IR21571: Dual Lamp Series Configuration

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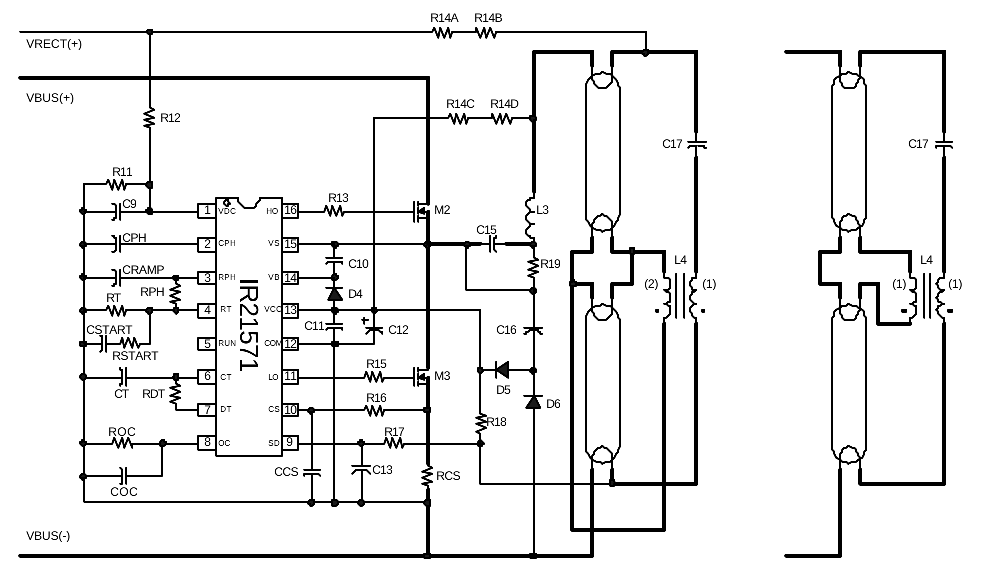
TOPICS COVERED

Basic Circuit Considerations
Schematic Diagrams
Waveforms
Bill of Materials

Dual lamps in series configuration are fast becoming the industry standard for fluorescent lighting. To make such a ballast's design efficient and compact, the IR21571 can be used with some modifications to the output stage. Through externally programmable components, the IR21571 affords flexibility of various features such as preheat time and frequency, ignition ramp characteristics, and running mode operating frequency. Comprehensive protection features protect the circuit against conditions such as lamp strike failures, filament failures, low DC bus, thermal overload, or ramp failure during normal operation. *This circuit switches off both lamps when one is taken out, and automatically restarts when both lamps are in place.*

BASIC CIRCUIT CONSIDERATIONS

The overall circuitry for a dual lamp configuration is shown below. As can be seen, the design for this setup is mainly the same as that for a single lamp, with differences only in the output stage.



Note: Thick traces represent high-frequency, high-current paths. Lead lengths should be minimized to avoid high-frequency noise problems. The above configuration shows the middle filaments connected in parallel. The configuratio the right shows the middle filaments connected in series with the secondary windings of L4.

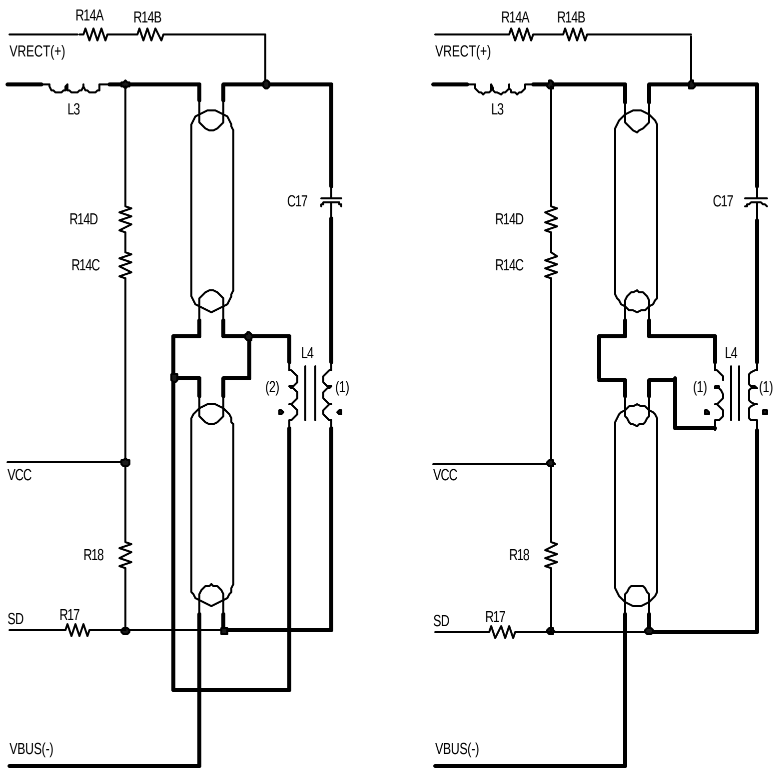


Fig. 1 **Fig. 2**

The configuration in Fig. 1 shows the middle filaments connected in parallel. The turns ratio for L4 is 1:2, primary:secondary. This setup doubles the current for the two middle filaments. As filament current begins to flow, the filament with the larger resistance draws less current which provides more current for the other cathode. This positive temperature coefficient effect balances the currents in the filaments. The configuration in Fig. 2 shows the filaments in series with the secondary winding of L4. The turns ratio in this case is 1:1. The same current flows through each filament. For either configuration, if one of the middle cathodes is removed, an over-current condition is sensed at the current sense pin. This causes a fault condition and the IC shuts down.

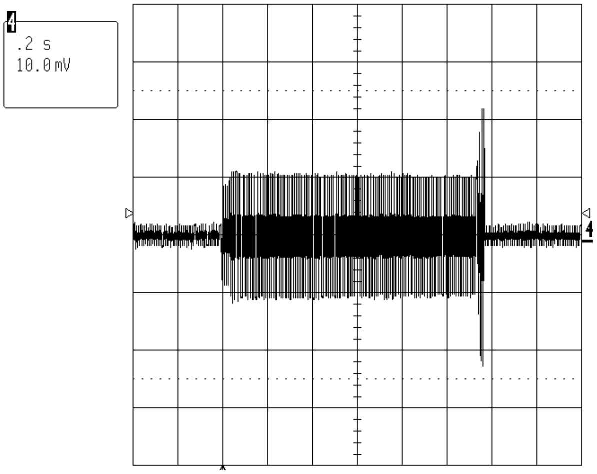
The threshold for the current sense pin is determined by the value of the resistor at the ROC pin. The ROC pin has a constant current output of 55uA. When the upper lamp is removed and reinserted, VCC recycles below the UV(-) threshold, and the IC returns to preheat mode.

The rectified line is connected to VCC through the upper filament. When the upper filament is removed, the charge pump no longer supplies the IC and VCC falls below under voltage lockout (UVLO). Pulling out the upper filament has interrupted the micropower supply path. When the lamp is re-inserted, the IC returns to preheat mode.

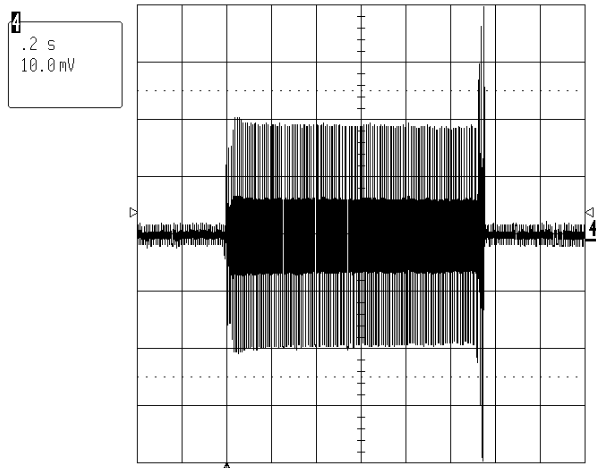
When the lower cathode is in place, current flows through the lamp, through resistor R17, and thus keeps the Shutdown pin (SD) low (below 2V). When the lower filament is removed, VCC pulls SD high through resistors R17 and R18. At this point, both IR21751 half-bridge outputs are pulled low, and the IC enters micropower mode. When the lower filament is reinserted, SD is pulled low which triggers a reset signal that restarts the chip from the beginning of the control sequence.

This setup, like the single lamp setup provides protective features such as DC Bus Voltage Detection and Half Bridge Current Sensing and Protection. (For additional information on these protective features please see the IR21571 datasheet.)

WAVEFORMS

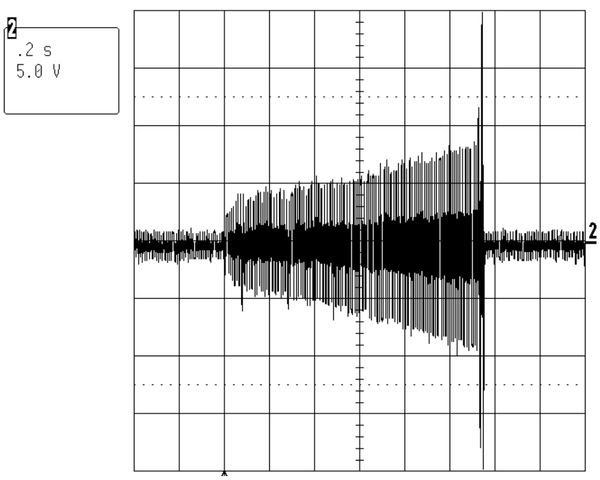


Upper and Lower Filament Currents
(1A/Div)

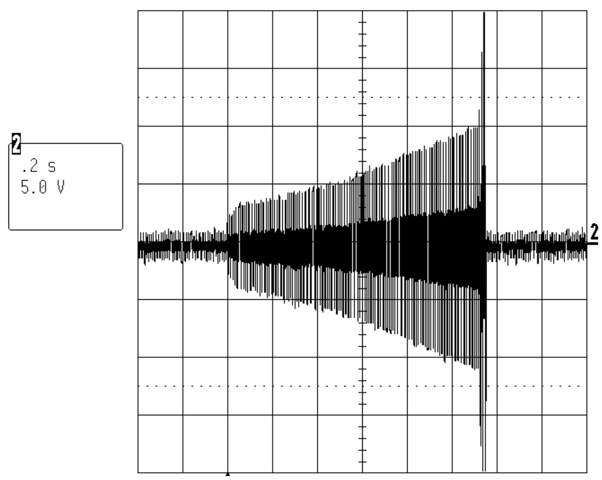


Middle Filament Currents
(1A/Div)

Note that in the parallel filament configuration, the middle filament currents are twice the amplitude of the upper and lower filaments. Transformer L4 doubles the current which flows through the two middle filaments. In the series filament configuration, the upper, middle and lower currents are similar to the waveform on the left. The waveforms on this page were taken during the preheat and ignition modes.

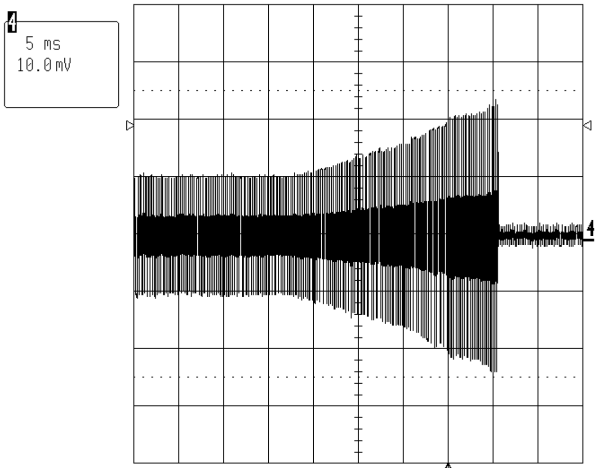


Upper and Lower Filament Voltages

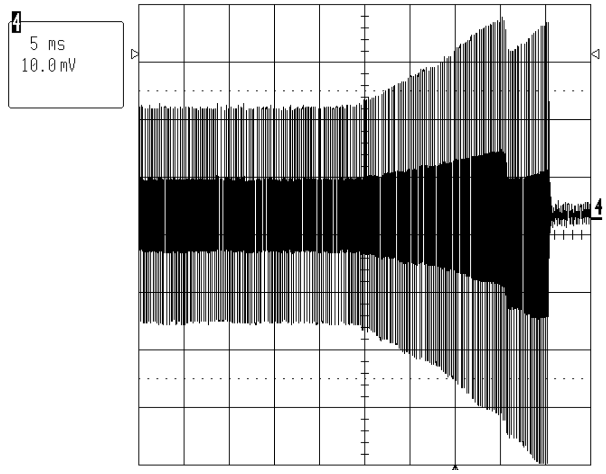


Middle Filament Voltages

Note that the filament voltages for the upper, middle and lower filaments are similar. This is the case for either the parallel or series filament configuration.

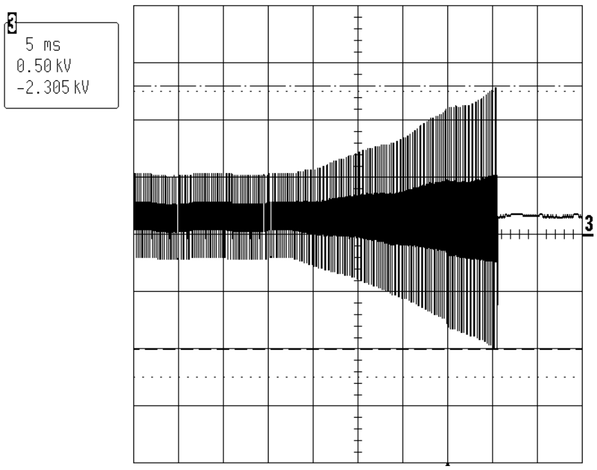


Upper and Lower Filament Ignition Currents (1A/Div)



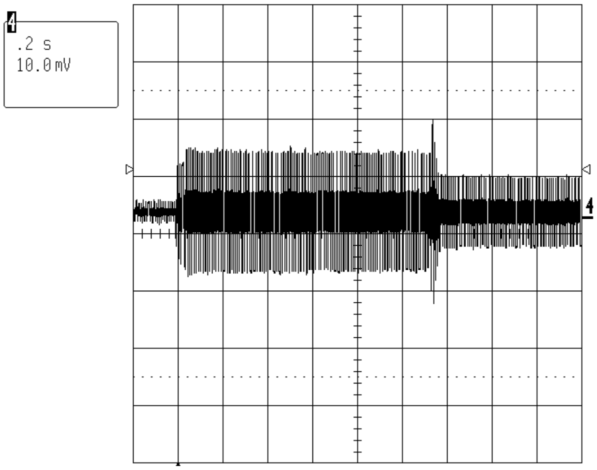
Middle Filament Ignition Current (1A/Div)

Note that the ignition current for the middle filaments is twice the amplitude of the upper and lower filaments in the parallel filament configuration. In the series filament configuration, the upper, middle and lower currents are similar to the waveform shown at left.

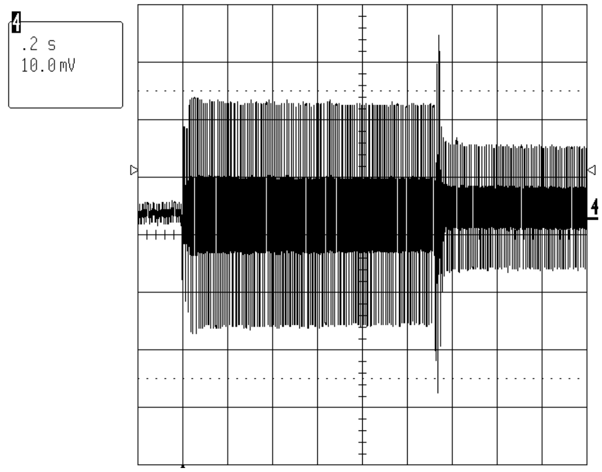


Lamp Ignition Voltage

The above waveform is the ignition voltage at the top of the upper lamp with reference to ground. This is the same for either filament configuration.

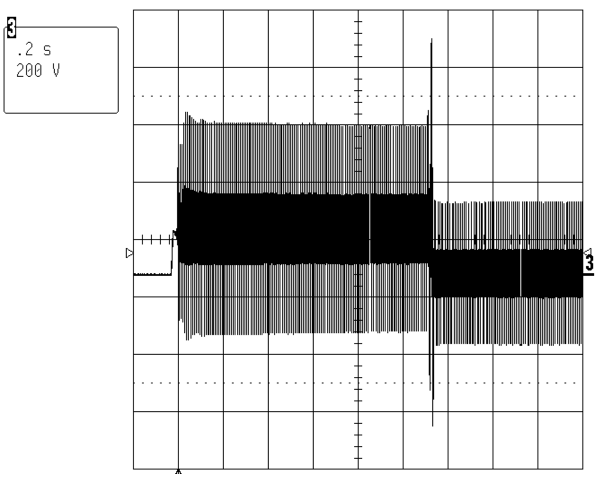


Upper and Lower Filament Current
(1A/Div)



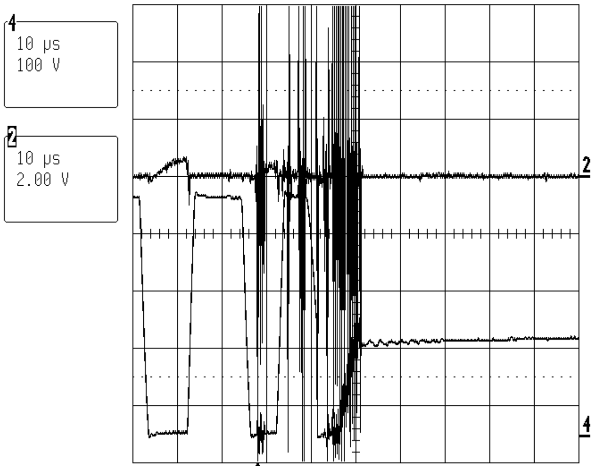
Middle Filament Current
(1A/Div)

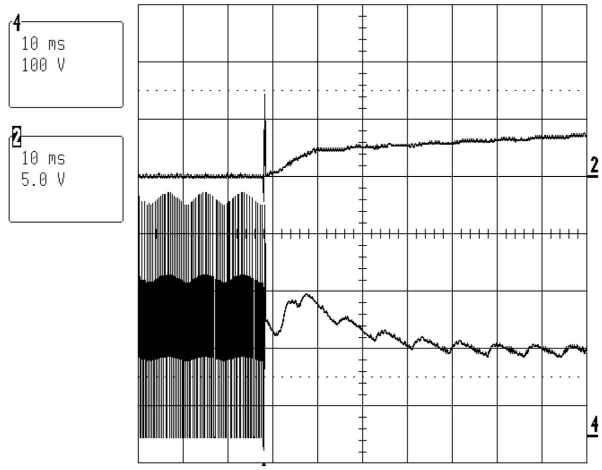
Note that in the parallel filament configuration, the current amplitude in the middle filaments is twice that in the upper and lower filaments. In the series filament configuration, the upper, middle and lower currents are similar to the waveform on the left. These waveforms show currents during the preheat, ignition and run modes.



Lamp Voltage

This waveform shows the lamp voltage during preheat, ignition and run modes. This is the same for either filament configuration.





CH#2 (CS), CH#4 (VS)

CH#2 (SD), CH#4 (VS)

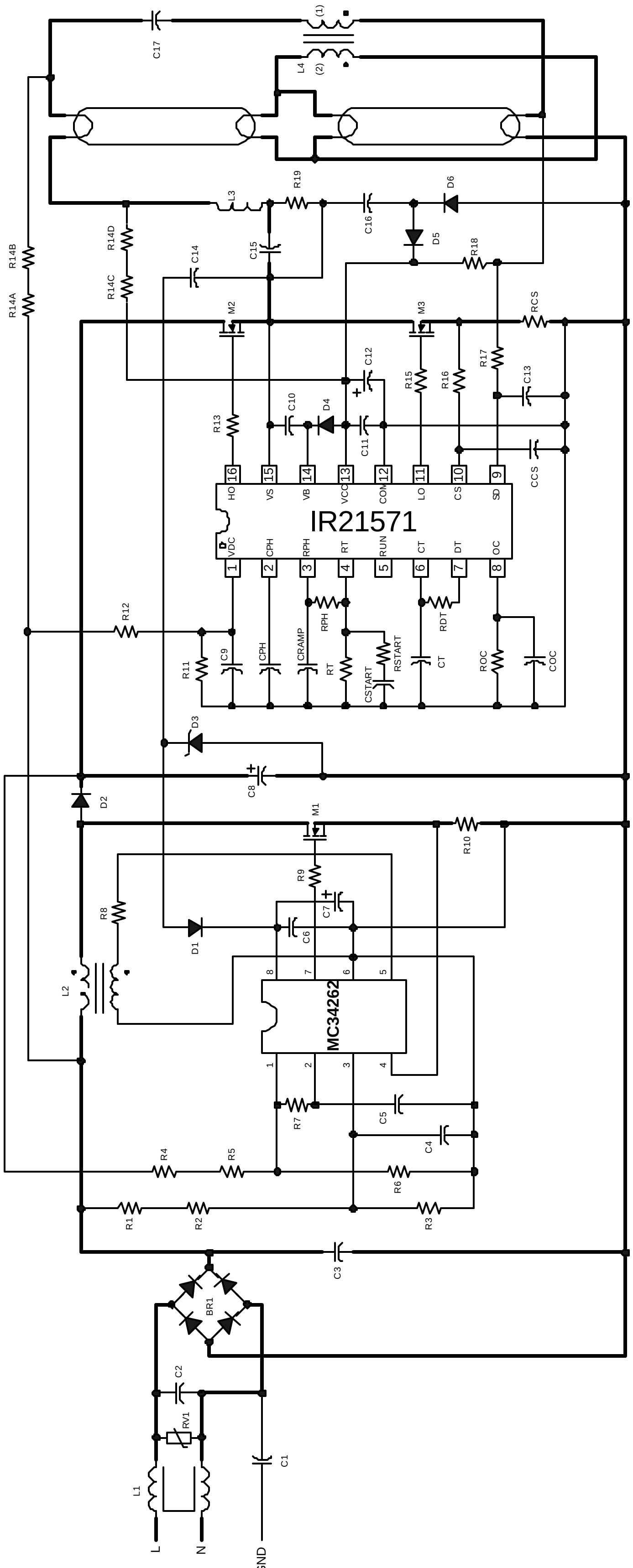
The above waveforms show an over-current condition when the upper or middle filaments open during running. The voltage at the current sense pin goes above the threshold as determined by ROC and shuts the IC off.

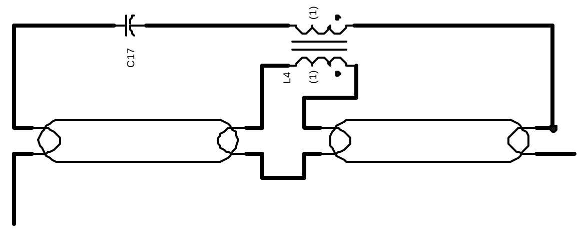
The above waveforms show what happens when the lower filament opens during Running. The voltage at the SD pin rises above 2V and shuts the IC off.

The above waveforms are similar for either filament configuration.

BILL OF MATERIALS AND CIRCUIT SCHEMATIC

Item #	Qty	Manufacturer	Part Number	Description	Reference
1	1	International Rectifier	DF10S	Bridge Rectifier, 1A 1000V	BR1
2	1	Roederstein	WY0222MCMBF0K	Capacitor, 2.2nF 275 VAC Y Cap	C1
3	1	Roederstein	F1772433-2200	Capacitor, 0.33uF 275 VAC	C2
4	2	Wima	MKP10	Capacitor, 0.01uF 400 VDC	C3, C15
5	2	Panasonic	ECU-V1H103KBM	Capacitor, 0.01uF SMT 1206	C4, CSTART
6	3	Panasonic	ECJ-3YB1E474K	Capacitor, 0.47uF SMT 1206	C5, C6, C13
7	4	Panasonic	ECU-V1H104KBM	Capacitor, 0.1uF SMT 1206	C9, COC, C10, C11
8	1	Panasonic	EEU-EB2V100	Capacitor, 10uF 350VDC 105C	C8
9	1	Panasonic	ECU-V1H471KBM	Capacitor, 470pF SMT 1206	CT
10	1	Panasonic	ECJ-3VB1E334K	Capacitor, 0.33uF SMT 1206	CRAMP
11	1	Panasonic	ECJ-3VB1E274K	Capacitor, 0.27uF SMT 1206	CPH
12	1	Panasonic	ECE-A1HGE010	Capacitor, 1uF 50VDC 105C	C12
13	1	Vitramon	1812A152KXE	Capacitor, 1.5nF 1KV SMT 1812	C14
14	1	Vitramon	1812A102KXE	Capacitor, 1nF 1KV SMT 1812	C16
15	1	Panasonic	ECW-H16682JV	Capacitor, 6.8nF 1.6KV	C17
16	1	Panasonic	ECU-V1H101KBM	Capacitor, 100pF SMT 1206	CCS
17	3	Diodes	LL4148DICT-ND	Diode, 1N4148 SMT DL35	D1, D5, D6
18	2	International Rectifier	10BF60	Diode, SMT SMB	D2, D4
19	1	Diodes	ZMM5250BCT	Diode, Zener 20V SMT DL35	D3
20	1	Motorola	MC34262	IC, Power Factor Controller	IC1
21	1	International Rectifier	IR21571	IC, Ballast Driver	IC2
22	1	Panasonic	ELF-15N007A	EMI Inductor, 1X10mH 0.7Apk	L1
23	1	R.G. Allen	RGA-K86960	PFC Inductor, 2.0mH 2.0Apk	L2
24	1			Inductor, 2mH 3.0Apk	L3
25	1			Inductor, 1:2, EF20, no gap	L4
				50 Turns:100 Turns, AWG 28	
				Inductor, 1:1, EF20, no gap	
				100 Turns:100 Turns, AWG 28	
26	3	International Rectifier	IRF840	Transistor, MOSFET	M1, M2, M3
27	5	Panasonic	ERJ-8GEYJ680K	Resistor, 680K ohm SMT 1206	R1, R2, R4, R5, R17
28	2	Panasonic	ERJ-8GEYJ10K	Resistor, 10K ohm SMT 1206	R3, RSTART
29	1	Panasonic	ERJ-8GEYJ8.2K	Resistor, 8.2K ohm SMT 1206	R6
30	1	Panasonic	ERJ-8GEYJ100K	Resistor, 100K ohm SMT 1206	R7
31	1	Panasonic	ERJ-8GEYJ22K	Resistor, 22K ohm SMT 1206	R8
32	3	Panasonic	ERJ-8GEYJ22	Resistor, 22 ohm SMT 1206	R9, R13, R15
33	1	Dale	CW-1/2	Resistor, 0.5 ohm ½ watt	R10
34	1	Panasonic	ERJ-8GEYJ56K	Resistor, 56K ohm SMT 1206	R11
35	1	Yageo	2.2MQBK-ND	Resistor, 2.2megohm ¼ watt	R12
36	1	Dale	CW-1/2	Resistor, 0.68 ohm ½ watt	RCS
37	1	Panasonic	ERJ-8GEYJ6.8K	Resistor, 6.8K ohm SMT 1206	RDT
38	1	Panasonic	ERJ-8GEYJ30K	Resistor, 30K ohm SMT 1206	ROC
39	1	Panasonic	ERJ-8GEYJ68K	Resistor, 68K ohm SMT 1206	RPH
40	1	Panasonic	ERJ-8GEYJ20K	Resistor, 20K ohm SMT 1206	RT
41	4	Yageo	110KQBK-ND	Resistor, 110K ohm ¼ watt	R14A, R14B, R14C, R14D
42	1	Panasonic	ERJ-8GEYJ1K	Resistor, 1K ohm SMT 1206	R16
43	1	Panasonic	ERJ-8GEYJ1.0M	Resistor, 1.0megohm SMT 1206	R18
44	1	Yageo	100KQBK-ND	Resistor, 100K ohm ¼ watt	R19
45	1	Panasonic	ERZ-V05D471	Transient Suppressor	RV1
Total	67				





Note: Thick traces represent high-frequency, high-current paths. Lead lengths should be minimized to avoid high-frequency noise problems

The schematic above shows the middle filaments connected in parallel. In this configuration, L4 is wound in a 1:2 ratio.

The schmatic at the right shows the middle filaments connected in series with the secondary winding of L4. In this configuration, L4 is wound in a 1:1 ratio.