International
IOR Rectifier

APPLICATION NOTE

AN-1022

International Rectifier • 233 Kansas Street El Segundo CA 90245 USA

IR2159: 250W Metal Halide HID Dimmable Ballast

By T. Ribarich

TOPICS COVERED

Introduction
Basic Circuit Considerations
Schematic Diagrams

1. INTRODUCTION

The following design is a fully-functional dimming ballast adjusted specifically for a 250W Metal Halide HID lamp. The design includes EMI filter, rectifier, active PFC, ballast output stage, IR2159 Dimming Control IC, and additional timing circuitry for multiple ignitions. The IR2159 Dimming Control IC is used to regulate lamp power, set the minimum and maximum brightness levels and protect the ballast against conditions such as lamp strike failures, low DC bus, thermal overload or lamp failure during normal operation. When compared to conventional HID ballasts, this solution has the following advantages:

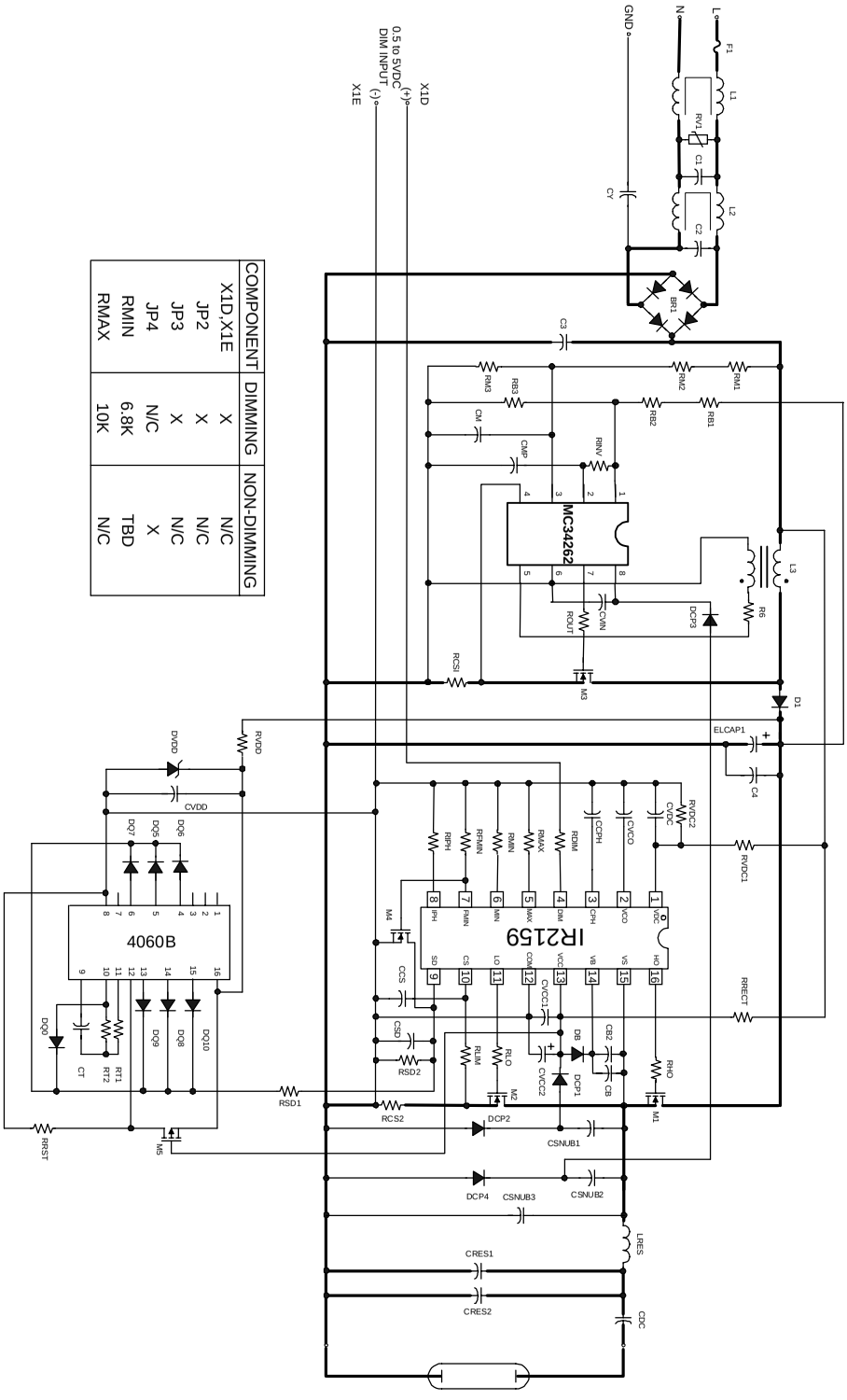
Dimmability (energy savings)
Higher Reliability (no igniter required)
Higher Efficiency (increased lumens/Watt)
Easy Adaptibility (minimal changes for different lamp types)
Less Weight

Please note that this design does not include a complete EMI filter or an isolated dimming interface.

2. BASIC CIRCUIT CONSIDERATIONS

The output stage consists of a series L, parallel C and lamp resonant circuit. This topology allows for ignition and dimming operating points to be fulfilled while operating at high frequency for good efficiency. The PFC circuit is a boost type running in critical continuous conduction mode. Because this ballast is for operation at 220VAC, the peak PFC currents are therefore managable in the PFC FET and inductor such that the running temperatures are not too high. The circuit also includes an additional timer circuit which provides multiple ignition pulses separated by a 5 minute wait period. By waiting until the lamp has cooled, the need for producing very high hot-restrike voltages has been eliminated.

Schematic



COMPONENT	DIMMING	NON-DIMMING
X1D,X1E	X	N/C
JP2	X	N/C
JP3	X	N/C
JP4	N/C	X
RMIN	6.8K	TBD
RMAX	10K	N/C

Bill of Materials

Lamp type: Metal Halide/250W Line Input Voltage: 185..265 VAC/50..60 Hz

Item	Qt	Manufacturer	Part Number	Description	Reference
1	1	IR	KBPC606	Bridge Rectifier, 6A 600V	BR1
2	1	Roederstein	WY0222MCMBF0K	Capacitor, 2.2nF 275 VAC Y	CY
3	2	RG Allen	275MKP334K	Capacitor, 0.33uF 275 VAC	C1, C2
4	3	RG Allen	400MPS104K06A	Capacitor, 0.1uF 400 VDC	C3, C4, CDC
5	1	RG Allen	2V10M350TB110X20	Capacitor, 100uF 450VDC 105C	ELCAP1
6	6	RG Allen	S1206Z104K1HRN	Capacitor, 0.1uF 50V	CVCC1, CB1, CB2, CVDD, CVCO, CCPH
7	1	RG Allen	S1206Z333K1HRN	Capacitor, 0.01uF 50V	CM
8	1	RG Allen	1H4R7M50TB15X11	Capacitor, 10uF 50VDC 105C	CVCC2
9	1	RG Allen	S1812N150K3ARN	Capacitor, 1nF 1KV	CSNUB1
10	1	RG Allen	S1812N150K3ARN	Capacitor, 2.2nF 1KV	CSNUB2
11	2	RG Allen	1600PPSA682K09A	Capacitor, 10nF, 2000V	CRES1, CRES2
12	1	RG Allen	R15W334M1HA5R	Capacitor, 0.33uF, 50V	CVDC
13	2	RG Allen	R15W334M1HA5R	Capacitor, 0.47uF, 50V	CMP, CT
14	1	RG Allen	S1206N201K2ARN	Capacitor, 200PF 50V	CCS
15	7	Microsemi	1N4148MSCT	Diode, 1N4148	DQ0, DQ5, DQ6, DQ7, DQ8, DQ9, DQ10
16	4	IR	10DF6	Diode	DCP1, DCP2, DCP3, DB
17	1	Diodes	1N5250BDICT	Diode, Zener 20V, 500mW	DCP4
18	1	Motorola	MUR460	Diode, 600V, 8A	D1
19	1	Diodes	1N5245BDICT	Diode, Zener 15V, 500mW	DVDD
20	1	Motorola	34262	IC, Power Factor Controller	IC1
21	1	IR	IR2159	IC, Ballast Driver	IC2
22	1	Motorola	MC14060B	Ripple Counter	IC3
23	2	JW Miller	7119	EMI Inductor, 5mH, 4A	L1, L2
24	1	TDK	EF28	PFC Inductor, 0.25mH 5.0Apk	L3
25	1	TDK	EF42	PFC Inductor, 0.2mH 8.0Apk	LRES
26	3	IR	IRFP22N50A	Transistor, MOSFET	M1, M2, M3
27	1	IR	IRFU014	Transistor, MOSFET, N-Channel	M4
28	1	IR	IRFU9014	Transistor, MOSFET, P-Channel	M5
29	5			Jumper	JP1, JP2, JP3, JP4, JP5
30	2	RG Allen	R25G684JT	Resistor, 680K ohm ¼ watt	RM1, RM2
31	1	RG Allen	R25G752JT	Resistor, 7.5K ohm ¼ watt	RM3
32	3	RG Allen	R25G103JT	Resistor, 10K ohm ¼ watt	RDIM, RB3, RMAX
33	1	RG Allen	R25G102JT	Resistor, 1K ohm ¼ watt	RLIM
34	1	RG Allen	R25G123JT	Resistor, 12K ohm ¼ watt	RIPH
35	3	RG Allen	R25G500JT	Resistor, 5 ohm ¼ watt	ROUT, RLO, RHO
36	1	RG Allen	R25G273JT	Resistor, 27K ohm ¼ watt	RVDC2
37	1	RG Allen	R25G223JT	Resistor, 22K ohm ¼ watt	RZX
38	1	RG Allen	R25G474JT	Resistor, 470K ohm ¼ watt	RVDD
39	1	RG Allen	R25G304JT	Resistor, 300K ohm ¼ watt	RRECT
40	2	RG Allen	R25G105JT	Resistor, 1M ohm ¼ watt	RVDC1, RT1
41	1	RG Allen	R25G123JT	Resistor, 12K ohm ¼ watt	RFMIN
42	1	RG Allen	R25G682JT	Resistor, 6.8K ohm ¼ watt	RMIN
43	1	RG Allen	R25G104JT	Resistor, 100K ohm ¼ watt	RINV
44	2	RG Allen	R25G824JT	Resistor, 820K ohm ¼ watt	RB1, RB2
45	2	RG Allen	R25G223JT	Resistor, 220K ohm ¼ watt	RSD1, RSD2
46	1	RG Allen	R25G474JT	Resistor, 470K ohm ¼ watt	RT2
47	1	RG Allen	RSMF1W0R33FT	0.33 Ohm, 1 Watt, 1%	RCS1
48	1	RG Allen	RSMF1W0R1FT	0.2 Ohm, 1 Watt, 1%	RCS2
49	1	RG Allen	RV05K300	Transient Suppressor	RV1
50	1	Littlefuse	F951	Fuse, 4A, 250V, (5mm x 20mm)	F1

Bill of Materials cont.

Lamp type: Metal Halide/250W Line Input Voltage: 185..265 VAC/50..60 Hz

50	1	Littlefuse	F951	Fuse, 4A, 250V, (5mm x 20mm)	F1
51	2	Bussman	283-2335	Fuse Holder	
52	1	Wago		Connector, 5 terminal	X1
53	1	Wago		Connector, 2 terminal	X2
Total	**87**				

Waveforms

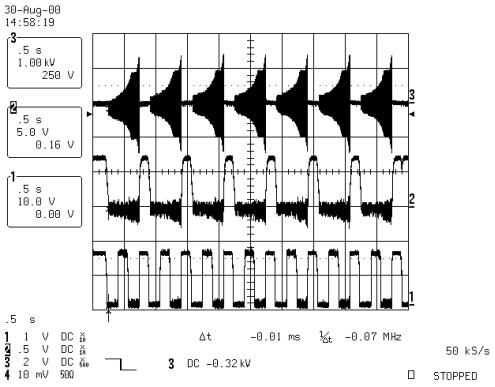


Figure 1. Lamp Voltage, SD pin and pin 9 of 4060B during non-strike pulsing.

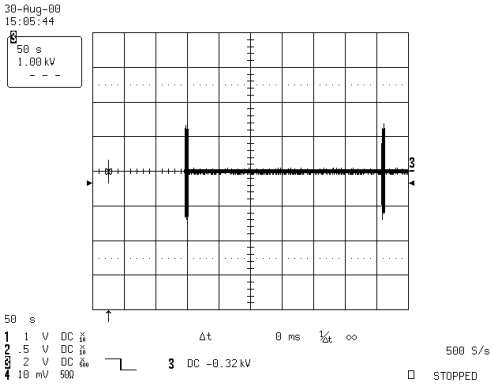


Figure 2. Lamp Voltage during non-strike showing 5 minute wait between pulses.

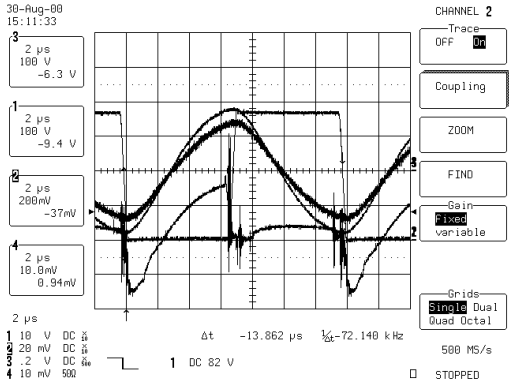


Figure 3. Lamp Voltage, Lamp Current (1A/div), VS and CS during 100% brightness.

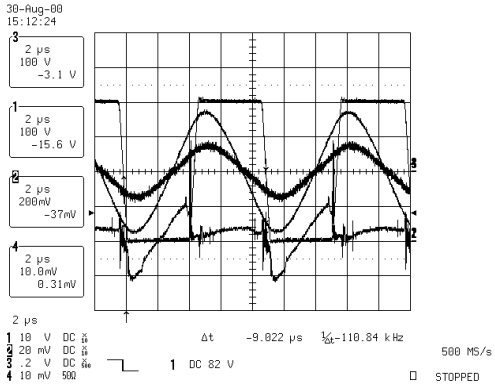


Figure 4. Lamp Voltage, Lamp current (1A/div), VS and CS during 50% dimming.

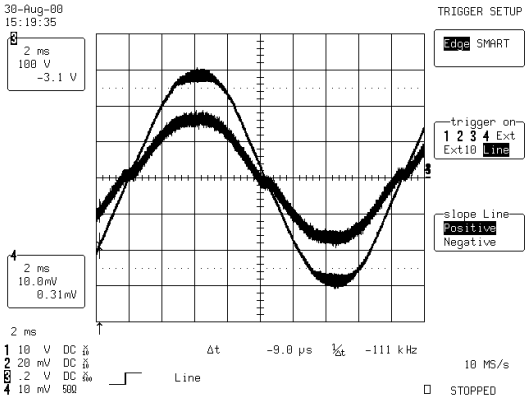


Figure 5. Line input voltage and line input current (1A/div) during 100% brightness.

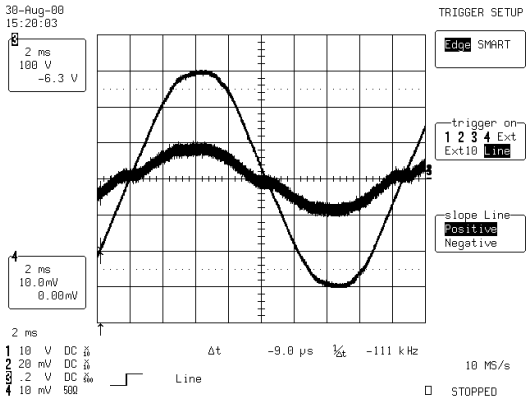


Figure 6. Line input voltage and line input current (1A/div) during 50% brightness.