BALLAST HANDBOOK

STANDARD™

LEADERS IN LIGHTING

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FLUORESCENT HANDBOOK

What is a ballast?

A ballast is an integral component of most modern lighting systems. It is primarily designed to perform three critical tasks:

- Deliver the proper voltage to start or ignite the lamp(s)
- Regulate the electric current flowing through the lamp(s)
- Compensate for variations in line voltage

The ballast must correspond exactly to the requirements of the lamp it is designed to operate in order to ensure optimal performance.

As a Canadian based company, STANDARD has the most complete range of 347V ballasts on the market. We offer a wide range of ballasts for all lighting applications:

- Linear fluorescent and CFL ballasts
- High intensity discharge ballasts
- Sign ballasts
- Transformers

One System Warranty

Maximize performance by combining STANDARD brand lamps and STANDARD brand ballasts and extend both your lamp and ballast warranties. The warranty is extended to 5 years on the ballast and 3 years on the lamp. For more information, please visit our website.

ONE SYSTEM
WARRANTY APPROVED

All STANDARD ballasts are approved by at least one of the major safety certification organizations including:

Ballast Efficacy Factor (BEF)

BEF is the ratio of ballast light output to input power. This is used to compare different ballasts on a light output to power consumption basis.

The comparison only holds true for ballasts operating the same number and type of lamps.

The formula for calculating BEF is:

$$\textbf{BEF} = \frac{\textbf{Ballast Factor x 100}}{\textbf{Input Watts}}$$

Ballast Factor (BF)

BF is the relative light output of a lamp operated on a given ballast compared to a lamp operated by a laboratory reference ballast. For example, a BF of 0.80 would produce 80% of the lamp's rated lumens (light output). Electronic ballasts are typically available in three BF ranges:

Low (LBF): > 0.85
Normal (NBF): 0.85 – 1.00
High (HBF): < 1.00

A lower BF will use less energy (watts) while reducing light output. A higher BF means higher energy consumption with increased light output.

To calculate the ballast factor for any ballast:

$$\textbf{BF} = \frac{\textbf{light output of lamp operated on commercial ballast}}{\textbf{light output on lamp operated on reference ballast}}$$

Input Power (ANSI Watts)

Input watts is a measure of energy used by the lighting system, in other words, it is the total consumed watts of the ballast and lamps it operates.

This measure varies according to the type of ballast and lamp used in the system. Input watts can be measured at the fixture using the appropriate meter, or by viewing the ANSI ratings as published by the ballast manufacturer.

The ANSI ratings offer a measure of performance, which can be used to compare energy savings between various lighting systems.

Inrush Current

Inrush current is the initial start-up current that occurs on all electrical devices. Typically, inrush current is several times higher than normal operating current.

Though it lasts for a very short time, generally less than 0.004 seconds, inrush current is also used to size the lighting system's circuit breakers or fuses.

Power Factor (PF)

PF is a measure on how efficiently a ballast can transform voltage and current provided by the power line into watts of usable power to the lamp.

A power factor of 1.00 would mean power is being used perfectly.

$$\textbf{PF} = \frac{\textbf{Input Watts}}{\textbf{Input current x Input voltage}}$$

High Power Factor (HPF)	0.90 or greater
Power Factor Corrected (PFC)	0.80 to 0.89
Normal (Low) Power Factor (NPF)	0.79 or less

Total Harmonic Distortion (THD)

When the wave shape of current or voltage diverges from a sine curve, harmonic distortion has occurred.

Ballasts, both magnetic and electronic, play a part in power line distortion, and THD measures the percentage of harmonic current which the ballast adds to the power distribution system.

Most electrical utilities now require that the THD of ballasts be below 20%.

Dimming Ballasts

These ballasts have special circuitry which enables them to operate lamp loads at reduced light levels. The light reduction may be continuous or in discrete steps.

Instant Start (IS)

Instant start ballasts are designed to ignite the lamp by providing a high voltage without the need of preheating the filaments. As a result, instant start ballasts are more energy efficient than other ballasts. They provide a reduction of two watts per lamp compared to rapid start ballasts.

Offering longer remote wiring distances and easy installation, instant start ballasts are ideal for applications that have long burn hours and minimal on/off switching.

Typically, 10,000 to 15,000 switch cycles can be expected before lamp failure.

Preheat (PH)

Preheat ballasts can be used with regular fluorescent lamps but require the use of a separate starter, which can be either manual or automatic. A high open circuit voltage will operate the starter which in turn will preheat the cathodes up to temperatures above 950°C. When the starter opens, a surge in voltage is provided which is high enough to ignite the lamp. The preheat ballast will limit the lamp current to the proper operating level.

Program Start (PS)

Program start electronic ballasts accurately heat the lamp cathodes prior to lamp ignition. This type of system allows for frequent switching (up to 50,000 on/off) while providing maximum lamp life and energy efficiency, making them ideal for applications using occupancy sensors.

Rapid Start (RS)

These ballasts use low voltage to preheat the filaments and a high open circuit voltage applied between the lamp electrodes to generate the arc.

This technology lends itself to both magnetic and electronic ballasts. The temperature of the filament increases until the lamp starts. The filament voltage is continuously applied during the life of the lamp. With rapid start ballasts it is normal to have a small delay in starting as compared to instant start ballasts.

Rapid start ballasts are recommended for use when you have frequent on and off switching. Typically, 15,000 to 20,000 on-off switch cycles can be expected before lamp failure.

Slimline Instant Start

A family of ballasts and lamps which use the instant start circuitry. The lamps have single pin bases and are most often T12, T8 and T6. This circuitry lends itself to both magnetic and electronic ballasts.

Trigger Start (TS)

These ballasts do not require a starter and are designed for use with regular fluorescent lamps. They are equipped with separate windings that will provide enough power to heat lamp filaments within one second. To ensure proper lamp ignition, trigger start ballasts require a higher open circuit voltage than rapid start ballasts.

Ballast Life

STANDARD fluorescent magnetic and electronic ballasts are intended to operate an average of 50,000 hours (at maximum rated case temperature). The useful life of a fluorescent ballast depends on the daily hours of operation and the operating temperature, the latter being the most critical. It is important to note that increasing the operating temperature by 10°C will cut the life expectancy in half, and lowering it by 10°C, will double ballast life.

Crest Factor

Crest factor is the ratio of the peak current value divided by the RMS current value. High current crest factors will reduce the life of the lamp. Many STANDARD electronic types of ballasts have low crest factors.

Effects of Ambient Temperature

The ambient temperature of a normal lighting installation is usually 25°C, which is why fluorescent fixtures are tested at this temperature. Lamps will operate down to 10°C (50°F) for standard lamps and 16°C (60°F) for energy saving lamps.

However, many applications (without air conditioning for example), have ambient temperatures as high as 50°C at the light source. An ambient temperature rise as minimal as 1°C, can cause ballast case temperature to rise by 0.9°C, which will affect lamp light output as most fluorescent lamps optimally perform at an ambient temperature of 25°C.

Low temperatures and cold weather applications such as outdoor or underground parking applications can affect starting and operation. If the ambient temperature decreases further the result will be decreased light levels and increased difficulty in starting the lamps which can lead to early lamp life failure. The ballast must always operate below the maximum rate case temperature in order to maximize life and operation.

EMI/RFI

Electromagnetic interference (EMI) or radio frequency interference (RFI) are unintentionally generated power that has a potential to interfere with other devices operating at high frequencies, such as radios, televisions or medical equipment. EMI/RFI levels are regulated by the FCC, and are usually reduced by filters, suppressor or other devices.

Lamp Operating Frequency

There are two types of operating frequencies associated with fluorescent ballasts: input and output frequency.

- Input frequency is delivered by the power company (utility). In Canada, 60 Hz is the norm.

- Output frequency is sometimes referred to as the lamp operating frequency. This is the frequency that the ballast delivers to the lamp. Magnetic ballasts deliver 50/60 Hz; whereas electronic ballasts deliver a frequency greater than 20,000 Hz. Fluorescent lamps can accept either of these frequencies.

The FCC however, regulates certain ranges such as 30-40 kHz and 56-62 kHz.

STANDARD brand electronic ballasts comply with FCC regulations operating above 20 kHz but avoiding the restricted ranges.

Infrared Interference

Infrared energy is emitted by fluorescent lamps, and may interfere with infrared controls. To avoid any interference, either increase the distance of the fluorescent lamp and the infrared equipment or use a protective shield for the infrared receiver to minimize this effect.

Noise and Sound Ratings

Fluorescent lighting fixtures produce a vibration (a slight buzzing sound) that originates in the core and coil assembly of magnetic ballasts. The buzzing sound can increase based on a variety of factors, including:

- The fashion in which the ballast is mounted in the fixture
- The design of the fluorescent lamp fixture
- Reverberating characteristics of the ceiling, walls, floors and furniture
- Ballast size: generally, the larger the ballast, the more humming it generates

To help sort through the variations, all ballasts carry a published sound rating of A, B, C, or D. These sound ratings are based on measurements of average ambient noise levels during conditions of normal occupancy. The following chart illustrates the average ambient noise level per application, and the corresponding recommended sound rating.

Application	Sound level rating*	Average ambient noise level of interior
Library, reception, reading room, church, school study hall, TV/Radio station	A	20 - 24 decibels
Classroom, residence, quiet office	B	25 - 30 decibels
Commercial building, general office area	C	31 - 36 decibels
Manufacturing facility, warehouse, retail store	D	37 - 42 decibels

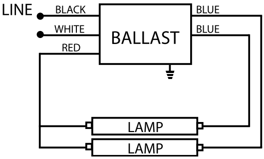
*These sound ratings are based off average ambient noise measurements during normal occupancy conditions. Amplified audible ballast hum may occur during exceptionnaly quiet periods and at times when area is unoccupied.

Series vs. Parallel

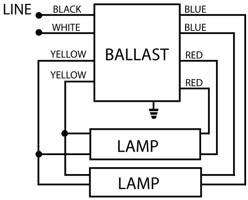
Lighting systems can typically be wired in two types of circuits: series or parallel. In a series circuit, when one lamp fails the circuit is broken and this causes all other lamps in the system to extinguish. Contrary, in a parallel circuit, the lamps actually operate independently of each other so, if one lamp fails, it does not affect the circuit to the other lamps, and they will continue to operate.

DID YOU KNOW?

Parallel



Series



Thermal Protection

In accordance with the National Electrical Code (NEC), all canned and potted electronic fluorescent ballasts require built-in Class P Thermal Protection. This protection is provided by a switching device that shuts down the circuit if the ballast temperature rises to 105°C or greater.

The switching device will reset so the ballast will resume operation once the ballast cools down. This off-again, on-again cycling will continue until the cause of the excess heat is eliminated.

Type 1 Ballasts

These ballasts are designed to meet cUL requirements for Type 1 use. Type 1 states that if ballasts are to be used in outdoor applications, a metal enclosure is required.

Electronic Fluorescent Ballast Lead "Bundling"

Electronic ballasts operate lamps at a high frequency (greater than 40 kHz), which increases the likelihood of capacitive coupling between ballast output leads. The distance between output leads, operative frequency, and the total bundled area are all directly proportionate to the amount of potential coupling. High coupling can negatively affect ballast performance, potentially causing incorrect lamp starting, hard starting, or even failure to start.

Coupling problems will not occur when lead wires are routed next to each other. The potential for capacitive coupling can occur when leads are bundled or tightly twisted. This could negatively impact lamp ignition in both single and multiple ballast fixture applications. Although problems due to lead bundling are rare, they can still occur as some ballasts are more prone to these problems than others. Problems due to bundling or twisting will typically show up immediately.

To reduce the potential of improper operation, it is strongly recommended to not bundle or tightly twist leads. Bending leads should not cause problems. Avoid using plastic wires to tightly hold leads together.

Compatibility with Power Line Carrier (PLC) Systems

PLC systems use electronic wiring devices to send information through high frequency signals over the 120 V or 227 V electrical power distribution system of a construction. A generator is used to impose a 1 V to 4 V high frequency signal on top of the existing voltage sine wave (60 Hz), which is generally in the 2500 to 9500 Hz range. Older systems operate at 19,500 Hz or higher.

STANDARD ballasts will not interfere with the electrical power distribution systems.

Fuse Protection

When many fixtures are on a single circuit, individual fusing is often used in order to immediately isolate a fixture which has failed. When troubleshooting, fusing will help circumvent complete circuit outage. Should you use a fuse, they should be of the slow-blow type. The inrush current and abnormal starting cycle should always be accomodated by the fuse.

Grounding

Grounding is when a connection between an electrical circuit and the earth is established. The symbol for earth ground is: ⏚

With A/C wiring, grounds are wires which are electrically connected to the earth creating another conduit for electric current, thus avoiding the potential for electrical shock. Ground wires can be directly or indirectly connected to one or several earth electrodes. They are also commonly connected to the neutral wire.

Ground wires are typically bonded to pipework, so that in case of a fault, the potential is kept the same as the electrical ground. Metal water supply pipes are commonly used as ground electrodes. All groundings should be made in accordance with applicable federal, provincial, and local codes and regulations.

Safety is the number one reason for grounding ballasts. A properly grounded ballast and electrical system are essential for personnel safety as they offer a low resistance path to the earth, meaning current will avoid workers' bodies.

Ballasts, namely electronic ballasts, produce Electromagnetic Interference (EMI) which is limited to a maximum amount by the Federal Communications Commission (FCC). In light of this, all electronic ballasts have an internal EMI filter, which requires a proper ground in order to be effective and control electrical noise. Without a proper ballast ground, FCC EMI limits cannot be respected. Ungrounded ballasts will generate much higher EMI emissions, and can be expected to interfere with other electrical equipment.

Grounding ballasts and luminaires is also important to ensure the proper starting of the fluorescent lamp, especially when working with magnetic ballasts. A metal reflector creates a capacitive path to ground through the wall of the fluorescent tube, which aids in ionizing the tube's gases and triggers conduction. Once the tube has started, the supplementary capacitance becomes obsolete because the impedance in the ballast circuit is actually lower than this capacitive path.

The most common way to ground ballast is by mounting it to a grounded metal luminaire. If the ballast enclosure material is not made of metal, a separate grounding wire is required.

Polarity

Polarity refers to the appropriate connection of ballast lead wires to power lines. To ensure proper installation of ballasts, the lead wires are colour coded for easy recognition. The WHITE coloured lead wire needs to be connected to the neutral (grounded). The BLACK coloured lead wire must be connected to the live wire. With certain ballasts, a change in polarity may decrease voltage from the lead to the ground and may interfere with the starting feature of the ballast.

Safety

Ballasts should be installed and operated in compliance with the Canadian Electrical Code (CEC), Canadian Underwriters Laboratories Inc. (cUL), Canadian Standards Association (CSA) requirements, and all applicable local codes and regulations to ensure proper operation. All installations, inspections and maintenance of fluorescent lighting fixtures should be carried out with the power to the fixture turned off. Only qualified persons should execute ballast installations since there may be exposure to potentially hazardous voltages.

Supply Voltage

Dedicated vs. Multiple Voltage and Frequency

Ballasts can either be dedicated to one voltage, or multiple voltages. Multi-volt ballasts offer input and frequency flexibility, as well as reduce inventory. It is critical to connect a ballast to the input voltage as indicated on the ballast label. To do contrary will be certain to cause damage to the ballast. Often, the utilities which supply the voltage experience voltage variations, and when these occur, it can cause light output to vary. The table below illustrates the recommended limits for electronic and magnetic ballasts:

Nominal Voltage	Magnetic Voltage Limits	Electronic Voltage Limits
120 V	112 - 127 V	108 - 132 V
208 V	199 - 216 V	187 - 229 V
220 V	210 - 230 V	198 - 242 V
240 V	225 - 250 V	216 - 264 V
250 V	235 - 260 V	225 - 275 V
277 V	255 - 290 V	249 - 305 V
347 V	322 - 365 V	312 - 382 V
480 V	450 - 500 V	432 - 495 V

Ventillation

Fluorescent ballasts should be installed to respect case temperatures in order to avoid a reduction in the life of the ballast due to heat generation during normal operation. For ballasts that have no case temperature indication on the product label, contact your respective customer service department prior to installation.

When several ballasts are installed in the same closed fixture, it is imperative that the ballasts be positioned with enough distance between them to allow for adequate heat dissipation. For proper ventilation of fixture, consult the fixture manufacturer.

Lamp Sockets and Wiring

Improper wiring may cause field problems related to the installation of instant start ballasts. Installers should always familiarize themselves with the wiring and other requirements issued by the lamp, ballast, and socket ma-nufacturers. The following document illustrates some of the principal requirements that contribute to the safe operation and optimum performance of T8 and PLL lamps when used with instant start ballasts.

Instant start electronic ballasts are quickly replacing rapid start magnetic ballasts. Rapid start ballasts are typically wired in series, while most instant start ballasts are wired in parallel. If a ballast is wired in series, this means that if one lamp fails or is intentionally removed, all lamps in the circuit will not be lit. Contrary, in a parallel circuit, should one lamp fail or intentionally be removed, all other lamps will remain lit and the ballast will continue to operate efficiently. Because of these wiring differences, different sockets are required for these different ballast types.

Fixtures containing rapid start ballasts are equipped with conventional sockets (Figure A) that are connected from the ballast by two wires per socket. Instant start ballasts on the other hand, require the use of a shunted socket (Figure B).

Diagram 1 - Sockets

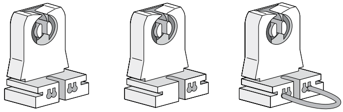


Figure A
Rapid Start

Figure B
Instant Start

Figure C
Jumpered

A shunted socket serves essentially the same function as installing a jumper (Figure C) from one side of the socket to the other, just internally. By doing this, the two pins at one end of the lamp have been connected together, protecting the lamp cathode and ensuring longer lamp life. Should a shunted socket or a short jumper not be used, the cathodes will sputter, emitting excessive amounts of tungsten, resulting in blackening of the lamp ends and ultimately reduce lamp life.

Diagram 2 illustrates the proper way to wire (jumper) lamps when shunted sockets are not being used.

Diagram 2 - Correct Wiring

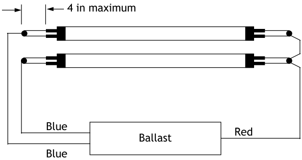


Figure D - T8 Lamps

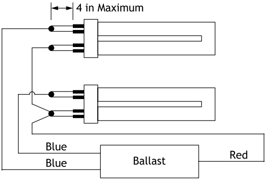


Figure E - PLL lamps

When installing bipin based T8 lamps (up to 5 feet in length and including U-shaped), the two wires from each socket must be connected together prior to connecting them to the appropriate single lead of an instant start ballast, as shown in Figure D. This connection should also be made within 4 inches of the sockets, and any jumpers between sockets used in any prior rapid start systems should be reconfigured as shown in Figure D.

When installing eight foot T8 lamps with high frequency electronic instant start ballasts in retrofit situations, existing single-pin sockets should be checked for signs of arcing and pitting; replace sockets if needed.

The spacing between existing or new sockets should also conform to the socket and lamp manufacturer's requirements. Please keep in mind that a high frequency ballast will sustain an arc more easily in adverse conditions than the 60 Hz magnetic ballast it replaces.

When installing PLL lamps, the wiring should be as shown in Figure E. The socket contacts must be connected in pairs prior to connecting them to the appropriate single lead of the instant start ballast, as shown in Figure E. The common connections should be within 4 inches of the sockets.

Note: For all installations, check that all existing socket leads are securely connected to the socket and all socket contacts should be in good condition and show no signs of arcing or pitting; replace sockets, if needed. Spacing between existing or new sockets must conform to both the socket and lamp manufacturer's requirements.

Failure to perform either of the above functions may result in an arc being sustained between the single lamp pin and the socket, damaging the socket over time which may cause the lamp to fall out.

The following 2 diagrams illustrate the incorrect way to wire T8 and PLL lamps. These types of wiring or any derivative of them should be avoided as they are not acceptable. In each case, the lamp denoted by "the letter "C" is carrying the current of the other lamp(s) in the circuit and will overheat. Incorrect application of sockets voids the lamp and ballast warranties because they result in shortened lamp and ballast life.

Diagram 3 - Incorrect Wiring

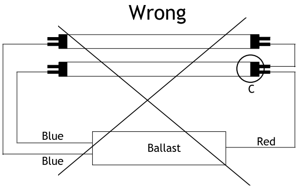


Figure F - T8 Lamps

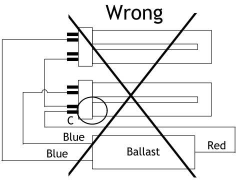


Figure G - PLL Lamps

While normally the ballast is the first component of a lighting fixture that is checked in case of trouble with more than one lamp, as often as not the trouble lies elsewhere.

The purpose of this section is to assist in locating the source of trouble which causes a particular condition or symptom. By following the trouble shooting guide, you may be able to locate the source of trouble in minimum time and with least expense. While the guide lists many common system problems, it is presumptuous to assume that it covers all possibilities.

Lamp(s) Do Not Start

Possible Causes	Corrective Maintenance
Lamp failure	Replace lamps with known good lamps
Improper ballast application	Check lamp/ballast compatibility
Poor lamp-to-lamp holder contact	Twist lamp in socket, reset
Poor lamp holder	Replace lamp holder
Incorrect wiring	Refer to wiring diagrams
Low voltage supply	Measure voltage supply with lamps on, refer to technical data
Dirty lamps or lamp pins	Clean surfaces on lamps and pins
Defective starters (applies only to preheat)	Replace starter
Lamp wall temperature too low or high	Check ambient temperature and refer to lamp manufacturer data
Fixture not grounded	Ground fixture
Defective ballast	Replace ballast

Lamp Cycling

Possible Causes	Corrective Maintenance
Improper fixture design application	Refer to fixture manufacturer
High voltage	Measure input voltage with lamps on, refer to technical data
Improper wiring or installation	Refer to wiring diagram
Poor lamp(s) maintenance (instant start and preheat systems)	Replace lamp(s)
Wrong type lamps	Refer to lamp/ballast compatibility
Wrong number of lamps	Refer to lamp/ballast compatibility
High ambient temperature	Reduce ambient temperature Check for insulation above the fixture and remove if possible Replace ballast with a cooler operating ballast

Lamp Swirling

Sometimes fluorescent lamps may appear as if the light is swirling or spiraling inside the tube. This phenomenon is known as lamp swirling or spiraling and is usually caused by cold temperatures. Should swirling or spiraling occur, the best solution is to protect the lamps from the cold draft, air-conditioning or other cold sources by using a tube guard, available at an authorized STANDARD distributor. It is important to verify that the tube guard is rated is rated for the lamp/ballast combination being used.

Lamp Striations

Occasionally, an unappealing visual phenomenon, known as striations, may occur under specific circumstances. Striations which are determined by a lamp's physics are a sequence of light and dark bands of light within a fluorescent lamp, which appear to either move down the length of the lamp, or appear as a standing wave.

Lamps made with heavy fill gases such as Krypton are prone to striations, which are made worse when operated in low temperature applications or where the lamp is directly affected by localized air flows. Striations are usually more common in energy saving lamps, but can also affect full wattage lamps. Striations do not imply an electrical problem; they are simply an undesired visual condition. Lamp performance and life are not affected by striations.

Energy saving lamps usually require higher operating temperatures than full wattage lamps. Energy saving lamps usually have a minimum operating temperature of 15°C (and sometimes higher). In order to ensure the correct application for the lamps, the lamp operating temperature should always be verified.

Full wattage lamps (ex: F32T8 32 W)

Striations in full wattage lamps are not common, but can still occur. When they do, it is typically the result of one or a combination of the following situations:

1. Low lamp currents: Striations can occur should the lamp current become too low (i.e. deep dim operations). If using a dimming ballasts, this issue can be resolved by adding extra circuitry.

2. Airflow: A lamp which is exposed to airflow across the lamp will often have striations. This is especially common when the lamp is located close to an air vent. Shielding or deflecting the flow of air to the lamp will typically resolve the incidence of striations.

3. Ambient Temperature: The bulb wall temperature of a lamp is directly proportionate to its light output. Every lamp is rated for maximum light output at a given optimal operating temperature. When presented with extreme cold ambient temperatures, the light levels will noticeably drop and striations may appear. Using tube guards or luminaires with more heat retention in the lamp compartment may decrease or eliminate the striations. Please contact STANDARD Products to ensure tube guard and lamp compatibility.

Energy saving lamps (ex: F32T8 30 W, 28 W, or 25 W)

STANDARD Products always recommended that you confirm that the energy saving lamp used is suitable for the application. Energy saving lamps are more temperature sensitive than full wattage lamps and are not typically rated for use below 15°C, nor for use with dimming ballasts. Should striations occur with the energy saving lamps, please verify if there is cool air flowing across the lamps or exceedingly low ambient temperatures, as explained in the Full Wattage Lamps section above.

If the lamp is striating, but none of the above reasons are the cause, the striations could be attributed to lamp characteristics. Striations can occur with energy saving T8 lamps and electronic ballasts, but do not imply an electrical problem; they are simply an undesired visual condition. Lamp performance and life are not affected by striations.

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HID HANDBOOK

Today HID lighting users demand long lamp life, high lumen output, quick starting, improved lumen maintenance, and most of all, energy efficiency. To satisfy the needs of yesterday, today, and the future, STANDARD has developed one of the most complete and comprehensive line of HID ballast products available.

What is a ballast?

HID lamps require ballasts to perform the following functions:

- Provide starting voltage and, in some cases, a high voltage pulse through the use of an ignitor. Ballasts must provide a specific minimum starting voltage to ignite the lamp. Pulse start metal halide and high pressure sodium lamps, require an additional high voltage pulse (typically between 2.5 to 6.0 kV).

- Regulate lamp current and power. The ballast current is set to a level that provides proper power to the lamp. In addition, the ballast regulates the lamp current through the range of typical line voltage variations, thus keeping the lamp power relatively stable, maximizing lamp life and performance.

- Provide the appropriate sustaining voltage and current wave shape to achieve the published rated lamp life. The ballast provides sufficient voltage to sustain the lamp as it ages. Lamp voltage typically increases as the lamp ages, and a well engineered ballast prevents the lamp from dropping out or cycling during the lamp's rated life. The ballast must also deliver a suitable current wave form to the lamp as specified by ANSI (American National Standards Institute).

Efficacy

A metric used to compare light output to energy consumption. Efficacy is measured in lumens per watt. Efficacy is similar to efficiency, but is expressed in dissimilar units. For example, if a 100 watt source produces 9000 lumens, then the efficacy is 90 lumens per watt.

High Pressure Sodium (HPS)

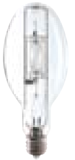
A high intensity discharge lamp type that uses sodium under high pressure as the primary light producing element.

Metal Halide (MH)

A high intensity discharge lamp type that uses mercury and several halide additives as light producing elements.

Metal Halide Pulse Start

A metal halide lamp which offers higher light output, longer lamp life, more stable colour rendering, and quicker startup.



Open Circuit Voltage (OCV)

The voltage applied across the output terminals of a ballast when no load is connected. This is the voltage applied across a lamp circuit to start a lamp. After starting, the voltage rapidly decreases and stabilizes at the operating voltage. When testing OCV it is recommended that a true RMS be used to insure accuracy.

Power Factor (PF)

PF is a measure on how efficiently a ballast can transform voltage and current provided by the power line into watts of usable power to the lamp.

A power factor of 1.00 would mean power is being used perfectly.

- Low power factor (LPF):
  Essentially, an uncorrected ballast power factor of less than 0.90.

- Normal power factor (NPF):
  Aballast/lamp combination in which no components (e.g., capacitors) have been added to correct the power factor, making it normal (essentially low, typically 0.50 or 50%).

- High power factor (HPF):
  A ballast with a 0.9 or higher rated power factor, which is achieved by using a capacitor.

Regulation

The ability of a ballast to hold constant (or nearly constant) the output watts (light output) during fluctuations in the voltage feeding of the ballast. Normally specified as +/- percent change in output compared to +/- percent change in input.

Core and Coil

The basic and most common ballast is the open core and coil which is most often used as a component within a lighting fixture. The core and coil also forms the main component of the other HID product types listed below. The core and coil type consists of either one, two or three copper coils depending on the circuit type. These coils are on what is called a core (or “stack”) of electrical grade steel lamination. The coils are assembled to core sections which are then surface-welded together using typically automatic welders to insure consistency.

Fluorescent Style Can (F-Can)

This type of HID ballast is used in indoor commercial applications such as offices, schools and retail stores, where ballast noise must be minimized as much as possible. A core and coil ballast type is encased within a fluorescent style, which is potted with an asphalt type material before being sealed. This type of ballast utilizes Class A (90°C) asphalt insulating materials, which is the same material used in the potting of fluorescent ballasts.

Indoor and Outdoor Enclosed

These types of HID ballasts are designed for use indoors and outdoors where the ballast must be mounted remotely from the lighting fixture. Applications that most typically require remotes are in factories or arenas where the luminaire may be mounted in a high-bay style fixture where very high ambient temperatures or varying weather conditions may be experienced. Our remote ballasts contain a core and coil type ballast which is sealed within a gasketed rectangular shaped metal can. The case is constructed of die cast aluminum and is fully gasketed and its stainless steel latches allow for easy access to the ballast for maintenance purposes. These ballasts do not require potting and therefore can be maintained more efficiently.

Postline

Post-top fixtures mounted on slender poles often require ballasts which will fit into these small diameter poles. Special, elongated core and coil ballasts are potted in resin in thin cylindrical cans. The capacitor and ignitor (where required) are included within this can. To help prevent overheating, one to three feet of air space should be allowed in the pole above the ballast, and the ballast should be positioned against the post interior wall to provide a heat-sink. All units rated 100W and above now include a mounting kit consisting of an 18 inch chain to hang the ballast within the pole and a spring clip to force the ballast's cylindrical can to make line contact with the pole's interior surface to maximize heat transfer, thus prolonging the ballast life.

TECHOLOGY

Reactor (R-NPF)

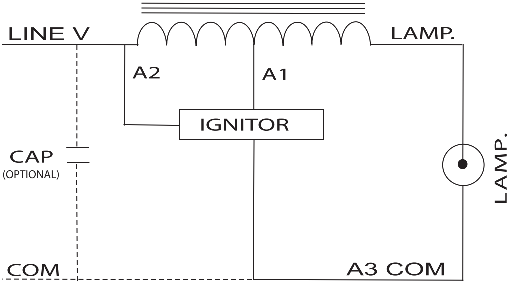
This is the most common and simplest type of HID ballast available. The only purpose of this type of ballast is to limit the current being fed to the lamp. Reactor ballasts can only be used when the line voltage is greater than the lamp starting voltage.

Reactors are the most compact, economical and most efficient ballasts because their job is to perform only one function. However, reactor ballasts are not recommended where power fluctuations are greater than +/- 5% because they offer little regulation capability.

Reactor (R-HPF)

By adding a capacitor (typically dry type) across the line, the power factor of the reactor system can be increased to be better than 90%. Adding the capacitor drops the required input current for starting and operating conditions down to as low as 50% lower than is needed for the normal power factor reactor system. This allows for more lamps and ballasts per circuit using the same wire gauge as with NPF systems.

Typical Reactor Circuit with Optional Capacitor



Auto-Lag Autotransformer (HX-NPF)

In this type, a transformer is used in conjunction with the reactor to raise line voltage that is below the minimum lamp starting voltage. Such a function is performed by combining a secondary winding with a primary winding to form a single phase autotransformer.

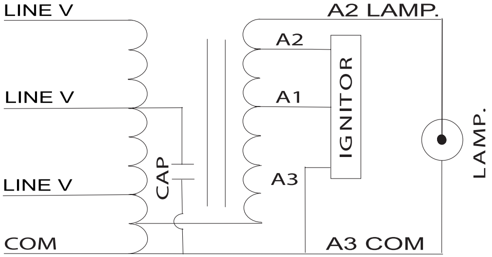
This circuit has the advantages of a normal power factor reactor, with a power factor of approximately 50%.

Auto-Lag Autotransformer (HX-HPF)

In this type, the addition of a capacitor to the primary circuit makes it possible for an autotransformer ballast to provide a high power factor.

The high power factor autotransformer is usually designed with an extra capacitor winding within its copper windings in order to provide a more economical and efficient system. The ballast's power factor can be increased to about 90% by combining the extended windings with the capacitor. The input current is reduced, as in the high power factor reactor. Lamp performance and regulation are also the same as a reactor ballast at +/- 5%.

Typical High Reactance Autotransformer Circuit with Optional Capacitor



Constant Wattage Autotransformer (CWA)

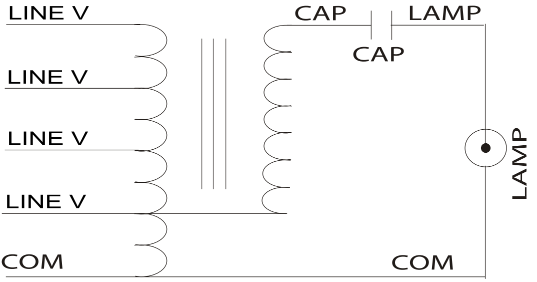
The constant wattage autotransformer HID ballast type should be used where a stabilized light output is required.

CWA is an HID ballast type that comes in a fairly small economical size, yet still provides a reasonable degree of regulation. It also offers the advantage of a high power factor, low line extinguishing voltage, and line starting currents that are lower than operating currents.

Unlike the high power factor auto-transformer (HX-HPF), which uses a capacitor as a parallel component, the capacitor on a CWA ballast type is used in series with the lamp. This provides the lamp with a more stable wattage when voltage on the branch circuit fluctuates.

The capacitor is referred to as a lead circuit when, as in the case of the CWA ballast, it performs an important ballasting function.

Typical Constant Wattage Autotransformer Circuit



Constant Wattage Isolated (CWI)

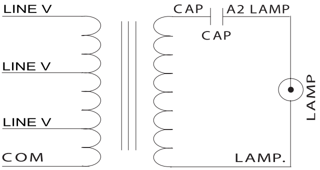
When electrical isolation for the lamp power regulation is required, CWI ballasts are recommended because the primary and secondary coils are not connected. When the secondary coil does not share a portion of the primary coil, more efficient shunting of the ballast core flux can be achieved by the shunts of the ballast. This provides better lamp power regulation than with CWA ballasts. Electrical isolation is an important consideration when line to line supply voltages are used. The isolation allows the lamp screw shell to be safely grounded, and not be a shock hazard when the lamp is removed.

CWI designs eliminate the need for time delay relays, oversize circuit breakers, and heavier wiring (which is required by reactor and lag autotransformer ballasts for the same number of fixtures per circuit).

Lamp wattage and consequent light output from the lamps is maintained in spite of line voltage variations as great as 13% from nominal. This ensures reliable starting and operation within lamp specifications, and guaranteeing full lamp life and optimum performance.

Lamp extinguishing due to line voltage dips is improved over the previous circuit types. The CWI circuit will hold the lamp in operation even if supply voltage dips to 25 % below normal.

Typical Constant Wattage Isolated Circuit

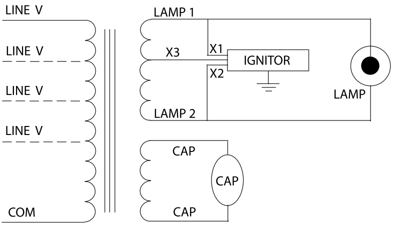


Magnetic Regulator (Mag-Reg)

The magnetic regulator ballast is a three isolated coil ballast. The third coil is used to connect to a capacitor which resonates with the coil providing a stable magnetic flux in the ballast core as well as power factor correction. The resonating current, and flux of the third coil produce significantly higher ballast losses, cost and larger size than other ballast types. Lamp extinguishing due to line voltage dips is virtually eliminated because the Mag-Reg circuit will hold the lamp in operation even if supply voltage dips to 30 % below normal.

TECHOLOGY

Typical Regulated Lag Circuit



STANDARD

Ignitors/Starters

Ignitors, often referred to as starters, are used in conjunction with a ballast to initially start the HID lamp. A high voltage pulse, typically in the range of 2.5 to 6.0 kV, is provided by the ignitor/starter. Ballasts that include an ignitor/starter are typically limited in the distance which they may be mounted remotely from the lamp because the ignitor pulse attenuates as the wire length between the ballast and lamp increases. For ballast-to-lamp distances greater than the capability of the standard published ignitor/starter ballast-to-lamp (BTL) distance, a long range ignitor/starter is required and is available from STANDARD.

Ignitors are intended to function with specific ballasts. Always check ballast and ignitor compatibility prior to installation. Ignitors should always be installed near the ballast but not on the ballast. A lighting system which calls for an ignitor must come with a pulse rated lamp socket in order to avoid voltage breakdown and arcing, caused by the high voltage ignitor pulse.

Capacitors

The capacitor is a very important part of the ballast and its function is often overlooked or forgotten.

Both oil-filled and dry-film capacitors are used with ballasts, neither of which contain PCB's.

Oil-filled capacitors come in metal cases which contain a dielectric fluid. The maximum case temperature for an oil filled capacitor is usually 90°C.

Oil-filled capacitors are available in ratings up to 525 V and for higher wattage HID ballasts, they are the only choice. When installing an oil-filled capacitor, it is important to follow UL regulations, which requires clearance of at least 3/8 inch above the terminals.

Dry film capacitors come in a compact, light weight and cylindrical non-conductive case. They do not use a dielectric fluid and are temperature rated for 100°C. Dry film capacitors do not need to be grounded, and do not have any special clearances above the terminals.

Remote Mounting

Certain noise sensitive applications and difficult to access locations require ballasts to be mounted remotely. When installing ballasts remotely, the ballast spacing, temperature, distance to lamp, and wire sizing, must be taken into consideration.

Remote ballasts mounted in groups in a panel box must dissipate the heat generated by the ballasts, or there is a great risk of overheating.

Spacing between these ballasts is critical, and a minimum of 12 inches must be maintained between each ballast. Furthermore, the ballasts must not be directly mounted to a non-metallic surface.

F-can ballasts must be spaced with mounting brackets, thus enabling air to flow under the ballast base.

Ballast to lamp (BTL) distance and wire size must also be taken into account when remotely mounting a ballast. For ballasts using an ignitor, the BTL is limited by the ignitor used. A long range ignitor might be required. Please refer to the ignitor specifications for more details.

BTL is determined by wire size for ballasts without ignitors. The size of the wire is related to voltage drop, and voltage drop to the lamp must remain below 1%. The wire used must have a voltage rating greater than that of the ballast's open circuit voltage.

Lamp Does Not Start

Possible Causes	Corrective Maintenance
Normal end of lamp life	Replace lamp with a known good lamp
No power to ballast	Verify breakers or other causes of power interruption or outage
Defective or improper wiring	Refer to wiring diagrams and check for circuit continuity. Check for under-sizing of wire gauge, which would result in lowered voltage. Repair if required.
Poor lamp-to-socket connection	Verify that there is no sign of arcing at the center contact of the socket. Tighten the lamp if required. Should the lamp base be distorted and does not seat properly in the socket, please replace the lamp.
Incompatible application	Check lamp/ballast compatibility. The ballast label data must be match the line voltage and the lamp used. Refer to ANSI codes in order to confirm compatibility.
Low voltage supply	Measure voltage supply with lamps on, refer to technical data (line voltage should be within 10% of rating). For remotely wired ballasts, verify distance and wire gauge meet specifications.

Lamp Does Not Start (Continued)

Restrike	Should supply voltage be cut or interrupted, all HID lamps will require a period of time to cool and re-establish optimum starting conditions
Environmental Conditions	Environmental conditions such as extreme temperatures, high humidity, and other factors can affect ballast operation. Check lamp and ballast specifcations.
Defective ignitor or starter	Should the lamp appear to be in good standing, disconnect the ignitor and install a specified test lamp. If the test dlamp lights, the ignitor must be replaced. The ballast and ignitor must match according to specifications.
End of ballast life / defective ballast	Replace ballast

Lamp Life is Reduced

Possible Causes	Corrective Maintenance
Lamp is physically damaged	Check the lamp for outer bulb damage (air leaks), especially where the glass meets the base. Also check for a broken arc tube or loose metal parts within the lamp. Replace the lamp if necessary.
Incompatible application	Check lamp/ballast compatibility. The ballast label data must be match the line voltage and the lamp used. Refer to ANSI codes in order to confirm compatibility.

Lamp Life is Reduced (Continued)

Faulty capacitor	Check the capacitor: Disconnect and discharge the capacitor. Use an ohmmeter on the highest scale: if the meter reads low resistance initially and increases, the capacitor is GOOD. If the meter reads low resistance initially and does not change, it is SHORTED and must be replaced. If meter reads high resistance initially and does not change, it is OPEN and must be replaced.

Lamp Flickers or Cycles On and Off

Possible Causes	Corrective Maintenance
Incompatible application	Check lamp/ballast compatibility. An incorrect lamp/ballast com- bination can create an improper voltage/ current relationship deli-vered by the ballast, causing cycling. Refer to ANSI codes in order to confirm compatibility. Some new lamps may cycle, but usually after three tries to start at 30 to 60 seconds intervals, the lamps will stabilize and operate normally.

Lamp Flickers or Cycles On and Off (Continued)

Variable voltage	Heavy motor loads or welding appliances on the line can cause flickering during operation. Remove the lighting circuits from the circuits serving these devices. Provide voltage regulators and check for loose connections. The use of CWI (not CWA) ballasts can be useful in these situations because of the improved regulation and sustained voltage.
High lamp operating voltage / low open circuit voltage	Measure both lamp operating voltage and ballast open circuit voltage, and compare to specifications.
HPS Cycler	As an HPS lamp is burned for long periods of time, its operating voltage tends to increase, to the point where the ballast cannot sustain the lamp. At this point, the lamp will exhibit cycling features, which is normal at end of lamp life. Replace the lamp after verifying the ballast open circuit voltage and lamp operating voltage. Note: the same may apply for pulse start and ceramic metal halide lamps.

Lamp Starts Slowly or Fuses Blow or Circuit Breakers Open on Lamp Start-up

Possible Causes	Corrective Maintenance
Overloaded circuit	Circuits should only be loaded to 80% capacity. Rewire accordingly, keeping in line with lamp/ballast specified starting current.
High momentary transient current	This can be caused by reactor or autotransformer ballasts which can draw initial high currents. The use of current protective devices incorporating time delay elements is recommended. Should the problem, persist, replace the ballast.

Low Lamp Light Output

Possible Causes	Corrective Maintenance
Incorrect voltage	Verify ballast label rating and lamp rating are compatible and correct if necessary. Check line voltage at ballast and set ballast tap to voltage reading. If not tapped, check ballast voltage range against input voltage. Check wiring connections for voltage loss points. Check socket contact points.
Incorrect ballast output	Ballast output should conform to lamp requirements. If voltage and current do not stabilize within 5-10 minutes of warm-up time, the ballast output is incorrect and must be corrected.
Faulty capacitor	Check capacitor wiring and ensure proper connection. Also verify capacitor rating meets specification. Using a capacitance meter, measure capacitance to specification. If necessary, replace capacitor.

TROUBLESHOOTING

Sign of Scorching, Swollen or Blackened Arc Tube Early in Life

Possible Causes	Corrective Maintenance
Overwattage / Incompatible application	Check if the lamp is being operated on a ballast designed for a higher wattage lamp. Refer to ANSI codes in order to confirm compatibility.
Excessive current or voltage shorted capacitor	Check voltage at ballast for current or voltage surges. Should shorted capacitors be found, replace ballast.
“Hang and glow state” operation	If lamps are in partial discharge (dim glow), replace lamp and ensure the lamp/ballast system are rated for the application’s operating conditions.

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