International
IOR Rectifier

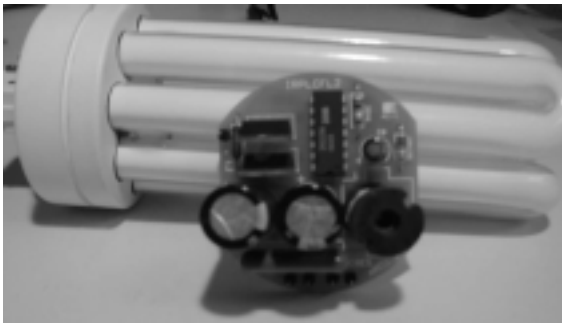
REFERENCE DESIGN IRPLCFL2

International Rectifier • 233 Kansas Street, El Segundo, CA 90245 USA

IRPLCFL2 42 Watt Compact Fluorescent Ballast Reference Design

Overview

The CFL-2 is an electronic ballast design for driving a 42 watt compact fluorescent lamp from a 120 or 230 volt AC line. The circuit was designed using the IR2156 Ballast Driver IC. The main features of the circuit are programmable frequency, preheat time, over-current threshold and dead time. A circuit board was designed and tested to verify reliable functionality under actual operating conditions.



LAMP TYPE: GE BIAX Q/E 42W (F42QBX)

Features

* Programmable preheat frequency
* Programmable preheat time
* Programmable over-current threshold
* Programmable run frequency
* Programmable dead time

Electrical Characteristics

Parameter	Value
Input Power	42W
Input Current (120V)	530mA
Preheat Frequency	75kHz
Run Frequency	45kHz

Circuit Description

The schematic for CFL-2 is shown in Figure 1. With a 120 volt AC line input (AC1-N), the voltage is rectified and doubled to provide a bus voltage of approximately 300 volts. With a 220 volt AC line input (AC1-AC2), the voltage is rectified but not doubled and again provides a bus voltage of approximately 300 volts. The start up resistor, R_{SUPPLY}, is sized such that it can supply the micro-power current during under-voltage lockout (UVLO). When V_{CC} exceeds the UVLO+ threshold, the IR2156 begins to oscillate and the charge pump circuit (C_{CP}, D_{CP1}, and D_{CP2}) supplies the current to VCC which causes the internal 15.6V shunt clamp to regulate.

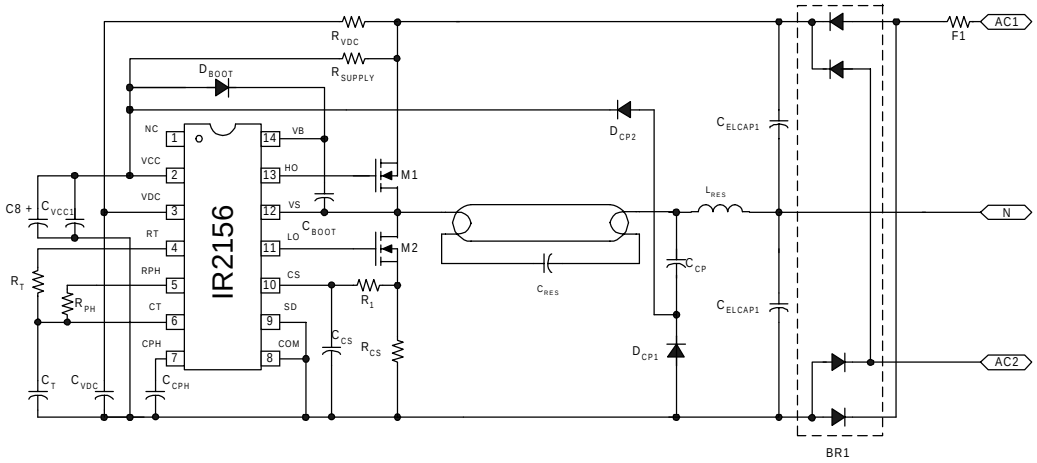


Figure. 1, IRPLCFL2 Schematic Diagram

At initial startup, the output frequency is determined by timing capacitor C_T and the parallel combination of R_T, R_{PH} and an internal resistor, $R_{SOFTSTART}$. C_T is selected depending on the desired deadtime and is given as:

$$t_{DT} = C_T \cdot 1475 \quad \text{[Seconds]} \qquad (1)$$

After a few hundred micro-seconds, $R_{SOFTSTART}$ is slowly switched away (See Figure 4). This provides a soft-start of the resonant output stage which eliminates large voltage transients which can cause a small start-up flash across the lamp. Once $R_{SOFTSTART}$ is disconnected, the parallel combination of RT and RPH determine the output frequency during preheat and is given as:

$$f_{PH} = \frac{1}{2 \cdot C_T \cdot \left(\frac{0.51 \cdot R_T \cdot R_{PH}}{R_T + R_{PH}} + 1475 \right)} \qquad (2)$$

The IC remains in preheat mode until the voltage on CPH exceeds V_{CC}-2V. The preheat time is determined by an internal current source charging external capacitor C_{PH} and is given as:

$$t_{PH} = C_{PH} \cdot 2.6e6 \qquad (3)$$

When CPH exceeds V_{CC}-2V, RPH is slowly disconnected from RT, which causes the frequency to ramp smoothly from the preheat frequency, through the ignition frequency to the final run frequency.

The voltage across the lamp at ignition should be sufficient to ignite the lamp under all operating conditions. The ignition current should never saturate the inductor, and is given as:

$$I_{IGN} = \frac{1.3}{R_{CS}} \text{ [Amps Peak]} \qquad (4)$$

The run frequency is programmed using only external components R_T and C_T and is given as:

$$f_{RUN} = \frac{1}{2 \cdot C_T \left(0.51 \cdot R_T + 1475\right)} \text{ [Hertz]} \qquad (5)$$

If V_{CS} exceeds the over-current threshold of 1.3V, the IC will enter fault mode, and the half-bridge is disabled (See Figure 6). At this point, V_{CC} requires only micro-power current and remains at the shunt clamp voltage. The IC can only be reset with a re-cycling of VCC below and back above the UVLO thresholds, or, pin SD, (shown grounded in the schematic) can be recycled above and back below the internal 5.1V threshold.

If the lamp is removed during normal operation, or either of the lamp filaments fail, the resonant tank is interrupted and the charge pump becomes disconnected. The charge pump can no longer supply current to VCC and VCC drops below UVLO-. R_{SUPPLY} charges VCC up to UVLO+ and the half-bridge begins to oscillate again, but only temporarily. Since R_{SUPPLY} cannot supply enough current to VCC to sustain oscillations, VCC once again drops below UVLO- and oscillations stop. This burst mode continues (See Figure 5) until a lamp is re-inserted, and the IR2156 starts again in the preheat mode. For a more detailed description of the IR2156, including a STATE diagram, TIMING diagram, and a complete functional description and electrical characteristics, please refer to the ”IR2156 Ballast Control IC” data sheet.

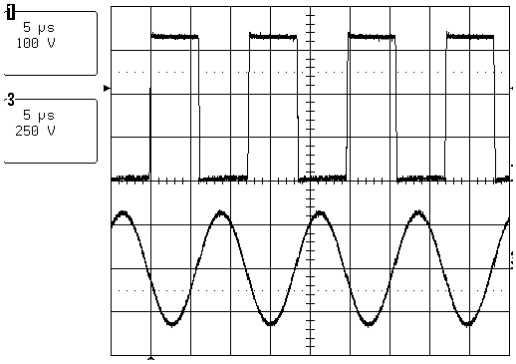


Fig. 2: VS & V_{LAMP} during Preheat Mode

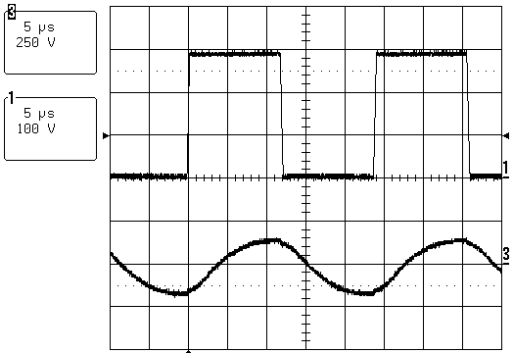


Fig 3: VS & V_{LAMP} during Run Mode

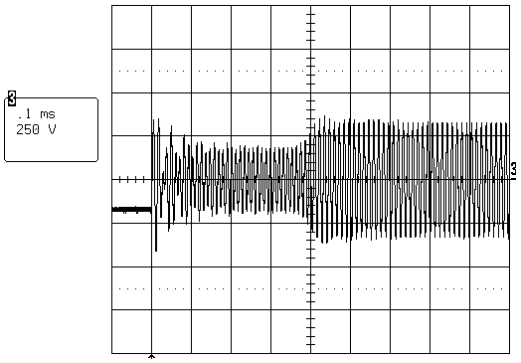


Fig 4: V_{LAMP} during Softstart Mode

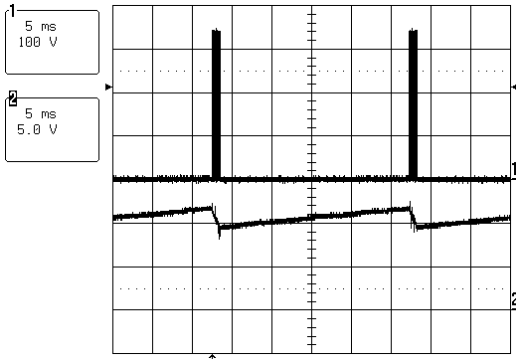


Fig 5: VS & V_{CC} during lamp out or filament failure

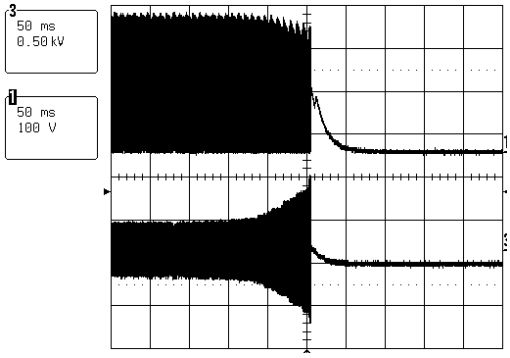


Fig 6: DCBUS & V_{LAMP} during a non-strike lamp fault condition

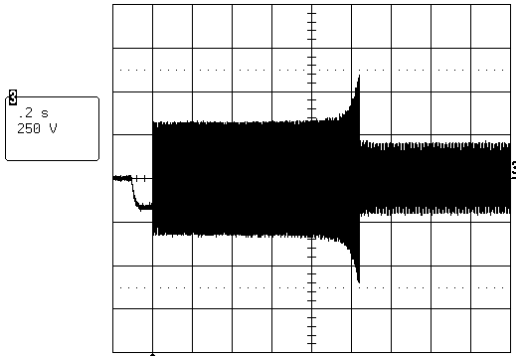


Fig 7:V_{LAMP} during Preheat, Ignition and Run Modes

Bill Of Materials

Schematic: IRPLCFL2, Figure 1 Lamp Type: 42W-Quad Biax Line Input Voltage: 120VAC

Item	Qty	Description	Designator	Value	Manufacturer	Part No.
1	1	Fuse	F1	0.5Ω / 0.5Ω	Dale	CW-1/2 0.5Ω 5%
2	1	Bridge Rectifier	BR1		International Rectifier	DF10S
3	2	Electrolytic Capacitor	CELCAP1, CELCAP2	47uF/250V	Panasonic	EEU-EB2E470
4	1	Resonant Inductor	LRES	1.25mH/1.5A		
5	1	Charge Pump Capacitor	CCP	330pF/1kV	Johanson	102S43N331JV4U
6	2	Charge Pump Diodes	DCP1, DCP2	1N4148	Diodes	LL4148DICT
7	1	Resonant Capacitor	CRES	4.7nF/1.6kV	Wima	MKP10
8	2	Half-Bridge MOSFET	M1, M2	IRF730	International Rectifier	IRF 730
9	1	Current Sense Resistor	RCS	0.75Ω / 0.5W	Dale	CW-1/2 0.75Ω 5%
10	1	Limit Resistor	R1	1k / 1/8W	Panasonic	ERJ-8RQJ102Y
11	1	Filter Capacitor	CCS	1nF/25V	Panasonic	ECU-V1H102KBM
12	2	Supply Capacitor	CBOOT, CVCC1	0.1uF/25V	Panasonic	ECJ-3VB1E104K
13	1	Supply Capacitor	C8	2.2uF/25V	Panasonic	ECE-A1HFS2R2
14	1	Bootstrap Diode	DBOOT		International Rectifier	10BF60
15	1	Ballast Control IC	IC1	IR2156	International Rectifier	IR2156
16	2	Resistor	RSUPPLY, RVDC	1M/0.25W	Yageo	105QBK
17	1	Timing Resistor	RT	39k/ 1/8W1%	Panasonic	ERJ-8RQF333Y
18	1	Timing Capacitor	CT	560pF/25V	Panasonic	ECU-V1H561KBM
19	1	Preheat Resistor	RPH	33k/ 1/8W1%	Panasonic	ERJ-8RQF333Y
20	1	Preheat Capacitor	CPH	0.33uF/25V	Panasonic	ECJ-3VB1E224K
21	1	Capacitor	CVDC	0.01uF/25V	Panasonic	ECU-V1H103KBM
TOTAL	**26**					

Table 1 CFL-2 Bill of Materials

4/26/2001