Application Note AN-1019

IR21571: Dual Lamp Ballast: Parallel Configuration

By T. Ribarich, E. Thompson, A. Mathur, International Rectifier

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Driving two lamps in parallel results in lower voltage stress on the ballast output stage components, the wiring, and the fixture sockets. Additionally, the resonant L and C associated with the lamps will be less sensitive to component tolerances due to the lower running lamp voltages compared to the series configuration. For these reasons, the parallel configuration is becoming more popular. The IR21571 can be used in a ballast to control parallel lamp configurations. 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, and ramp failure during normal operation. **Two variations of this circuit are included in this application note. The first one switches off both lamps when one is taken out, and automatically restarts when both lamps are in place. The second variation allows one lamp to remain running when the other is removed. When the lamp is reinserted, the ballast restarts in the pre-heat mode.**

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International Rectifier • 233 Kansas Street El Segundo CA 90245 USA

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TOPICS COVERED

Introduction
Functional Description
Schematic Diagrams
Measurements
Bill of Materials

INTRODUCTION

Driving two lamps in parallel results in lower voltage stress on the ballast output stage components, the wiring, and the fixture sockets. Additionally, the resonant L and C associated with the lamps will be less sensitive to component tolerances due to the lower running lamp voltages compared to the series configuration. For these reasons, the parallel configuration is becoming more popular. The IR21571 can be used in a ballast to control parallel lamp configurations. 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, and ramp failure during normal operation. ***Two variations of this circuit are included in this application note. The first one switches off both lamps when one is taken out, and automatically restarts when both lamps are in place. The second variation allows one lamp to remain running when the other is removed. When the lamp is reinserted, the ballast restarts in the pre-heat mode.***

FUNCTIONAL DESCRIPTION (Variation I: Both lamps turn off when one is removed)

The output stage circuitry for a dual lamp configuration is shown in Figure 1. This is the portion of the ballast that is controlled by the IR21571. The design is similar to that for a single lamp; with the addition of a second lamp resonant circuit connected in parallel. The second lamp in parallel is connected in a manner that mirrors the immediate circuitry surrounding the first bulb. This provides the exact same resonant L and C, and basic protective circuitry for both bulbs due to their parallel setting. Protective features include DC Bus Voltage Detection and Half Bridge Current Sensing and Protection. (For additional information on these protective features please see Page 2 of the IR21571 datasheet.) Lamp detection and automatic restart work similarly to a single lamp configuration. Both lower filament sensing networks are OR-ed into the SD pin through resistors R17A and R17B. If either lamp is removed, the SD pin is pulled above the internal turn-off threshold of 2V, and the half-bridge is disabled. When both lamps are in place, the shutdown pin falls below the internal 1.7V threshold and the IC re-initiates the preheat sequence

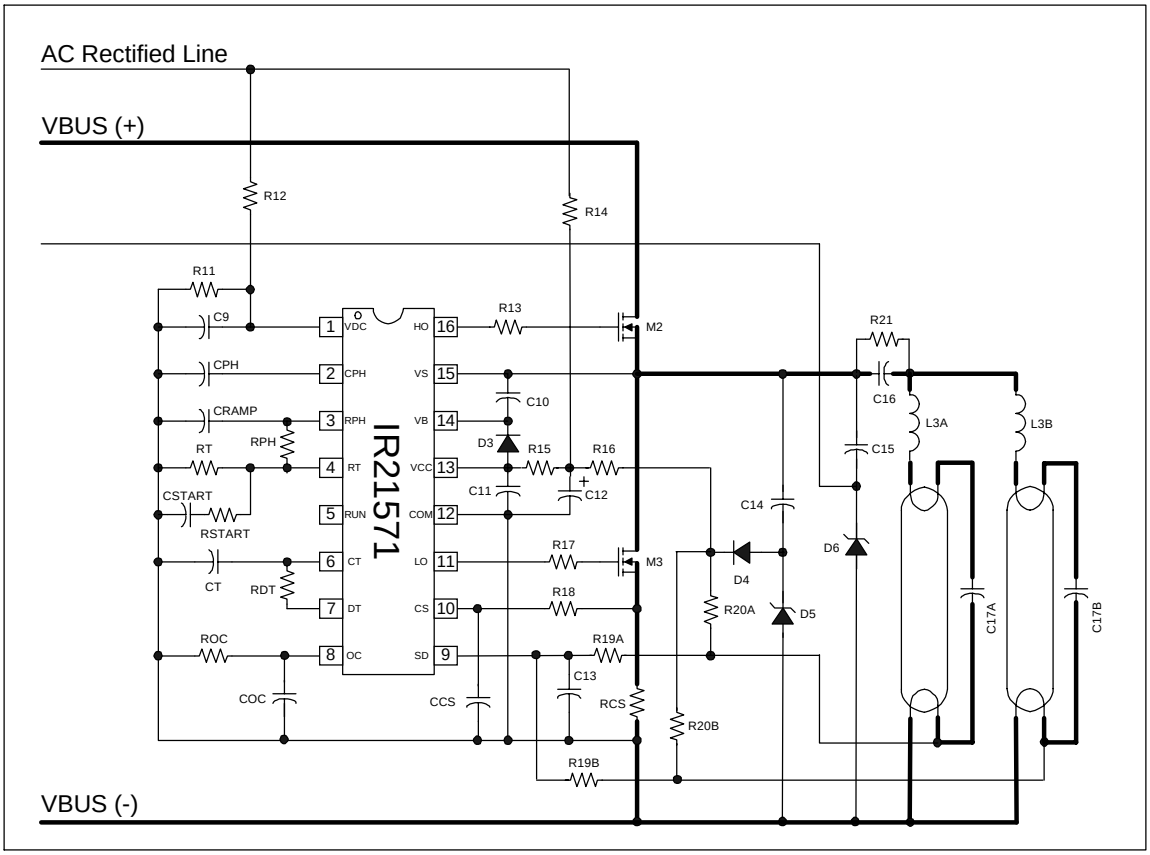
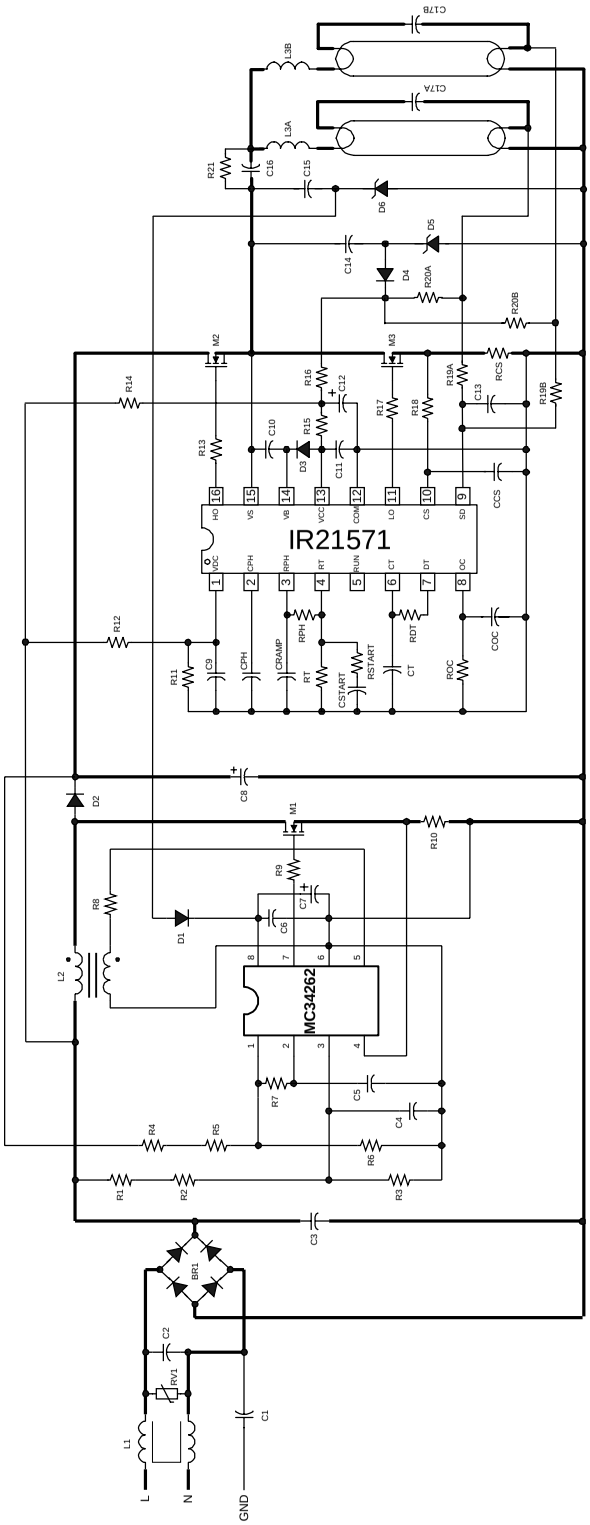


Figure 1: Ballast output stage circuitry for the dual lamp parallel configuration (Variation I).

Schematic Diagram
(Variation 1)



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

MEASUREMENTS (VARIATION I: Both lamps turn off when one is removed)

The waveforms shown in Figures 2 and 3 were captured during the ignition mode. They are similar for either lamp in the parallel configuration. Dummy filament resistors have been inserted to simulate a lamp non-strike fault condition. This forces the over-current threshold of the IR21571 to be exceeded during igntion mode and the half bridge is disabled. It is at this time that maximum inductor current and lamp voltage are measured. Figures 4 and 5 show the filament current and lamp voltage during preheat and igntion modes. Figures 6 and 7 show the filament current and lamp voltage during preheat, ignition and run modes. Figure 8 shows a typical lamp filament voltage during preheat mode.

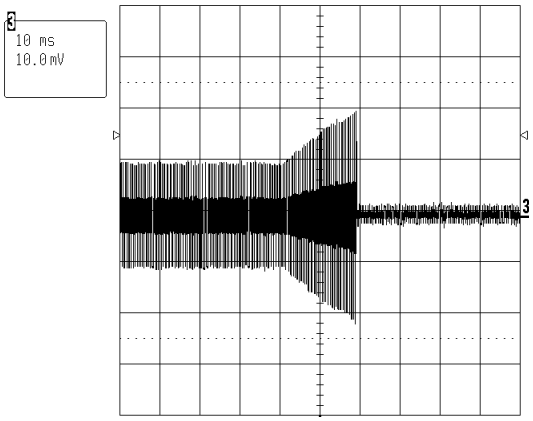


Figure 2: Upper and lower filament currents during ignition mode (1A/Div).

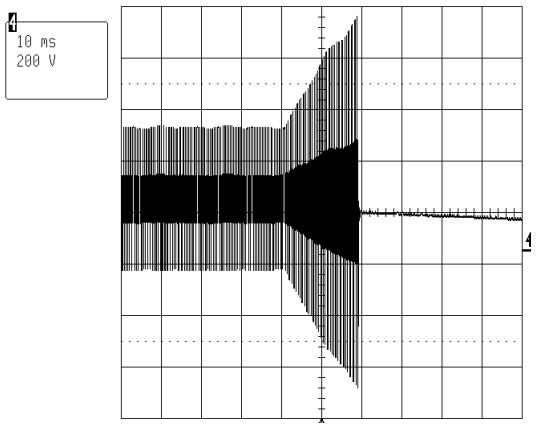


Figure 3: Lamp ignition voltage during ignition mode.

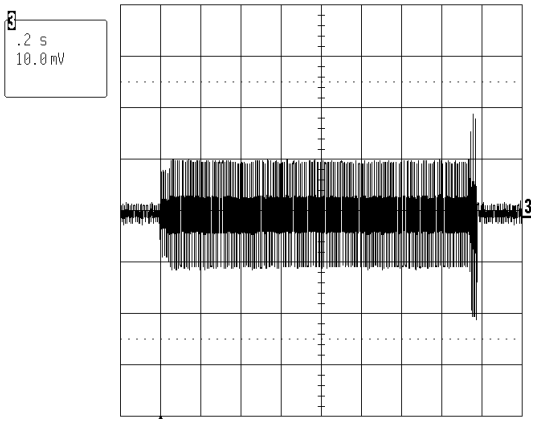


Figure 4: Upper and lower filament current during preheat and ignition (1A/Div).

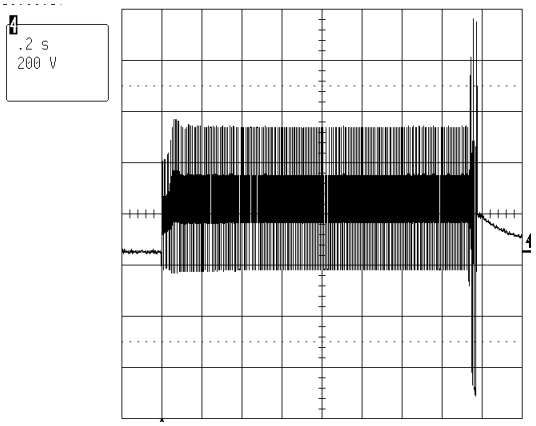


Figure 5: Lamp voltage during preheat and ignition

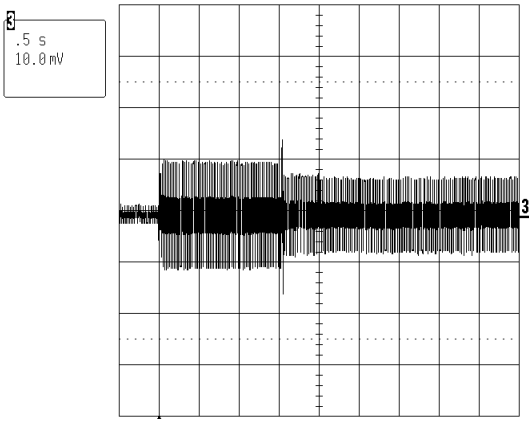


Figure 6: Upper and lower filament current during preheat, ignition and run modes (1A/Div).

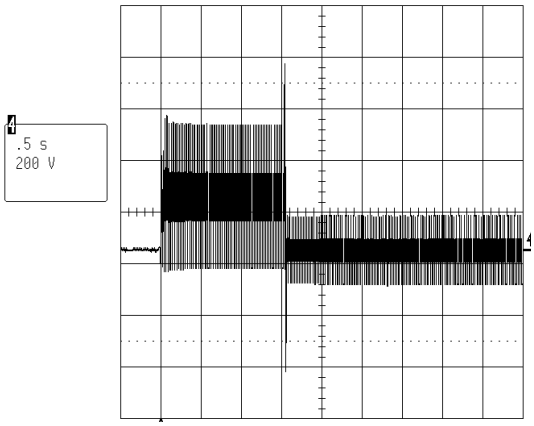


Figure 7: Lamp voltage during preheat, ignition and run modes.

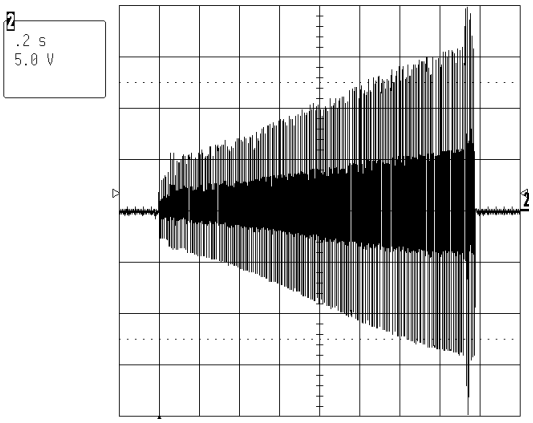


Figure 8: Preheat filament voltage

Bill of Materials (VARIATION I)

Item #	Qty	Manufacturer	Part Number	Description	Reference
1	1	Int'l Rectifier	DF10S	Bridge Rectifier, 1A 1000V	BR1
2	1	Roederstein	WY0222MCMBF0K	Capacitor, 2.2nF 275 VAC Y Cap	C1
3	1	RG Allen	275MKP334K	Capacitor, 0.33uF 275 VAC	C2
4	2	RG Allen	400MPS104K06A	Capacitor, 0.1uF 400 VDC	C3, C16
5	2	RG Allen	S1206Z103K1HRN	Capacitor, 0.01uF SMT 1206	C4, CSTART
6	3	RG Allen	S1206Z474K1HRN	Capacitor, 0.47uF SMT 1206	C5, C6, C13
7	1	RG Allen	1H2R2M50TB15X11	Capacitor, 2.2uF 50VDC 105C	C7
8	1	RG Allen	2W10M450TB113X21	Capacitor, 10uF 450VDC 105C	C8
9	4	RG Allen	S1206Z104K1HRN	Capacitor, 0.1uF SMT 1206	C9,C10, C11, COC
10	2	RG Allen	S1206Z334K1HRN	Capacitor, 0.33uF SMT 1206	CPH, CRAMP
11	1	RG Allen	1H4R7M50TB15X11	Capacitor, 4.7uF 50VDC 105C	C12
12	1	RG Allen	S1812N152K3ARN	Capacitor, 1.5nF 1KV SMT 1812	C14
13	1	RG Allen	S1812N102K3ARN	Capacitor, 1nF 1KV SMT 1812	C15
14	2	RG Allen	1600PPSB103K09A	Capacitor, 10nF,1600V	C17A, C17B
15	1	RG Allen	S1206N471K2ARN	Capacitor, 470pF SMT 1206	CT
16	1	RG Allen	S1206N101K2ARN	Capacitor, 100pF SMT 1206	CCS
17	2	Diodes	LL4148DICT-ND	Diode, 1N4148 SMT DL35	D1, D4
18	2	Int'l Rectifier	10BF60	Diode, SMT SMB	D2, D3
19	2	Diodes	ZMM5250BCT	Diode, Zener 20V SMT DL35	D5, D6
20	1	ST	L6560	IC, Power Factor Controller	IC1
21	1	Int'l Rectifier	IR21571	IC, Ballast Driver	IC2
22	1	Panasonic	ELF-15N007A	EMI Inductor, 1X10mH 0.7Apk	L1
23	1	RG Allen	RGA-K86960	PFC Inductor, 2.0mH 2.0Apk	L2
24	2	RG Allen	RGA97408C	Inductor, 2.0mH, 3.0Apk	L3A,L3B
25	3	Int'l Rectifier	IRF840	Transistor, MOSFET	M1, M2, M3
26	6	RG Allen	CR32C684JT	Resistor, 680K ohm SMT 1206	R1, R2, R4, R5, R19A, R19B
27	2	RG Allen	CR32C103JT	Resistor, 10K ohm SMT 1206	R3, RSTART
28	1	RG Allen	CR32C822JT	Resistor, 8.2K ohm SMT 1206	R6
29	2	RG Allen	R25G104JT	Resistor, 100K ohm ¼ watt	R7, R21
30	1	RG Allen	CR32C223JT	Resistor, 22K ohm SMT 1206	R8
31	3	RG Allen	CR32C220JT	Resistor, 22 ohm SMT 1206	R9, R13, R17
32	1	RG Allen	RSMF1/2W0R5FT	Resistor, 0.5 ohm ½ watt	R10
33	1	RG Allen	CR32C563JT	Resistor, 56K ohm SMT 1206	R11
34	1	RG Allen	R25G225JT	Resistor, 2.2Mohm ¼ watt	R12
35	1	RG Allen	R25G394JT	Resistor, 390K ohm ¼ watt	R14
36	2	RG Allen	CR32C100JT	Resistor, 10 ohm SMT 1206	R15, R16
37	1	RG Allen	CR32C102JT	Resistor, 1K ohm SMT 1206	R18
38	2	RG Allen	CR32C105JT	Resistor, 1.0M ohm SMT 1206	R20A, R20B
39	1	RG Allen	RSMF1/2W0R7FT	Resistor, 0.7 ohm ½ watt	RCS
40	1	RG Allen	CR32C562JT	Resistor, 5.6K ohm SMT 1206	RDT
41	1	RG Allen	CR32C513JT	Resistor, 51K ohm SMT 1206	ROC
42	1	RG Allen	CR32C823JT	Resistor, 82K ohm SMT 1206	RPH
43	1	RG Allen	CR32C203JT	Resistor, 20K ohm SMT 1206	RT
44	1	RG Allen	RV05K300	Transient Suppressor	RV1
Total	69				

FUNCTIONAL DESCRIPTION (VARIATION II: One lamp remains running when the other is removed)

Figure 10 shows the output stage for the parallel lamp configuration with the additional control circuitry for lamp presence detection and automatic restart. When one of the lamps is removed, the base of Q1 is pulled high. This turns Q1 on but does not affect SD. The other lamp will therefore remain running. When the lamp is re-inserted, Q1 is turned off and a momentary voltage pulse appears at the SD pin due to C18, R20 and R21. This pulse momentarily pulls SD above the 2V threshold and resets the IR21571. As SD falls below 1.8V, the IR21571 is restarted in the preheat mode. This assures proper heating of the filaments before the lamp is re-ignited. If both lamps are removed, hard-switching will occur at the half-bridge and the resulting currents will cause the voltage across the current sensing resistor, RCS, to exceed the over-current threshold programmed by resistor ROC. This will disable the half-bridge driver outputs HO and LO.

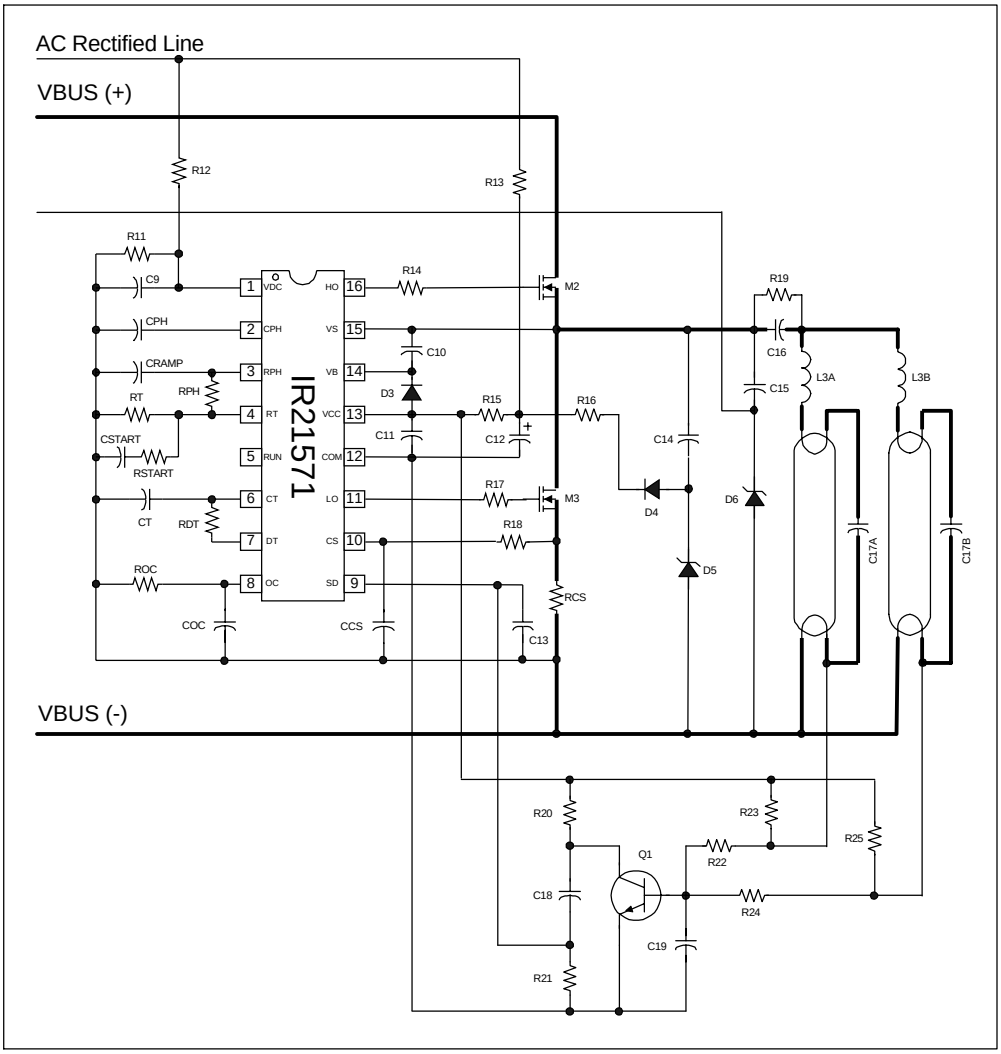
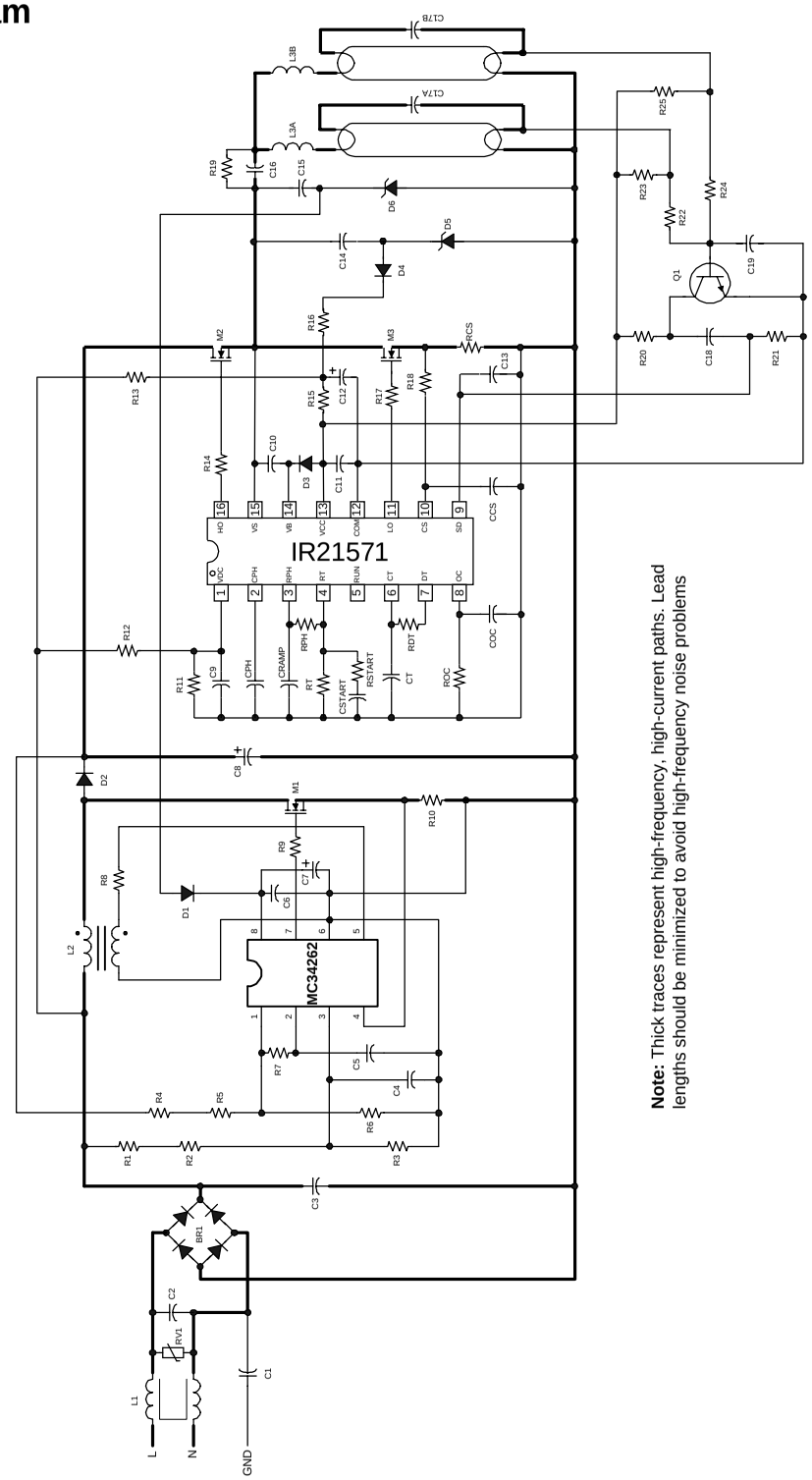


Figure 10: Ballast output stage with additional circuitry for Variation II.

Schematic Diagram
(Variation II)



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

Bill of Materials (Variation II)

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	RG Allen	275MKP334K	Capacitor, 0.33uF 275 VAC	C2
4	2	RG Allen	400MPS104K06A	Capacitor, 0.1uF 400 VDC	C3, C16
5	3	RG Allen	S1206Z103K1HRN	Capacitor, 0.01uF SMT 1206	C4, CSTART, C18
6	3	RG Allen	S1206Z474K1HRN	Capacitor, 0.47uF SMT 1206	C5, C6, C13
7	1	RG Allen	1H2R2M50TB15X11	Capacitor, 2.2uF 50VDC 105C	C7
8	1	RG Allen	2W10M450TB113X21	Capacitor, 10uF 450VDC 105C	C8
9	4	RG Allen	S1206Z104K1HRN	Capacitor, 0.1uF SMT 1206	C9,C10, C11, COC
10	2	RG Allen	S1206Z334K1HRN	Capacitor, 0.33uF SMT 1206	CPH, CRAMP
11	1	RG Allen	S1206Z474K1HRN	Capacitor, 0.47uF SMT 1206	C19
12	1	RG Allen	1H4R7M50TB15X11	Capacitor, 4.7uF 50VDC 105C	C12
13	1	RG Allen	S1812N152K3ARN	Capacitor, 1.5nF 1KV SMT 1812	C14
14	1	RG Allen	S1812N102K3ARN	Capacitor, 1nF 1KV SMT 1812	C15
15	2	RG Allen	1600PPSB103K09A	Capacitor, 10nF,1600V	C17A, C17B
16	1	RG Allen	S1206N471K2ARN	Capacitor, 470pF SMT 1206	CT
17	1	RG Allen	S1206N101K2ARN	Capacitor, 100pF SMT 1206	CCS
18	2	Diodes	LL4148DICT-ND	Diode, 1N4148 SMT DL35	D1, D4
19	2	International Rectifier	10BF60	Diode, SMT SMB	D2, D3
20	2	Diodes	ZMM5250BCT	Diode, Zener 20V SMT DL35	D5, D6
21	1	ST	L6560	IC, Power Factor Controller	IC1
22	1	International Rectifier	IR21571	IC, Ballast Driver	IC2
23	1	Panasonic	ELF-15N007A	EMI Inductor, 1X10mH 0.7Apk	L1
24	1	RG Allen	RGA-K86960	PFC Inductor, 2.0mH 2.0Apk	L2
25	2	RG Allen	RGA97408C	Inductor, 2.0mH, 3.0Apk	L3A, L3B
26	3	International Rectifier	IRF840	Transistor, MOSFET	M1, M2, M3
27	4	RG Allen	CR32C684JT	Resistor, 680K ohm SMT 1206	R1, R2, R4, R5
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37	2	RG Allen	CR32C100JT	Resistor, 10 ohm SMT 1206	R15, R16
38	1	RG Allen	CR32C102JT	Resistor, 1K ohm SMT 1206	R18
39	1	RG Allen	CR32C514JT	Resistor, 510K ohm SMT 1206	R21

Bill of Materials (Variation II) cont.

40	2	RG Allen	CR32C105JT	Resistor, 1.0M ohm SMT 1206	R23, R25
41	1	RG Allen	RSMF1/2W0R7FT	Resistor, 0.7 ohm ½ watt	RCS
42	1	RG Allen	CR32C562JT	Resistor, 5.6K ohm SMT 1206	RDT
43	1	RG Allen	CR32C513JT	Resistor, 51K ohm SMT 1206	ROC
44	1	RG Allen	CR32C823JT	Resistor, 82K ohm SMT 1206	RPH
45	1	RG Allen	CR32C203JT	Resistor, 20K ohm SMT 1206	RT
46	1	Zetex	FMMT2222ACT	Transistor, Bipolar, NPN SMT	Q1
47	1	RG Allen	RV05K300	Transient Suppressor	RV1
Total	75				