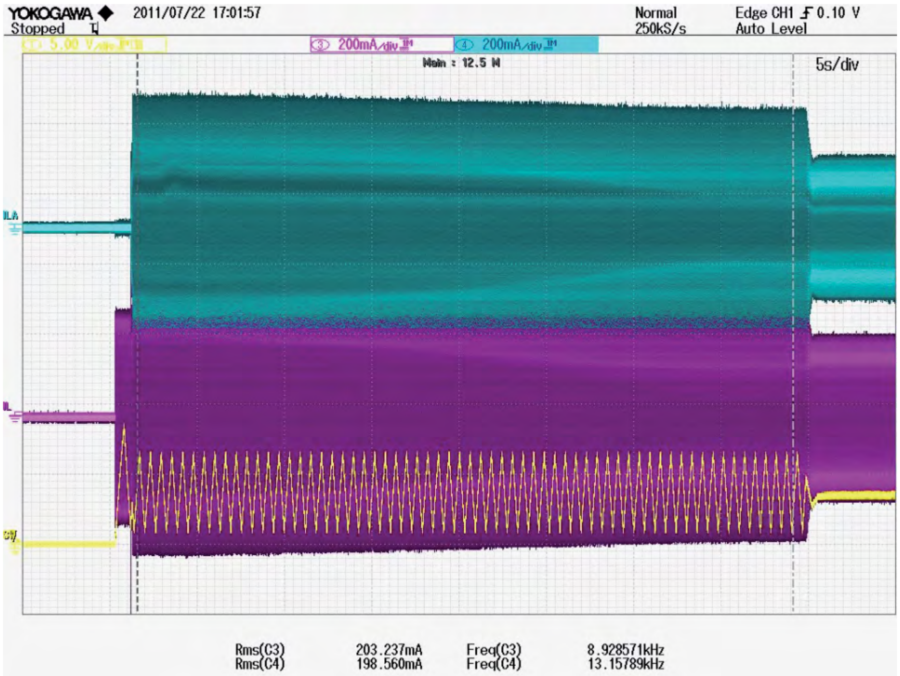
Table 13. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.6 Ω	1
8	C_{lamp}	2.7 nF	1
9	L_{lamp}	3.5 mH	1
10	C_{HB}	100 nF	2
11	E_{lcap}	3.3 μF	1
12	R_{fuse}	10 Ω	1
13	Burner	14 W, spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213BT	1
16	Connector		2

14.6 15 W Spiral lamp

Table 14. 15 W Spiral lamp (UBA2213BT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	83	12.2	0.62	85	127	63	145	10.8	43	0.8	188		
	97	14.6	0.65	64	207	34	212	12.7	27	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 19. 15 W Spiral lamp measurements

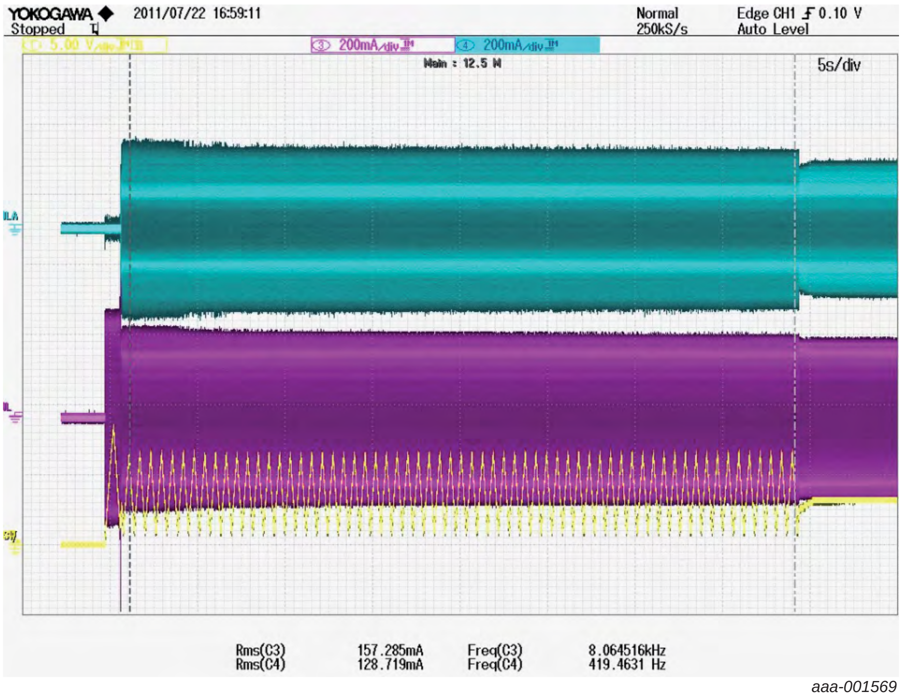
Table 15. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.6 Ω	1
8	C_{lamp}	2.7 nF	1
9	L_{lamp}	3.5 mH	1
10	C_{HB}	100 nF	2
11	E_{lcap}	3.3 µF	1
12	R_{fuse}	10 Ω	1
13	Burner	15 W spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213BT	1
16	Connector		2

14.7 15 W Spiral lamp

Table 16. 15 W Spiral lamp (UBA2213BT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	102	15.5	0.65	118	118	86	150	13.9	43	0.8	199		
	107	16.7	0.66	107	152	63	166	15.1	32	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 20. 15 W Spiral lamp measurements

Table 17. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.6 Ω	1
8	C_{lamp}	2.7 nF	1
9	L_{lamp}	3.5 mH	1
10	C_{HB}	100 nF	2

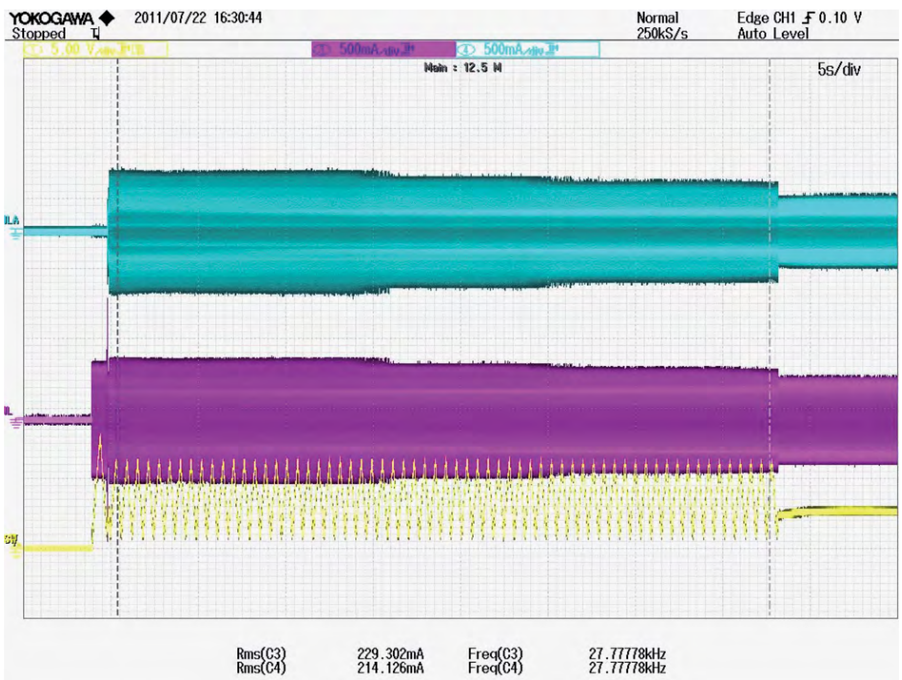
Table 17. Component list

No	Part	Value	Remarks
11	E_{lcap}	3.3 μF	1
12	R_{fuse}	10 Ω	1
13	Burner	15 W spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213BT	1
16	Connector		2

14.8 20 W Spiral lamp

Table 18. 20 W Spiral lamp (UBA2213CT N1B)

V_{IN} (V)	I_l (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	139	20.6	0.65	117	161	107	198	18.2	44	0.8	250		
	143	22.1	0.66	102	211	76	228	20	32	T_{boost}	T_{trans}		Boost
				ratio	1.3					38 s (63 cycles)	0.5 s		



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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 21. 20 W Spiral lamp measurements

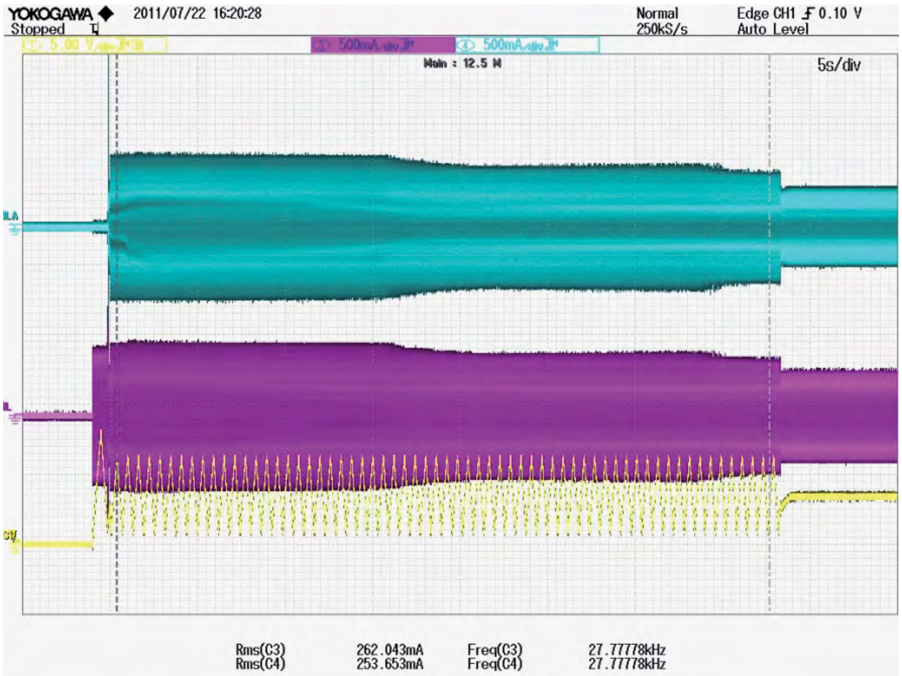
Table 19. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.2 Ω	1
8	C_{lamp}	3.3 nF	1
9	L_{lamp}	2.5 mH	1
10	C_{HB}	100 nF	2
11	E_{lcap}	4.7 µF	1
12	R_{fuse}	10 Ω	1
13	Burner	20 W spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213CT	1
16	Connector		2

14.9 20 W Spiral lamp

Table 20. 20 W Spiral lamp (UBA2213CT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	134	19.7	0.64	104	169	97	199	17.1	44	0.8	296		
	144	22.1	0.66	77.5	274	51	279	19.8	27	T_{boost}	T_{trans}		Boost
				ratio	1.6					38 s (63 cycles)	0.5 s		



(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 22. 20 W Spiral lamp measurements

Table 21. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.2 Ω	1
8	C_{lamp}	3.3 nF	1
9	L_{lamp}	2.5 mH	1
10	C_{HB}	100 nF	2
11	E_{lcap}	4.7 µF	1
12	R_{fuse}	10 Ω	1
13	Burner	20 W spiral	1
14	L_{fil}	1 mH	1
15	IC	UBA2213CT	1
16	Connector		2

14.10 20 W T3 lamp

Table 22. 20 W T3 lamp (UBA2213CT N1B)

V_{IN} (V)	I_I (mA)	P_{in} (W)	PF	V_{lamp} (V)	I_{lamp} (mA)	I_h (mA)	I_t (mA)	P_{lamp} (W)	f_{osc} (kHz)	T_{ph} (s)	I_{ph} (mA)	f_{ph} (kHz)	Remark
230	143	20.6	0.62	108	173	105	208	18.5	45	0.8	250	83	
	143	20.4	0.62	63	291	45	296	18	28	T_{boost}	T_{trans}		Boost
				ratio	1.7					38 s (63 cycles)	0.5 s		

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(1) Dark blue: lamp current

(2) Purple: half-bridge current

(3) Yellow: SW signal

Fig 23. 20 W T3 lamp measurements

Table 23. Component list

No	Part	Value	Remarks
1	R_{osc}	100 kΩ	1
2	C_{osc}	220 pF	1
3	C_{dvdt}	220 pF	1
4	C_{SW}	68 nF	1
6	C_{FS}	10 nF	1
7	R_{SENSE}	1.2 Ω	1
8	C_{lamp}	3.3 nF	1
9	L_{lamp}	2.5 mH	1
10	C_{HB}	100 nF	2

Table 23. Component list

No	Part	Value	Remarks
11	E_{lcap}	6.8 µF	1
12	R_{fuse}	10 Ω	1
13	Burner	20 W T3	1
14	L_{fil}	1 mH	1
15	IC	UBA2213CT	1
16	Connector		2

15. Abbreviations

Table 24. Abbreviations

Acronym	Description
CFL	Compact Fluorescent Lamps
CMP	Capacitive Mode Protection
MOSFET	Metal-Oxide Semiconductor Field-Effect Transistor
OTP	OverTemperature Protection
PCB	Printed-Circuit Board
PF	Power Factor
RMS	Root Mean Squared
SCP	Saturation Current Protection
ZVS	Zero Voltage Switching

16. References

[1] UBA2213 — Data sheet: Half-bridge power IC family for CFL lamps

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