

High Frequency Electronic Ballast

Function of an UV ballast

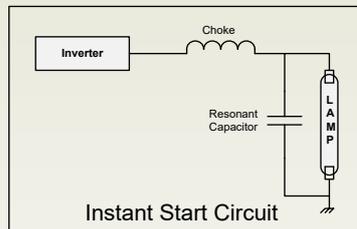
- To provide the proper voltage and current such that a steady plasma can be established between the lamp electrodes and by which a constant UV intensity can be generated.
- To maximize UV lamp life at its desired operating condition and prevent premature lamp filament deterioration.



Methods of starting lamps

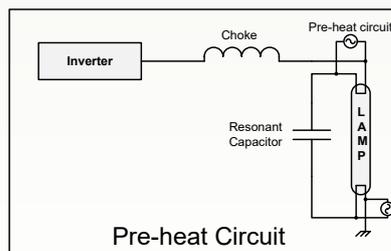
1. Instant Start

- Starts a lamp by inducing a relative high voltage across the electrodes.
- Usually connects to a single pin at each end of the lamp
- Work in conjunction with instant start lamp to minimize emission coating sputtering
- Suitable for low switching (on/off) cycle



1. Pre-heat Start

- Starts a lamp by heating the lamp filament and then applies a relative low strike voltage across the lamp electrode
- Connects to a pair of pins at each end of the lamp
- Work with a pre-heat style lamp
- Suitable for many switching (on/off) cycle



High Frequency Electronic Ballast

Lamp connection



- **Series** - When lamps are connected in series to a ballast, if one lamp fails, every lamp will extinguish in the series. Instant start ballast is not recommended to drive lamps in series.
- **Parallel** - When lamps are connected in parallel to a ballast, if one lamp fails, the remaining lamps in the circuit will continue to work.
- Consult LightWave technical staff for assistance in selecting a ballast to operate multiple lamps.

Ballast terminologies

- **Input Voltage**

- **Dedicated** - Ballast is designed to work at the specific voltage such as 110V, 230V, 24V. Ballast is typically designed to operate with normal power factor.
- **Universal** - Ballast is designed to work over a wide range of input voltage from 120V - 277V. Ballast is typically designed to operate with high power factor.

- **Input Wattage**

Input wattage published by the manufacturer is the total power consumed by both the ballast and the lamp. The unit of measurement is watts which is voltage (V, volts) multiple by current (I, Amps).

$$W = V \times I$$

- **Power Factor**

Power factor is the measurement of how efficiently a ballast converts the input voltage and current supplied by the power source into watts of usable power delivered to the ballast and lamp.

$$PF = \frac{\text{Input Watts}}{\text{Input Voltage} \times \text{Input Current}}$$

Normal Power Factor : ≥ 0.79
 Power Factor Corrected : 0.80 to 0.89
 High Power Factor : ≥ 0.90



High Frequency Electronic Ballast

Ballast terminologies

- **Total Harmonic Distortion (THD)**



Harmonic distortion occurs when the wave form of voltage or current deviates from a pure sinusoidal wave shape. All electronic devices, due to their tolerances and behaviors, will deviate from a pure sine wave and hence contribute to the harmonic distortion of the device. The ballast, therefore, will inject this harmonic distortion to the power line. THD is the percent of total harmonic current that the ballast adds to the power distribution system. ANSI standard for electronic ballast specifies a maximum of 32% THD for commercial application. The problem with high THD is that it can cause overheating of the wire. Light-Wave ballasts are rated at 20% THD or less.

- **Total Harmonic Current (THC)**

Total Harmonic Current is the factor that directly affects the heating of the wires and distribution transformer. It can be calculated as follows.

$$THC = \frac{\text{Ballast Input Current}}{(1 + 1/THD^2)^{0.5}}$$

For a magnetic ballast which has an input current that is higher than an equivalent electronic ballast, the THC will be much higher. This additional THC will increase thermal load to wires and distribution transformer.

- **Inrush Current**

Due to the capacitive impedance nature of electronic devices, the initial current surge is usually larger than the steady state operating current. The peak of this surge current is called the inrush current. The duration for this peak input current, however, is short. Electrical system and circuit design should consider this factor in the selection of proper component. NEMA 410 governs the worst case inrush current requirement for electronic ballast. LightWave ballasts are designed to limit the inrush current to 2 times the operating current.



High Frequency Electronic Ballast

Ballast terminologies

- **Ballast Noise**



Sometimes, one may hear a slight “humming” sound associated with the ballast. This noise is a result of vibration caused by the inherent electromagnetic action in the transformer or other magnetic devices. To various degree, all ballasts exhibit this noise and are governed by a sound rating, “A through F”, A being the quietest. Since there is no ANSI standard for this rating, it is up to the manufacturers to rate their ballasts.

- **Crest Factor**

Lamp Current Crest Factor is the ratio between the peak current and the RMS current (assuming a sinusoidal wave form). It is a measurement on the effectiveness of current utilization. High crest factor usually cause the lamp to wear out faster, thus, reducing lamp life.

$$\text{Crest Factor} = \frac{I_{\text{peak}}}{I_{\text{rms}}}$$

- **Certifications**

LightWave Ballasts are certified to UL, CUL, CE, NATA standards. In addition, LightWave ballasts also meets the requirements to FCC Part 18, Class A, B, EMC directive of 89/336/EEC and low voltage directive of 73/223/EEC, and EMC requirement of AS/NZS CISPR 15: 2006. Some of LightWave’s ballasts are also certified to IPX4 for outdoor applications.

- **Other LightWave ballast specifications**

End of lamp life protection circuit
 Ballast over temperature protection circuit
 Maximum case temperature : 60°C
 Total Harmonic distortion - < 10%
 Power factor —nominal and high



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Low Pressure UV lamps

Characteristic of lamp failure



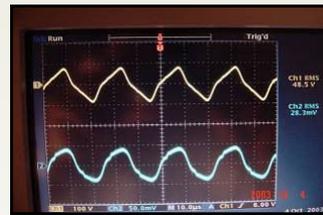
The majority of lamp failures can be attributed to the loss of emission coating on lamp filaments (den Hoek 2002, Verderber 1985, Waymouth 1971). Occasionally, other failures such as filament breakage and lamp leakage are also observed. Low pressure UV lamps use thermionic emission process to discharge electrons for lamp operation. Therefore, maintaining the electrode temperature is a key factor in enhancing lamp operation and lamp life.

Evaporation - A process whereby the emission coating is removed from the electrode when the temperature at the electrode is too high ($> 1000^{\circ}\text{C}$). When the emission materials are deposited on the cooler lamp wall, a lamp-end darkening results.

Sputtering - A process whereby the emission material is removed by the accelerated charged ions when the electrode temperature is too low. The result can also be darkening of lamp wall surface.

Ballast's features that affects lamp operation

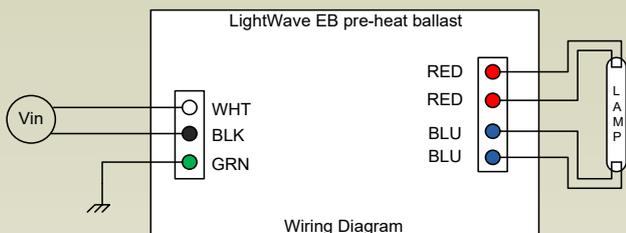
- **Current Crest Factor** - A high current crest factor is indicative of a distorted wave shape which may have a high peak current that is damaging to the electrode. ANSI standard recommends a CCF of less than 1.7 for ballast. LightWave's CCF is about 1.5.



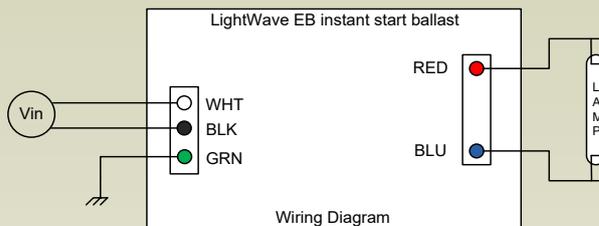
- **Supplemental electrode heating voltage** - Supplemental electrode heating voltage is applied across the lamp filament at each end of the lamp during operation. It is used to reduce the possibility of sputtering effect of the lamp. LightWave pre-heat ballasts have this feature included in the design.
- **Lamp operating current** - Lamp operating current should be designed to provide the desired light output. LightWave's ballasts are designed to optimize the UV output without causing a potential emission coating evaporation effect.

Wiring Diagrams

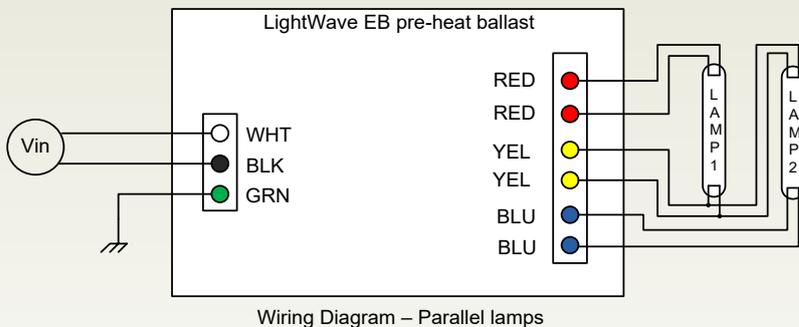
Pre-heat ballast



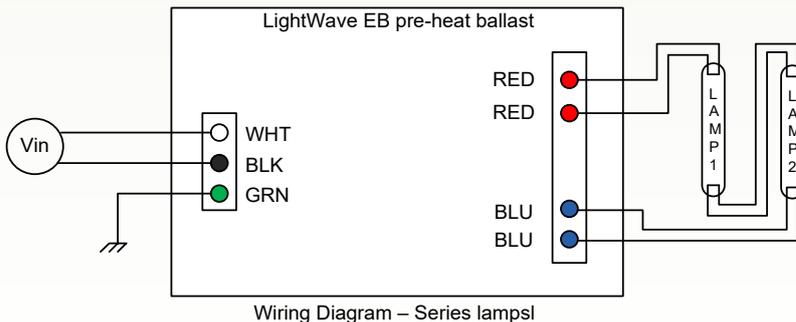
Instant start ballast



Lamps wired in paral-



Lamps wired in series



4W - 16W

For T5 Lamps

Applications

- Water cooler
- Water dispenser
- In line water disinfection unit
- Personal sanitizer
- Air disinfection with PCO



Special Features

- Small size
- Economical
- High on/off cycles
- Switchable option for either 120V or 230V input
- Customizable to match lamp output

Ballast Model	Available with Input Voltage					Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Lamp Models	Case outline
	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)						
EB-1032	x	x				0.3	8	29 - 56	150 -170	TUV 4W, TUV 6W, TUV 8W	A
EB-1024	x	x				0.3	16	37 - 51	230 -360	TUV 10W, TUV 11W, TUV 15W, TUV 16W	B
EB-1017	x	x		x		0.3	8	29 - 56	150 -170	TUV 4W, TUV 6W, TUV 8W	B



18W - 25W

For T5, T8, T10 Lamps

Applications

- Water dispenser
- In line water disinfection unit
- AC coil cleaning
- Air disinfection with PCO
- Aquarium, pond cleaner
- Upper air disinfection



Special Features

- Multiple sizes
- Suitable for outdoor applications
- High on/off cycles
- 24V input
- Switchable option for either 120V or 230V input
- Customizable to match lamp output

Ballast Model	Available with Input Voltage						Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Max. # of lamps	Lamp Models	Case outline
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)							
EB-1007		x	x	x			0.2	21	25 - 51	380 - 420	1	GPH212, GPH287, GPH303, GPH357, GPH406, GPH436, TUV15, TUV16, G10T5	B
EB-1011		x	x				0.2	18	48	385	1	G20T10	B
EB-1014		x	x				0.3	25	40	400 - 600	1	TUV25, G25T8	B
EB-1025		x	x				0.3	25	45 - 55	400-450	1	GPH436, TUV25, G25T8	B
EB-1008		x	x				0.3	18	25 - 51	400-450	1	GPH212, GPH287, GPH303, GPH357, TUV15, TUV16, G10T5	A
EB-1003		x	x	x	x	x	0.2	21	25 - 51	380 - 420	1	GPH212, GPH287, GPH303, GPH357, GPH406, GPH436, TUV15, TUV16, G10T5	C
EB-1036		x	x				0.3	25	60	420	1	G25T5	C
EB-1042	x	x	x				0.38	41	70 - 120	380 - 420	1	PLL13W, PLL24W	I
EB-1046	x						0.2	21	25 - 51	380 - 420	1	GPH212, GPH287, GPH303, GPH357, GPH406, GPH436, TUV15, TUV16, G10T5	D



36W - 40W

For T5 Lamps

Applications

- Water dispenser
- In line water disinfection unit
- AC coil cleaning
- Air disinfection with PCO
- Aquarium, pond cleaner
- Upper air disinfection

Special Features

- Multiple sizes
- Suitable for outdoor applications
- High on/off cycles
- 24V input
- Switchable option for either 120V or 230V input
- Customizable to match lamp output



Ballast Model	Available with Input Voltage						Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Max. # of lamps	Lamp Models	Case out-line
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)							
EB-1005		x	x				0.38	41	70 - 120	380 - 420	1	GPH793, GPH843, TUV30, TUV36, G36T5, GSL692T5	B
EB-1012		x	x				0.38	30	100	365	1	G30T10	B
EB-1020		x	x				0.38	41	70 - 120	380 - 420	1	GPH793, GPH843, TUV30, TUV36, G36T5, GSL692T5	C
EB-1040				x			0.38	41	70 - 120	380 - 420	1	GPH793, GPH843, TUV30, TUV36, G36T5, GSL692T5	D
EB-1021	x	x	x				0.38	41	70 - 120	380 - 420	2	GPH793, GPH843, TUV30, TUV36, G36T5, GSL692T5	F
EB-1044	x	x	x	x			0.38	41	70 - 120	380 - 420	1	GPH793, GPH843, TUV30, TUV36, G36T5, GSL692T5	I



45W - 55W

For T5 HO Lamps

Applications

- AC coil cleaning
- Air disinfection with PCO
- Aquarium, pond cleaner
- Marine air sanitizer



Special Features

- Multiple sizes
- Suitable for outdoor applications
- High on/off cycles
- 12V and 24V input
- Switchable option for either 120V or 230V input
- Customizable to match lamp output
- Output for optional lamp on LED indicator
- 2 lamps ballast available

Ballast Model	Available with Input Voltage					Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Max. # of lamps	Lamp Models	Case out-line
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)							
EB-1016		x	x			0.38	55	60 - 80	600 - 800	1	GHO436, TUV55W	B
EB-1034		x	x	x		0.38	55	60 - 80	600 - 800	1	GHO436, TUV55W	C
EB-1039					x	0.38	45	75	600	1	GHO406	D



60W - 75W

For T5, T6 HO Lamps

Applications

- Waste water
- Duct cleaner
- Aquarium, pond cleaner
- Swimming pool
- Commercial AC coil cleaner



Special Features

- Multiple sizes
- Suitable for outdoor applications
- High on/off cycles
- Switchable option and universal inputs
- Customizable to match lamp output
- Output for optional lamp on LED indicator
- 2 lamps ballast available

Ballast Model	Available with Input Voltage						Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Max. # of lamps	Lamp Models	Case out-line
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)							
EB-1006		x	x				0.38	75	110 - 179	600 - 800	1	GHO36, TUV 75W	D
EB-1027		x	x				0.38	75	135 - 179	425	1	G48T5, G64T5, G67T5, GPH1148, GPH1554	D
EB-1022		x	x				0.58	75	60 - 80	650 - 800	2	GXO36, GHO609, GHO762, TUV55HO	G
EB-1026		x	x				0.38	75	135 - 179	425	2	G48T5, G64T5, G67T5, GPH1148, GPH1554	G
EB-1043		x	x				0.38	60	65 - 75	700	1	GHO439, GHO527	I



75W - 90W

For T5, T6 HO Lamps

Applications

- Waste water
- Duct cleaner
- Aquarium, pond cleaner
- Swimming pool
- Commercial AC coil cleaner

Special Features

- Multiple sizes
- Suitable for outdoor applications
- High on/off cycles
- 230V or universal input
- Customizable to match lamp output
- Output for optional lamp on LED indicator



Ballast Model	Available with Input Voltage						Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Max. # of lamps	Lamp Models	Case outline
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)							
EB-1013			x				0.58	90	113 - 140	700 - 800	1	GHO846, GHO1100, PLL95	E
EB-1041		x	x				0.58	110	130 - 155	750	1	GHO886, GHO1067	I



110W - 150W

For T5, T6 HO Lamps

Applications

- Waste water
- Aquarium, pond cleaner
- Swimming pool
- Commercial AC coil cleaner

Special Features

- Multiple sizes
- High on/off cycles
- 230V or universal input
- Customizable to match lamp output
- Output for optional lamp on LED indicator



Ballast Model	Available with Input Voltage						Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (mA)	Max. # of lamps	Lamp Models	Case out-line
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)							
EB-1019			x				0.58	155	195	800	1	GHO64	E
EB-1028			x				0.58	155	195	800	2	GHO64	H



31W - 154W

For T5, T6
Amalgam Lamps

Applications

- Waste water
- Aquarium, pond cleaner
- Swimming pool
- Commercial AC coil cleaner

Special Features

- Multiple sizes
- High on/off cycles
- Universal input
- Customizable to match lamp output
- 5V output for optional status circuit



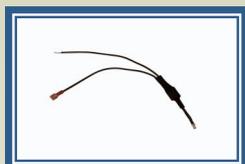
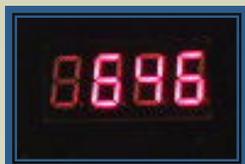
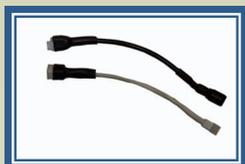
Ballast Model	Available with Input Voltage						Max. Input Current (Amp)	Max. Lamp Power (Watts)	Lamp voltage range (V)	Lamp Current range (A)	Max. # of lamps	Lamp Models	Case outline
	Univ.	120 (Vac)	230 (Vac)	24 (Vac)	12 (Vdc)	24 (Vdc)							
EBA-100-21U	x	x	x				0.58	100	31 - 88	1.8 - 2.1	1	GPH357T6L, GPHHA357T6L	J
EBA-110-12U	x	x	x				0.58	100	36 - 88	1.2	1	GPH357T5L, GPH843T5L	J
EBA-180-21U	x	x	x				0.58	180	71 - 82	1.8 - 2.1	1	GPH843T6L, GPHHA843T6L, GPHA1000T6L	J
EBA-320-21U	x	x	x				0.58	320	134 - 154	1.8 - 2.1	1	GPHA1554T6L, GPHHA1554T6L	K



Accessories

For Electronic Ballast

Applications

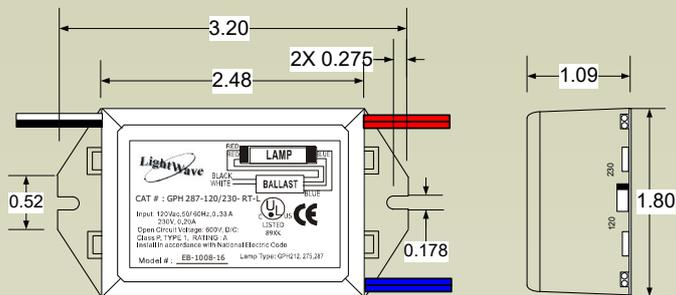


- Interface with different connectors
- Lamp life count down indicator
- External LED indicators for power on and lamp life
- Surge protector

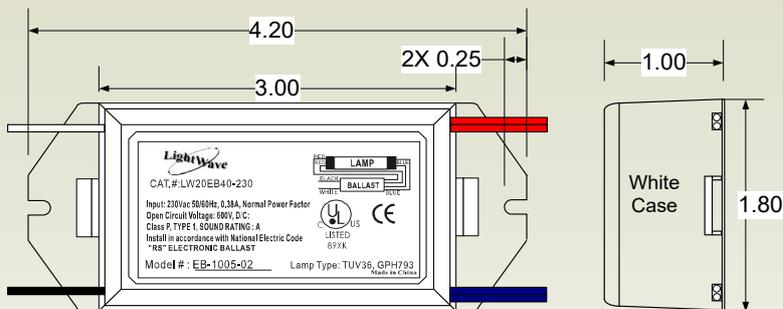
Model #	Description	Specifications	Case outline
FR-1001	Extrenal input EMI filer and suppressor for UV ballast	Suitable for 30W to 95W ballast	B
LW06HW	External LED status indicator	Add-ons LED indicators for line voltage and lamp output	
LW09HW	Interchangeable connector harness	Provides interchangeability between different connection systems	
DHM-1001	LED display and count down controller	Digital readout in either hours or days on remaining lamp life.	
RE-1001	Dual On/Off relay module - 24V-250V, 3A	Suitable for BMS control	



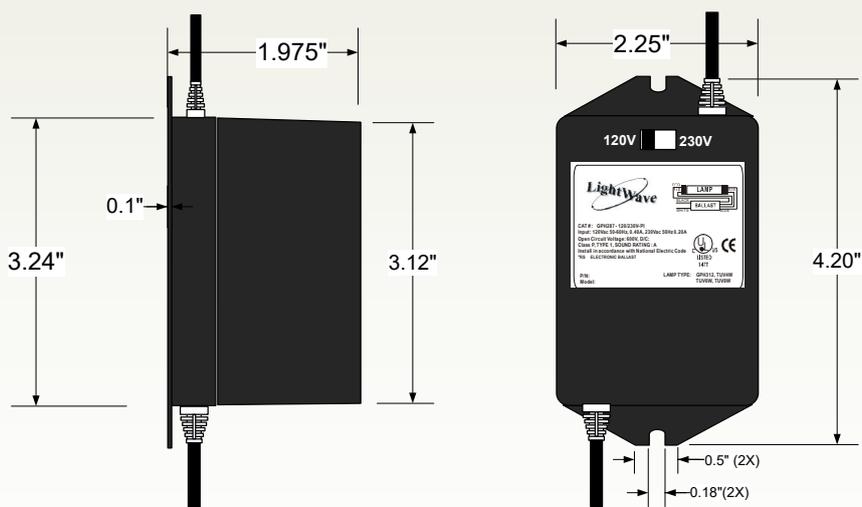
Electronic Ballast Outline Drawing



Case Outline A



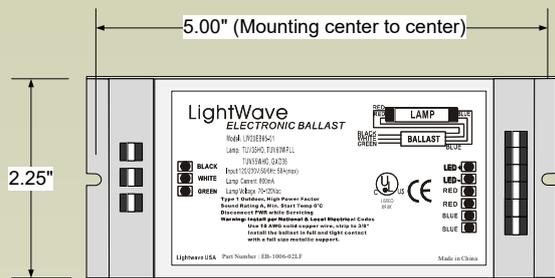
Case Outline B



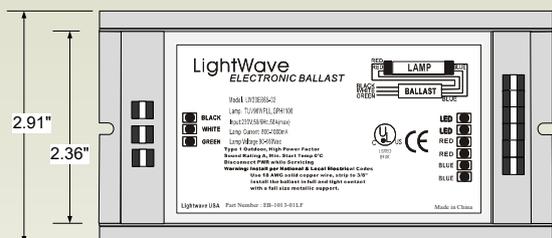
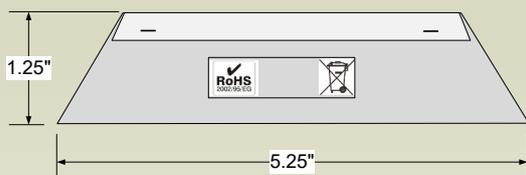
Case Outline C



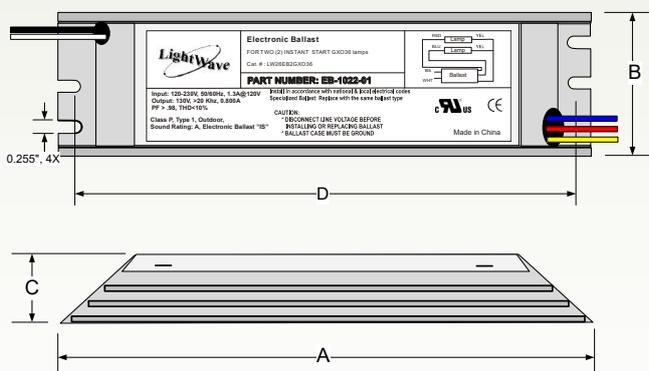
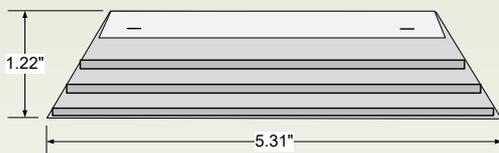
Electronic Ballast Outline Drawing



Case Outline D



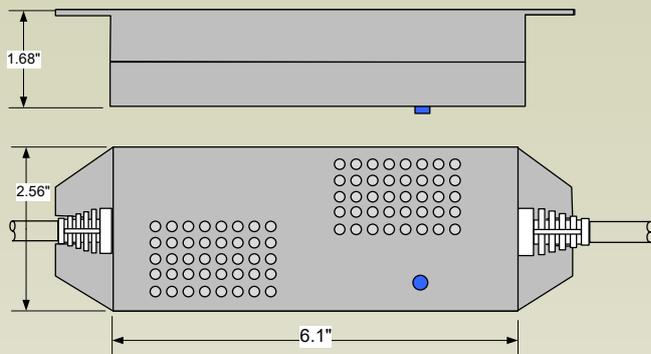
Case Outline E



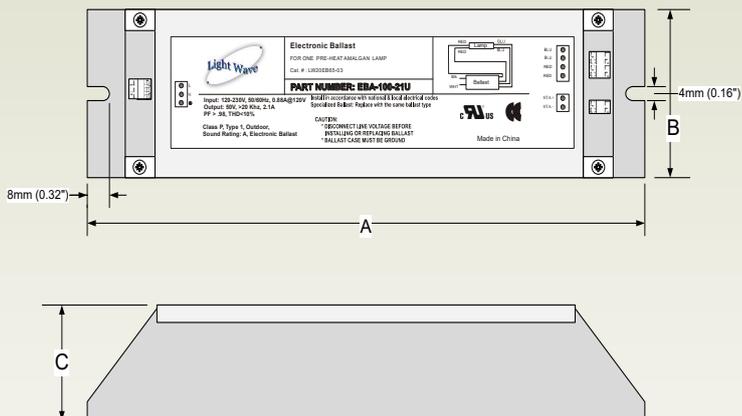
Case Outline	A (in)	B (in)	C (in)	D (in)
F	9.03	2.8	1.25	8.68
G	11.75	2.8	1.25	11.13
H	14.75	2.8	1.25	14.13



Electronic Ballast Outline Drawing



Case Outline I



Case Outline	A (in)	B (in)	C (in)
J	9.76	2.36	2.09
K	9.76	4.13	2.36