International
IOR Rectifier

DESIGN TIP

DT 95-3

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Ultra-Compact Flourescent Ballasts using the IR51H420 Hybrid

Notices:
(HEXFET is the trademark for International Rectifier Power MOSFETs)

Summary:

Figure 1 The IR2151 has set the standard for low cost compact fluorescents which demand minimum size ballasts in order to fit into unmodified light fixtures designed for the ubiquitous tungsten filament light bulb of 60 - 100W rating.

IR has now combined the (2) inverter MOSFETs with the IR2151 driver to produce on even more compact ballast which can now be built within the footprint of the lamp itself!

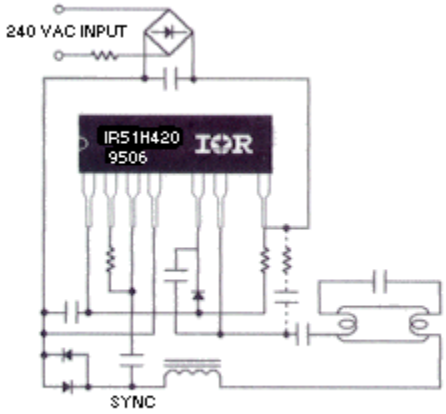

Figure 1

The above schematic shows the extreme simplicity of the ballast circuit. Note the back-to-back IN4001 diodes which form a zero current crossing detection circuit for synchronizing the oscillator to the natural frequency of the series resonant lamp circuit.

Features:

- Floating channel designed for bootstrap operation
  - Fully operational to +500V
  - Tolerant to negative transient voltage
  - dV/dt immune
- Under voltage lockout
- Programmable oscillator frequency

$$f = \frac{1}{1.4 \times (R_T + 75\Omega) + C_T}$$

- Matched propagation delay for both outputs
- Half-Bridge output out of phase with RT

The synchronizing feature allows the use of wide tolerance components while still maintaining perfect resonance of the lamp circuit for reliable starting. Synchronization also allows the ballast to compensate for lamp ageing and temperature related component drift which would otherwise prevent reliable striking of the lamp under all conditions of input line voltage variation and ambient temperature range.

The basic component values for a 13 watt 240VAC input are shown on the schematic. There are several components whose values change for different power levels and input voltages and these are shown in Table 1. Note that the 1.3 inch square demo board is usable only to 26 watts Max (see figure 2). Higher power levels would need larger components and a P.F.C. pre-regulator in order to meet the THD requirement of IEC 555-2 power quality standard.

In the interests of RFI reduction a snubber is generally added at the half-bridge AC node (pin 7) to ground (V-) (pin 4). Switch times using snubber values of 10[[Omega]] and 0.001uF increase transition times (tr and tf) from 100nSec to 600nSec. These switch times are still comfortably within the deadtime of 1.2us but reduce the bandwidth of the RFI components from 10MHz to around 400kHz.

The synchronization feature is necessary to ensure reliable starting with 100VAC or 120VAC inputs but may be omitted in the 240V version which has twice the AC output amplitude of the 120VAC ballast and therefore does not need to be in true resonance in order to provide sufficient starting voltage. To omit the synchronization function the 1N4001 diodes are replaced by a jumper wire to provide a return path for C6 and the lamp current.

Table 1.

V_{CC} Dropper R3 47K, ¼W			120 VAC INPUT					IR51H214, IR51H224
Power Level	Main Filter Capacitor C1	Bus Ripple Voltage	Resonant Lamp Circuit L1	Winding	Core(Fairite)	C5	R2	f_{osc}
13W	22 µF, 250V	25V P-P	1.60 mH	202T#32HAPT	9677001015	0.01 µF, 300 VAC	12.6K	37 KHz
16W	22 µF, 250V	30V P-P	0.98 mH	130T#28HAPT	9677142009	0.02 µF, 300 VAC	10K	44 KHz
18W	47 µF, 250V	15V P-P	0.96 mH	130T#28HAPT	9677142009	0.02 µF, 300 VAC	11K	40 KHz
22W	47 µF, 250V	20V P-P	0.83 mH	120T#28HAPT	9677142009	0.02 µF, 300 VAC	14.2K	35.7 KHz
26W	47 µF, 250V	25V P-P	0.83 mH	120T#28HAPT	9677142009	0.02 µF, 300 VAC	16.9K	28.5 KHz

Table 2.

V_{CC} Dropper R3 91K, ¼W			240 VAC INPUT					IR51H420
Power Level	Main Filter Capacitor C1	Bus Ripple Voltage	Resonant Lamp Circuit L1	Winding	Core(Fairite)	C5	R2	f_{osc}
13W	10 µF, 450V	35V P-P	2.56 mH	250T#32HAPT	9677001015	0.01 µF, 300 VAC	9.9K	40 KHz
16W	10 µF, 450V	40V P-P	2.56 mH	250T#32HAPT	9677001015	0.01 µF, 300 VAC	12.6K	36 KHz
18W	22 µF, 450V	20V P-P	1.85 mH	180T#30HAPT	9677142009	0.01 µF, 300 VAC	9.6K	43 KHz
22W	22 µF, 450V	22V P-P	1.85 mH	180T#30HAPT	9677142009	0.01 µF, 300 VAC	13.8K	33 KHz
26W	22 µF, 450V	25V P-P	1.85 mH	180T#30HAPT	9677142009	0.01 µF, 300 VAC	17.3K	27 KHz

NOTES:

1) The resonant inductor values shown above are guidelines. Different lamp types with the same power input values do not have the same burning voltages. Therefore, some experimentation in inductance values and/or frequency may be necessary.

2) C5 is a polypropylene type capacitor.

3) The snubber circuit (0.001uF and 10[[Omega]]) shown dashed in the schematic diagram is optional. These components are not included in the circuit board layout.

4) All resistors are ±5%.

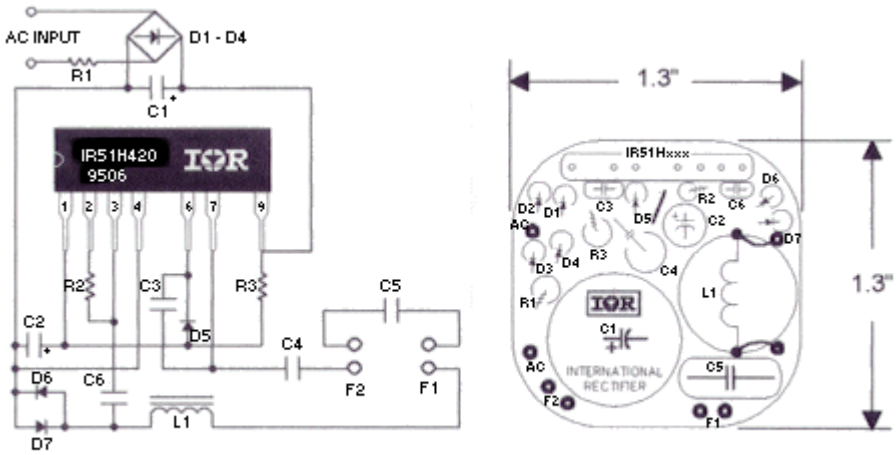

Figure 2: Demo Board Schematic and Layout

REF	DESCRIPTION
R1	10Ω, ½W, ±5% Carbon Comp.
R2	See Tables 1 and 2
R3	See Tables 1 and 2
C1	See Tables 1 and 2
C2	22 µF, 25V Alum. electrolytic
C3	0.1 µF, 50V
C4	0.1 µF, 200V Polyester
C5	Tables 1 and 2, 300 VAC Polyprop. WIMA # MKP-4
C6	0.001 µF, 50V
D1-D4	1N4007
D5	10DF4
D6-D7	1N4148
L1	See Tables 1 and 2

NOTES:

I) For 120VAC mains input, use hybrid IR51H214 up to 18 watts. Use IR51H224 up to 32 watts output. For 240VAC mains input, use hybrid IR51H420 from 13 to 26 watts output.

2) A printed wiring board of the same dimensions using surface mount technology is available from IR.