



POCKET GUIDE TO
**High Intensity
Discharge
Lamp Ballasts**



TABLE OF CONTENTS

Description of HID Lamp Types - 5

- Mercury Vapor - 5
- Low Pressure Sodium - 5
- High Pressure Sodium - 6
- Metal Halide - 6
- Pulse Start Metal Halide - 7

General Ballast Description - 8

Ballast Circuitry - 9

- Lamp/Ballast Regulation Characteristics - 9

Ballast Circuits - 10

- Reactor - 10
- High Reactance Autotransformer - 11
- Constant Wattage Autotransformer (CWA) - 12
- Constant Wattage Isolated (CWI) - 13
- Regulated Lag - 14
- Electronic HID Ballasts - 15

Standards and Safety Agencies - 16

- ANSI – American National Standards Institute - 16
- UL – Underwriters Laboratories - 16
 - UL Bench Top Temperature Rise - 16
- CSA- Canadian Standards Association - 17

Ballast Design Applications - 18

- Magnetic Ballasts - 18
 - Core & Coil - 18
 - Encapsulated Core & Coil - 19
 - Indoor Enclosed - 19
 - F-Can - 19
 - Outdoor Weatherproof - 20
 - Postline - 21

- Electronic HID (e-HID) - 21
 - e-Vision Low Frequency - 21
 - DynaVision - 21

TABLE OF CONTENTS

Ballast Components - 22

- Capacitors - 22
 - Dry Metalized Film - 22
 - Oil Filled - 23
- Ignitors (Starters) - 23

Application and Installation Information - 25

- Remote Mounting - 27
- Input Wiring - 27
- Bi-Level Operation - 27
- Warranty - 28

Troubleshooting - 28

- Safety - 28
- Instruments and Test Equipment - 29
- Troubleshooting Procedures - 29
 - Normal End of Lamp Life - 29
 - Mercury and Metal Halide Lamps* - 30
 - High Pressure Sodium Lamps* - 30
 - Low Pressure Sodium Lamps* - 30
 - Electronic Ballasts - 30

- Troubleshooting Charts - 32
 - Measuring Line Voltage - 36
 - Measuring Open Circuit Voltage - 36
 - Short Circuit Lamp Current Test - 40
 - Capacitor Testing - 42
 - Ballast Continuity Checks - 43
 - Continuity of Primary Coil* - 43
 - Continuity of Secondary Coil* - 44
 - Ignitor Testing - 45
 - Further Magnetic Ballast Checks - 46
 - Electronic HID Ballasts - 47
 - Electronic Troubleshooting Flow Chart* - 48

INTRODUCTION

High Intensity Discharge (HID) lighting sources are important for commercial, industrial and outdoor locations, such as high bay, parking lot and street lighting. HID lighting sources include mercury vapor, low pressure sodium (LPS), high pressure sodium (HPS), and metal halide (MH) ballast and lamp systems. Since the introduction of HID lighting, steady improvements in lamp and ballast technology have increased efficiency and other performance characteristics of HID systems. The improved systems include pulse start (both quartz, ceramic arc tubes and ballasts), as well as electronic HID ballasts.

The purpose of this booklet is to provide technical information with a major focus on troubleshooting techniques for all HID systems including pulse start and electronic systems. The booklet is physically designed to fit in your pocket or tool bag as a technical and troubleshooting ready reference.

For more detailed operational descriptions and specifications, refer to the "Advance Atlas", "ABC's of HID Ballasts", or www.advancetransformer.com.

Note: The information in this pocket guide is written based on our experience to date and believed to be reliable. It is a guide intended for use by persons having the necessary technical skills at their own discretion and risk. We do not guarantee favorable results or assume any liability in connection with its use. This information is not intended to conflict with existing code, ordinances and regulations. Existing codes, ordinances and regulations should be observed at all times.

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DESCRIPTION OF HID LAMP TYPES

There are four basic types of lamps considered as HID light sources: mercury vapor, low pressure sodium, high pressure sodium and metal halide. All are arc discharge lamps. Light is produced by an arc discharge between two electrodes at opposite ends of the arc tube within the lamp. Each HID lamp type has its own characteristics that must be individually considered for any lighting application.

There are four key parameters:

1. System efficiency (lumens per watt and ballast efficiency)
2. Lamp life
3. Lumen maintenance
4. Color rendition and stability over the life of the lamp

Mercury Vapor

Mercury vapor lamps are the least efficient HID source with an efficacy of 25 to 55 lumens per watt. They were developed as a more efficient alternative to incandescent light with lamp life 20 to 30 times longer. Mercury vapor light color is bluish and lumen maintenance is only fair when compared to other HID sources. Its benefits are low cost and long life (in the range of 16,000 to 24,000 hours or more) and a wide range of wattages from 50W to 1000W. Mercury vapor lamps require 3-6 minutes to cool down before they can be restarted. This interval is known as the re-strike time. Mercury vapor lamps are most commonly used for roadway lighting with a strong niche in landscape applications.



Low Pressure Sodium

Low pressure sodium (LPS) lamps are grouped with HID lamps, but in fact do not have a compact, high intensity arc. They are more like a fluorescent lamp with a long stretched-out arc. These lamps are the most efficient light source with an

DESCRIPTION OF HID LAMP TYPES

efficacy of 100 to 185 lumens per watt. LPS lamps have no color rendering index as the color output is monochromatic yellow. Consequently, LPS has few viable applications beyond street, parking lot and tunnel lighting. Low pressure sodium lamps range in size from 18W to 180W and average 14,000 to 18,000 hour lifetimes. They have excellent lumen maintenance but the longest warm up times, from 7 to 15 minutes. LPS lamps feature the shortest re-strike time among HID sources—only 3 to 12 seconds.



High Pressure Sodium

High pressure sodium lamps have an efficacy of 80 to 140 lumens per watt, a long lamp life of 20,000 to 24,000 hours, and the best lumen maintenance of all HID sources. Wattages range from 35W to 1000W and the warm-up time is from 2 to 4 minutes. Re-strike time is approximately 1 minute. The biggest drawback of high pressure sodium is the yellowish color light output, but it is acceptable for use in many industrial and outdoor applications (e.g. roadway lighting). High pressure sodium and metal halide lamps comprise the majority of HID lighting applications.



Metal Halide

Metal Halide lamps have an efficacy of 60 to 110 lumens per watt and have a warm-up time of 2 to 5 minutes. They have a re-strike time of 10 to 20 minutes. Lamp wattages range from 20W to 1000W with lamp life of 6,000 to 20,000 hours. Wattages from 1500W to 2000W are specialty lamps used for sports



DESCRIPTION OF HID LAMP TYPES

lighting, and have lamp life ratings of only 3000 to 5000 hours. The advantage of metal halide lighting is its bright, crisp, white light output suitable for commercial, retail, and industrial installations where light quality is important. However, lumen maintenance over the life of the lamps is less than optimal relative to other HID sources.

The arc tube material for metal halide lamps was quartz until 1995 when ceramic arc tube technology was developed. Ceramic arc tubes are now predominantly used in low wattage (20W to 150W) lamps, though new designs up to 400W have emerged in recent years. Ceramic arc tubes provide improved color consistency over lamp life. This technology is ideal for lamp applications requiring truer color as in fruit, vegetable, clothing and other accent lighting in retail displays.

Pulse Start Metal Halide

In the mid 1990s lamp manufacturers sought to improve standard probe start metal halide lighting (175W to 1000W). They did so by changing the chemistry and fill pressure in the lamp arc tube to increase lumen efficacy (lumens per watt). These lamp improvements required introduction of an ignitor or starter to provide a high voltage starting pulse eliminating the internal starting probe and its bi-metallic switch. Removal of the starting probe and switch from the arc tube construction allowed an optimized arc tube design and manufacturing process.

This technology improved the overall performance of metal halide systems. Lumen output per watt consumed can increase by 25%. Lumen maintenance is improved as much as 15%, lamp life is extended, warm-up time is reduced to two minutes and there is some improvement in color rendition. Adding an ignitor reduced re-strike time to 4 to 5 minutes

GENERAL BALLAST DESCRIPTION

from the standard metal halide lamp time of 10 to 20 minutes.

GENERAL BALLAST DESCRIPTION

HID lamps provide light from an electric discharge or arc and have a negative resistance characteristic that would cause them to draw excessive current leading to instant lamp destruction if operated directly from line voltage. The ballast is a power supply for arc discharge lamps. Its purpose in HID lighting is to provide the proper starting voltage to initiate and maintain the lamp arc and to sustain and control lamp current once the arc is established.

A ballast design incorporates basic circuitry to provide specific lamp/ballast operating characteristics. For some types of lighting applications a particular ballast circuit has proven the most cost effective and is, therefore, the only circuit offered. Other applications may require an optimum ballast selection from two or three available alternatives for that particular application. Final selection is based upon cost vs. performance requirements.

As described in the previous section, HID lamps come in various types and wattage selections. Each lamp type and wattage requires specific starting and operating conditions to develop rated light output and operate the lamp within allowable limits. Ballasts and lamps are designed to meet standards for interchangeability between lamps and ballasts of the same type and wattage. A lamp must be operated by the ballast designed for that lamp, as improper matching of lamp and ballast may cause damage to the lamp or ballast or both. The American National Standards Institute (ANSI) provides specifications to standardize lamp and ballast compatibility.

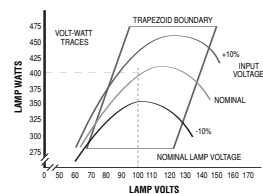
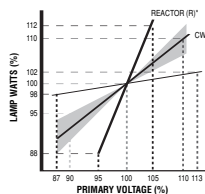
GENERAL BALLAST DESCRIPTION

For many years all HID ballasts were magnetic ballasts operating at the power line frequency of 50 or 60 Hertz to provide proper lamp operation. In the past few years electronic ballasts have been developed, primarily for metal halide lamps, using integrated circuits that monitor and control lamp operation. Electronic ballast circuits sense lamp operation characteristics and regulate lamp current to operate the lamp at constant wattage, thus providing a more uniform light output and color rendition throughout lamp life. They also sense lamp end of life and other circuit conditions and shut down the ballast when the lamp operating characteristics fail to meet operating specifications. These characteristics present more complicated troubleshooting conditions that will be discussed later.

BALLAST CIRCUITRY

Lamp/Ballast Regulation Characteristics

One of the most important characteristics of each particular ballast circuit is the degree to which it controls the lamp wattage, and hence light output, with changes of input line voltage. Ballast circuit design dictates the lamp wattage regulation characteristics. As a rule, better lamp regulation requires larger, more expensive ballasts. The following chart compares the relationship of the three basic types of ballast circuits as the input voltage changes.



BALLAST CIRCUITRY

As an example, the CWA line indicates that at 90% of line voltage, the ballast will operate the lamp at 90% of its nominal wattage. Similarly, at 110% of line voltage, the ballast will operate the lamp at 110% of nominal wattage.

The voltage of a typical mercury or metal halide lamp remains relatively constant throughout its operational life — for this reason, the lamp wattage regulation of these ballasts can be defined as a simple percent wattage change. High pressure sodium lamps, however, see significant arc tube voltage increases during their operational life; therefore, the high pressure sodium lamp ballast must compensate for this changing lamp voltage (even with stable input voltages) to maintain constant lamp wattage. Consequently, a simple percent wattage change is not an adequate definition for high pressure sodium lamp regulation. Instead, a trapezoid, established by the American National Standards Institute (ANSI), is defined, which restricts the operation of the lamp to certain acceptable limits with respect to lamp voltage and resulting lamp wattage. The ballast is designed to operate a high pressure sodium lamp throughout its life within the trapezoid for any input voltage within the rated input voltage range of the ballast. The resultant value of the lamp's actual operation wattage over the life of the lamp when shown on a graph follows a rising-then-falling path called a volt-watt trace.

BALLAST CIRCUITS

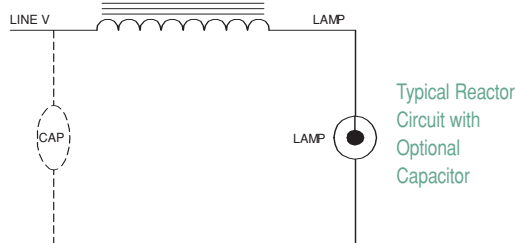
Reactor (R)—A single coil ballast can be used when the input voltage to a fixture meets the starting and operating voltage requirements of an HID lamp. In this situation, the reactor ballast performs only the current-limiting function since the voltage necessary to initiate the ignitor pulses, and start and sustain the lamp comes directly from the input voltage to the fixture.

BALLAST CIRCUITS

The reactor ballast is electrically in series with the lamp. There is no capacitor involved with the operation of the lamp. Because of that, the lamp current crest factor is desirably low, in the 1.4 to 1.5 range.

Without a capacitor, the reactor ballasts are inherently normal power factor devices (50%). When desired to reduce the ballast input current required during lamp operation, a capacitor may be utilized across the input line to provide high power factor (90%) operation, but the addition of the capacitor will not affect how the ballast operates the lamp.

Reactor ballasts with power factor correction capacitors, can limit the number of fixtures that can be used on a circuit because they draw substantially more current during lamp starting (warm-up) and/or open-circuit operation (burned-out or missing lamp), than when the lamp is operating normally.

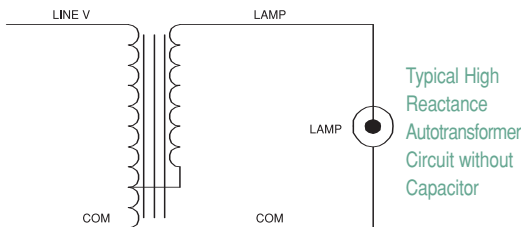


High Reactance Autotransformer (HX) - When the input voltage does not meet the starting and operating voltage requirements of the HID lamp, a high reactance autotransformer ballast can be used. In addition to limiting the current to the lamp, an HX ballast transforms the input voltage to the lamp's required level. Two coils, called the primary and secondary, are employed within the ballast. The operating characteristics, such as lamp wattage regulation are similar to the reactor.

BALLAST CIRCUITS

The high reactance autotransformer ballast is also inherently a normal power factor (50%) ballast but can be corrected to a high power factor (90%) with the addition of a capacitor across the primary coil. As with the reactor ballast, the addition of this capacitor does not affect the lamp's operation.

Both reactor and high reactance ballasts provide the same degree of lamp wattage regulation. For example, a simple 5% change in line voltage results in a 10-12% change in lamp operating wattage. However, this fair degree of lamp regulation is acceptable for many applications.

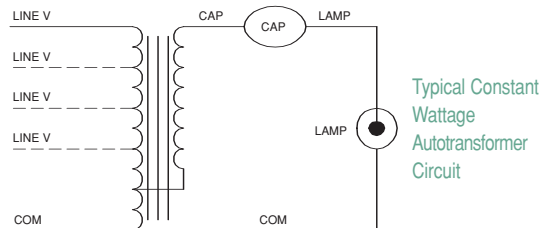


Constant Wattage Autotransformer (CWA), also referred to as a “Peak Lead Autotransformer” – To correct the higher input current associated with reactor and high reactance ballasts, and to provide a greater level of lamp wattage regulation, the 2-coil CWA ballast was developed. It is the most commonly used ballast circuit for medium and high wattage (175W – 2000W) applications and typically represents the best compromise between cost and performance. The CWA is a high power factor ballast utilizing a capacitor in series with the lamp rather than across the input. The capacitor works with the core-and-coil to set and regulate the lamp current to the prescribed level.

BALLAST CIRCUITS

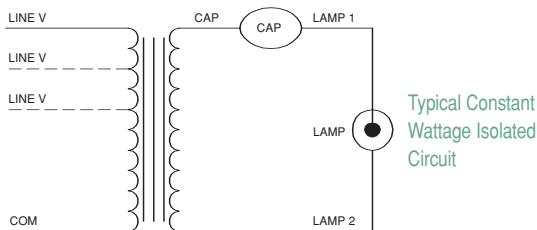
The CWA ballast provides greatly improved lamp wattage regulation over reactor and high reactance circuits. A $\pm 10\%$ line voltage variation will result in a $\pm 10\%$ change in lamp wattage for metal halide. The metal halide and high pressure sodium ballasts also incorporate wave shaping of the open circuit voltage to provide a higher peak voltage than a normal sine wave. This peak voltage (along with a high voltage ignition pulse when an ignitor is used) starts the lamp and contributes to the lamp current crest factor (typically 1.60 -1.65).

With the CWA ballast, input current during lamp starting or open circuit conditions does not exceed the input current when the lamp is normally operating. CWA ballasts are engineered to tolerate 25-30% drops in line voltage before the lamp extinguishes (lamp dropout), thus reducing accidental lamp outages.



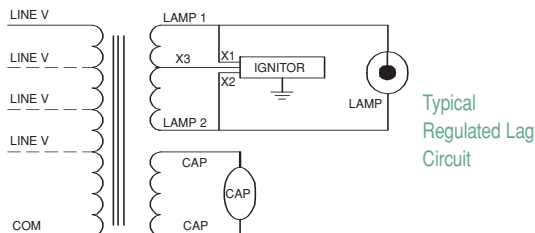
Constant Wattage Isolated (CWI) – The CWI ballast is a two-coil ballast similar to the CWA ballast except that its secondary coil is electrically isolated from the primary coil. This isolated design permits the socket screw shell to be grounded for phase-to-phase input voltage applications such as 208, 240 and 480 volt inputs. The use of the CWI ballast for these voltages is a CSA safety requirement in Canada.

BALLAST CIRCUITS



Regulated Lag (REG-LAG), also referred to as “Magnetic Regulator” or “MAG-REG” – This three-coil ballast circuit consists of a reactor ballast with a two-coil voltage regulator circuit all assembled on one core. The primary coil works with the tertiary coil and its capacitor to regulate the current through the lamp coil, and hence, the lamp. The lamp current crest factor is typically 1.5, similar to that of single-coil reactor ballast.

The lamp coil portion of the ballast is essentially isolated from line voltage variations and deviations from nominal. This circuit provides the best lamp wattage regulation for magnetic ballasts, (a $\pm 10\%$ change in input voltage yields only a $\pm 4\%$ change in lamp wattage) but carries an increase in ballast size, ballast losses and cost.



BALLAST CIRCUITS

Electronic HID (e-HID) Ballasts

There are two basic designs for electronic HID ballasts; low frequency square wave (typically used for low-wattage lamps or with ceramic arc tube lamps in the 250W-400W range) and high frequency (for medium wattage lamps in the 250W to 400W range). Both make use of integrated circuit technology to provide closer regulation and control of lamp operation over a variety of input voltage and lamp aging conditions. The integrated circuits in both types of ballasts continuously monitor input line voltage and lamp conditions and regulate lamp power to the rated wattage. If any power line or lamp circuit condition exists that will cause the lamp or ballast to operate beyond their specified limits the ballast shuts down (removes power from the lamp) to prevent improper operation. Electronic HID ballasts improve lamp life, lamp lumen maintenance, and system efficiency.

Integrated circuit control allows most electronic ballasts to operate at multiple input line voltages and, in some cases, operate more than one lamp wattage. The lamps are operated with constant lamp power that provides better light output regulation and more consistent light color over the life of the lamp. Some electronic HID ballasts also offer a continuous dimming function that will dim the lamp to 50% (minimum) lamp power using zero to ten volt (dc) dimming control voltage.

All functions required to correct power factor, line current harmonics, and to start and control lamp operation are inherent in the ballast. The lamp socket must be pulse rated (4kV) because there is an ignition pulse supplied to start the lamp.

STANDARDS AND SAFETY AGENCIES

STANDARDS AND SAFETY AGENCIES

ANSI – American National Standards Institute is a non-profit organization that generates voluntary product performance standards for many U.S. industries, including ballasts and lamps. ANSI lighting committees consist of members from ballast, lamp, and fixture designers and manufacturers that meet periodically to provide consistent product performance requirements. There are specific performance standards for each lamp and ballast type.

UL – Underwriters Laboratories, Inc sets safety standards for building materials, electrical appliances and other products, including ballasts and lighting fixtures. These standards include prescribed requirements for insulation systems and maximum operating temperatures.

UL provides, through testing, two different approvals for ballasts, **UL Listed** and **UL-Recognized**. UL Listing indicates the ballast is approved as a stand-alone unit and no further safety testing of the ballast is required by the fixture manufacturer. UL Listed ballasts are manufactured in an enclosure and the fixture manufacturer cannot change the internal components. UL-Recognized is a limited approval given to individual components that are not enclosed when manufactured. The fixture manufacturer must obtain UL Listing for the fixture enclosure that includes meeting temperature and insulation requirements of the ballast and associated components. The ballast manufacturer provides temperature and insulation rating information to the fixture manufacturer.

UL Bench Top Temperature Rise information is provided as a letter code for each core and coil ballast in the Advance Atlas and on the ballast label to facilitate UL inspection. The temperature rise code is shown on the label as 1029X, where

STANDARDS AND SAFETY AGENCIES

1029 is the UL standard for HID ballasts and the X is the temperature letter code. This temperature information should be used when ballast replacements are required. A ballast with a lower or equal letter rating may be used as a replacement without affecting UL listing of the fixture. For example, if a fixture is UL listed for 1029C then, automatically, electrically equivalent ballasts with an A, B, or C temperature classification are acceptable for use within that same fixture.

A table is shown below giving the letter code and the temperature range.

UL Bench Top Rise Letter Code	Temperature Range for Class H (180°C) Ballasts	Temperature Range for Class N (200°C) Ballasts
A	less than 75°C	less than 95°C
B	75°C < 80°C	95°C < 100°C
C	80°C < 85°C	100°C < 105°C
D	90°C < 95°C	105°C < 110°C
E	90°C < 95°C	110°C < 115°C
F	95°C < 100°C	115°C < 120°C
etc.	etc.	etc.

UL approves maximum temperature ratings for insulation systems that include the wire insulation and the ballast impregnation material. Advance ballasts may have one or both of two temperature ratings, Class H - 180°C or Class N - 200°C. These temperature ratings are maximum operation temperatures. However, greater ballast reliability will be realized when the operating temperatures are lower than the maximum. The rule of thumb is: Ballast life can double for each 10°C decrease in operating temperature.

CSA – Canadian Standards Association is the Canadian equivalent to UL. They generate performance and safety standards for many Canadian industries. When a product has the CSA symbol on the label, it has been investigated and approved for use in Canada.

BALLAST DESIGN APPLICATIONS



Magnetic Ballasts

Advance HID ballasts are available in a variety of shapes and sizes for the most popular lighting applications. Six basic designs are available for magnetic ballasts.

Core & Coil (71A)

The electromagnetic or “magnetic” ballast is an inductor consisting of one, two or three copper or aluminum coils assembled on a core (or “stack”) of electrical-grade steel laminations – commonly referred to as a core-and-coil ballast (71A). This assembly transforms electrical power into a form appropriate to start and operate HID lamps. Ballasts for high pressure sodium and pulse start metal halide lamps also include an ignitor to start the lamp. The third major component is the capacitor, which improves the power factor, subsequently reducing line current draw, and in some ballasts circuits works with the core-and-coil to set the lamp operating wattage.

Typically, all three components – the basic open core-and-coil, capacitor, and ignitor – are assembled directly into the lighting fixture by the lighting luminaire manufacturer. However, some ballast core-and-coil assemblies are encased in a container to meet specific needs. Core-and-coil ballasts

are UL-Recognized. A description of the various encased ballasts follows.

Encapsulated Core & Coil (73B)

In this configuration the capacitor is mounted separately in the luminaire, as is the ignitor (where required). Typical applications are installations requiring minimum ballast noise, including indoor installations such as offices, schools and retail stores. For a given application the encapsulated core & coil ballast also operates about 10°C cooler than the open core & coil. Encapsulated core & coil ballasts are UL-Recognized.



Indoor Enclosed (78E)

Indoor enclosed ballasts are UL-Listed for indoor use where the ballast must be mounted remotely from the luminaire. These ballasts are typically used in applications where the luminaire may be mounted in an area with very high ambient temperatures. The ballast can be mounted remotely in a cooler location. The case contains the core-and-coil ballast potted in a heat-dissipating resin (Class H, 180°C max.) within the ballast compartment. The capacitor and ignitor (where used) are also included within the case.

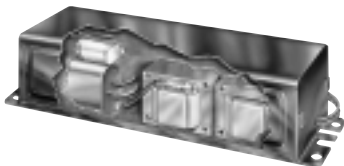


F-Can (72C)

F-Can ballasts are also UL-Listed for indoor use and are commonly used with recessed downlighting fixtures to

BALLAST DESIGN APPLICATIONS

minimize inherent ballast noise. F-Can ballasts are stand-alone products encased and potted in larger fluorescent ballast-style housings. F-Can ballasts utilize Class A (105°C rating, 90°C maximum case temperature) insulating materials for normal indoor ambients. Each ballast unit has an integral auto-reset thermal protector, which disconnects the ballast from the power line in the event of overheating to protect the ballast and prevent melting and dripping of the asphalt fill. All ballasts include the capacitor within the housing. All models for high pressure sodium, and medium and low wattage pulse start metal halide ballasts also include the ignitor within the housing.



Outdoor Weatherproof (79W)

Outdoor weatherproof ballasts are designed for remote mounting outdoors under all weather conditions. They may also be placed inside a pole base, but care must be taken to avoid areas prone to flood situations as weatherproof ballasts are not water-submersible. They must also be mounted base (nipple) down, with a drip loop for the wiring, when exposed to weather. A core & coil, with capacitor and ignitor (where required) are firmly mounted to the heat-sink base. This assembly is then protected with an aluminum cover, gasketed and bolted to the base. The most common applications are billboard, road sign lighting and some outdoor sports facilities, such as tennis courts. Outdoor weatherproof ballasts are



BALLAST DESIGN APPLICATIONS

UL Listed for operation remote from the lighting fixture.

Postline (74P)

Lantern-type, post-top fixtures mounted on slender poles often require ballasts which fit in the poles. Postline ballasts include a special, elongated core & coil encased and potted in high temperature resin (Class H, 180°C max.) in cylindrical housings of a diameter to accommodate being placed within 3" or 4" diameter poles. The capacitor and ignitor (where required) are included within the housing. Postline ballasts are often supplied with hanger chain for mounting and a spring clip designed to press the ballast against the pole wall for added heat sinking. Postline ballast are UL-Recognized.



Electronic HID (e-HID)

Note: e-HID ballast development is a rapidly expanding segment of the lighting industry. Consult Advance often for the latest specifications on currently available ballasts.

e-Vision Low Frequency

e-Vision ballasts are available in several case sizes for 20W to 200W metal halide, 150W high pressure sodium and 100W Mini whiteSON lamps.



DynaVision

Just as electronic ballasts for low wattage ceramic lamps provide critical lamp parameter control, electronic ballasts for medium wattage lamps serve similar critical functions.



BALLAST COMPONENTS

The Advance DynaVision electronic ballasts are designed for operation of 320W, 350W and 400W quartz arc tube, pulse start metal halide lamps, and provide dramatic lumen maintenance improvement over magnetically ballasted probe start MH and pulse start MH systems.

BALLAST COMPONENTS

Capacitors

All high power factor (HPF) Reactor (R) and High Reactance (HX) ballasts, as well as all Constant Wattage Autotransformer (CWA), Constant Wattage Isolated (CWI) and Regulated Lag ballasts require a capacitor. With core and coil and encapsulated core-and-coil units the capacitor is a separate component and must be properly connected electrically. The capacitor for outdoor weatherproof, indoor enclosed, F-can and postline types are already properly connected within the assembly.

Two types of capacitors are currently in use: dry metalized film and oil-filled. Present capacitor technology has allowed all but a few capacitor applications to be dry film. Oil-filled capacitors are used only when dry film technology cannot satisfy capacitor voltage requirements.

Dry Metalized Film Capacitors are available to fill almost all needs for HID ballast applications. Advance dry film capacitors typically require only half the space used by oil filled capacitor and do not require additional spacing for safety. The compact, light weight, cylindrical non-conductive case and two insulated wires or terminals reduce the required mounting space as compared with



BALLAST COMPONENTS

oil-filled capacitors. The discharge resistors (when required) are installed within the capacitor case. Dry film capacitors are UL-Recognized and contain no PCB material.

The maximum allowed dry film capacitor case temperature is 105°C.

Oil-Filled capacitors supplied today contain non-PCB oil and are a UL-Recognized component. Oil-filled capacitors are only supplied with ballasts where the capacitor operating voltage cannot be satisfied by dry film capacitors. When required, the capacitor discharge resistor is connected across the capacitor terminals.

Additional precautions must be taken when an oil filled capacitor is installed. Underwriters Laboratories, Inc. (UL) requires clearance of at least 3/8 inch above the terminals to allow for expansion of the capacitor in the event of failure.

The maximum case temperature for oil-filled capacitors is 90°C.



Ignitors (Starters)

An ignitor is an electronic component that must be included in the circuitry of all high pressure sodium, low wattage metal halide (35W to 150W) and pulse start metal halide (175W to 1000W) lighting systems. The ignitor provides a pulse of at least 2500 volts peak to initiate the lamp arc. **It is important to note that ignitors are specifically designed to operate properly with specific ballasts and cannot be interchanged with other ignitors or different brands of ignitors and ballasts. The ignitor should always be mounted near the ballast but not on the ballast.**

BALLAST COMPONENTS

When the lighting system is energized, the ignitor provides the required high voltage pulse until the lamp arc is established and automatically stops

pulsing once the lamp has started. It also furnishes the pulse continuously when the lamp has failed or the socket is empty.



All lighting systems requiring ignitors must be supplied with special pulse rated lamp sockets to prevent voltage breakdown and arcing from the high voltage ignitor pulse. If a lighting system is being converted to a lamp and ballast requiring an ignitor from a system without an ignitor, the lamp socket must be changed to a pulse rated lamp socket or the lamp may not start reliably.

Ballasts that include an ignitor to start the HID lamp are limited in the distance they may be mounted remotely from the lamp because the ignitor pulse attenuates as the wire length between the ballast and lamp increases. All Advance open core and coil ballasts listed in the “Atlas” include a standard ignitor that provides the proper electrical pulse to start lamps when the ballast is mounted within the lighting fixture. For most of these ballast/ignitor combinations, the typical maximum ballast-to-lamp distance is listed in the “Atlas” as 2 feet. When this distance is exceeded the lamp may not start reliably and a long range ignitor is required. The Atlas lists the proper long range ignitor required for various high pressure sodium and metal halide ballasts.

Advance has developed a long range ignitor called the Xtenza® for extended Metal Halide ballast to lamp distances. Ballasts using this ignitor have an extended distance to lamp

BALLAST COMPONENTS

of 50 feet for reliable starting. The list of ballasts that can be used with this extended range ignitor is in the ignitor section of the “Atlas”. There are also other long range ignitors for applications not satisfied by the Xtenza®.

Some lighting applications require instant restarting of lamps after a momentary loss of power to the fixtures. When an HID lamp is hot after operation and power is removed and reapplied, it will not restart with a standard ignitor until the lamp sufficiently cools. When instant restrike of a hot lamp is required, a special ignitor is necessary that will provide a pulse with much greater peak voltage. Advance has developed an instant restrike ignitor for low wattage mogul-based high pressure sodium lamps with a maximum ballast-to-lamp distance of 2 feet .

APPLICATION AND INSTALLATION INFORMATION

Remote Mounting of ballasts is often done to reduce ballast audible noise in sensitive applications and requires special attention to ballast spacing and temperature considerations, distance to the lamp, and wire sizing.

Remote mounted ballasts are often mounted in groups in a panel box or room away from the lamp location. Ballasts dissipate heat that must be removed to prevent the ballasts from overheating.

Spacing between ballasts and the mounting surface must be considered when the ballasts are remote-mounted. Twelve inches between ballasts must be maintained. If multiple rows vertically are used, there should be at least 12 inches between rows. In addition to ballast and row spacing, the ballast **must not be** directly mounted to a non-metallic surface.

APPLICATION & INSTALLATION INFORMATION

In such cases F-Can ballasts must be spaced with mounting brackets (available from Advance) to allow air flow under the ballast base.

Ballasts from the Advance 72C, 78E and 79W series and some e-HID ballasts are designed for stand-alone mounting, but maximum case temperature ratings **must** be adhered to for proper ballast operation and maximum ballast life. **Take time to measure ballast case temperatures of ballasts installed to verify the ballasts are operating below the maximum case temperature rating.**

Ballast to lamp (BTL) distance and wire size are also important mounting considerations. For ballasts using ignitors (high pressure sodium, low wattage metal halide and pulse start metal halide), the BTL distance is restricted by the ignitor used. The Advance Atlas ballast specifications list the maximum allowable distance. The remote distance of ballasts with ignitors can often be extended by using long range ignitors, but there is a limit to this distance. Be sure to check the Advance Atlas for maximum ignitor distances. When an ignitor is used, increasing wire size does not necessarily help to increase the allowable maximum distance. In fact, increased wire size can usually result in increased wire capacitance which, can further attenuate the ignition pulse. If the wire from ballast to the lamp is routed through metal conduit, the wire insulation rating may have to be increased to prevent insulation failure due to the ignitor pulse.

For ballasts without ignitors (mercury and probe start metal halide) the ballast to lamp distance is determined by wire size with the prevailed concern being voltage drop. In the Advance Atlas HID section there is a wire size table. This table lists the wire size by distance to the lamp to keep voltage drop to the lamp below 1%. Wire used must have a voltage rating above

APPLICATION & INSTALLATION

the open circuit voltage of the ballast.

Input Wiring to the Ballast

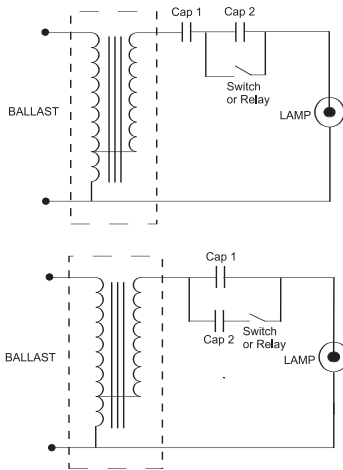
Many Advance HID ballasts have multiple voltage input taps. These taps allow 120, 208, 240, 277, 347 or 480 volt input connections. For 120, 277 and 347 volt input a common ballast lead wire is provided to be connected to the neutral input lead. However, for the 208, 240 or 480 volt inputs both supply conductors have voltage referenced to ground. One lead is connected to the proper ballast voltage lead and the other is connected to the ballast common lead. This connection causes the shell of the lamp socket to have voltage referenced to ground. The ballast will operate the lamp properly with these connections. The fixture can be grounded but the lamp shell cannot. An isolated output ballast (CWI or regulated lag) must be used if the lamp socket shell must be grounded, as is required for some installations in Canada.

Bi-Level Operation

Bi-level or two level dimming provide a means of saving energy when full light output from a fixture is not required. This is accomplished by changing capacitor values in the output of CWA ballast circuits using a control relay in the fixture. Generally, the lamp power level selections are 100% and 50%. Both High Pressure Sodium and Metal Halide ballasts may be dimmed using this method.

The required capacitor values for bi-level ballast operation are listed in the HID section of the Advance Atlas. The listed capacitor values are for 100% and 50% lamp power. Also the capacitor circuit arrangement, parallel or series, is listed. HID lamps should not be operated at less than 50% lamp power per lamp manufacturer specifications and must be started and operated until lamp is hot (15 minutes) at 100% power.

APPLICATION & INSTALLATION INFORMATION



Connection in series
Switch open for
reduced light output

Switch closed for
full light output

Connection in parallel
Switch open for reduced
light output

Switch closed for full
light output

Warranty of Advance Ballasts and Components

All Advance magnetic HID ballasts and components are warranted for 2 years from the date of manufacture. e-HID ballasts are warranted for 3 years. The date of ballast manufacture is stamped on the product. Contact Advance at 800-372-3331 and select option 2 (technical support) for additional information.

TROUBLESHOOTING

Safety

Safety measures should always be taken when troubleshooting HID systems. Most procedures will require that power be applied when electrical measurements are made. Wearing gloves and eye protection is a good practice when doing electrical measurements on HID systems.

TROUBLESHOOTING

Instruments and Test Equipment for troubleshooting

Only the input to HID lighting systems is a sine wave. Once the voltage and current is processed through the ballast and lamp, it is changed and is no longer a perfect sine wave. As a result of this transformation, **only TRUE RMS volt and amp meters will give proper readings.** TRUE RMS clamp-on current meters are also available and are most convenient when reading lamp current.

There are many brands of test meters available. Some indicate RMS and some indicate TRUE RMS on the meter. They are not the same. Only those that have TRUE RMS will read non-sinusoidal waveforms accurately. The RMS meters will give readings 10 to 20% low depending on the shape of the voltage or current waveform.

Some of these instruments will also read capacitance directly when connected to a disconnected, discharged capacitor.

There is no field usable meter to test ignitors.

Troubleshooting procedures

At times when an HID lighting system becomes inoperative, a complex and thorough, troubleshooting procedure may prove overly time-consuming. A simple series of checks can decrease this time considerably; a simple check of circuit breakers and power switches when a bank of fixtures becomes inoperative or a visual check or replacement of a lamp when an individual fixture becomes inoperative. At other times isolated inoperative fixtures may require systematic procedures to determine the cause of failure.

Normal End of Lamp Life

Most fixtures fail to light properly due to lamps that have reached end of life. Normal end of life indications are low light output, failure to start or lamps cycling off and on.

TROUBLESHOOTING

These problems can be eliminated by replacing the lamp. **Since many HID fixtures are not easily serviced due to their mounting height, the technician should take a replacement lamp when going up a ladder or on a lift.**

Mercury and metal halide lamps at end of life are characterized by low light output and/or intermittent starting. It is possible for metal halide pulse start lamps to cycle off and on like high pressure sodium lamps at end of life. Visual indications include blackening at the ends of the arc tube and electrode deterioration, but these are not conclusive. **The sure test is to replace the lamp.**

High pressure sodium lamps will tend to cycle at the end of life. After start-up, they will cycle off and on as the aged lamp requires more voltage to stabilize and operate the arc than the ballast is designed to provide.

Visual indications include general blackening at the ends of the arc tube. The lamp may also exhibit a brownish color (sodium deposit) on the outer glass envelope. **The sure test is lamp replacement.**

Low pressure sodium lamps retain their light output but starting becomes intermittent and then impossible. Visual signs include some blackening of the ends of the arc tube. **The sure test is lamp replacement.**

Electronic Ballasts

Lamps operated by electronic ballasts will not exhibit the above metal halide symptoms at end of lamp life. Because electronic ballasts have sensing circuits to detect lamp end of life, a ballast connected to an inoperative lamp will likely be in a shut down mode or will not start. **When servicing the fixture, always disconnect or shut off power to that fixture for safety.** When the power is cycled

TROUBLESHOOTING

off and then on, the lamp may re-start and later go off and stay off. Visual indications of the lamp may be the same. **However, the true and sure test is to replace the lamp. After the lamp is replaced the POWER TO THE BALLAST MUST BE CYCLED OFF AND BACK ON FOR THE BALLAST TO RE-START THE LAMP.**

NOTE: When the power is cycled off and back on via a circuit breaker or switch, other fixtures on the same circuit will extinguish and not come back on until the lamps cool. The energized ballast will continue to produce high voltage starting pulses for a specified period, usually between 10 and 30 minutes depending on the ballast model, allowing enough time for the hot lamp to cool.

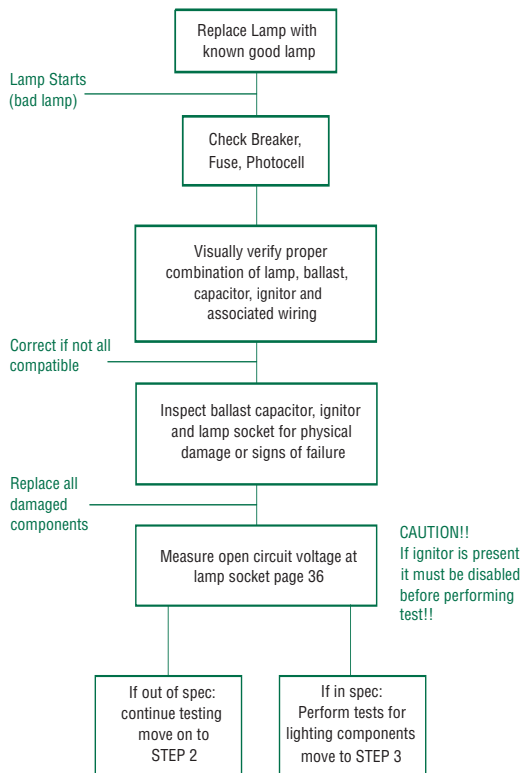
It is assumed at this point in the troubleshooting procedure that the lamp has been replaced with a known good lamp. If there is any doubt about a replacement lamp, it should be tested in an operational, good fixture.

Because troubleshooting can be time consuming, power to the fixture should be verified at the fixture. Photo cells, circuit breakers and switches should all be checked. The following flow charts are designed to minimize troubleshoot time and - if possible - eliminate taking the ballast housing apart.

TROUBLESHOOTING

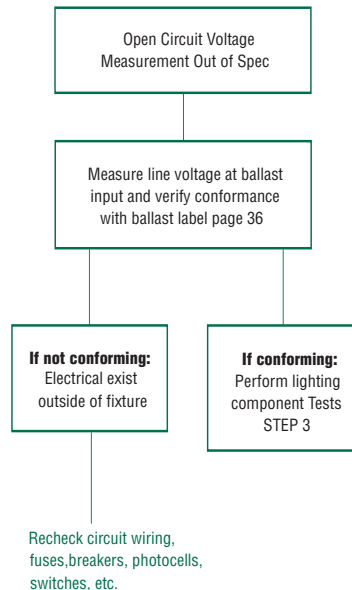
TROUBLESHOOTING HID FIXTURES

Lamp will not start (STEP 1)



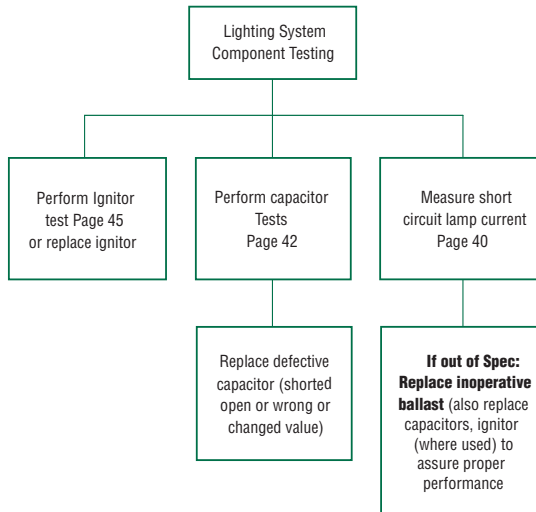
TROUBLESHOOTING

Lamp will not start (STEP 2)



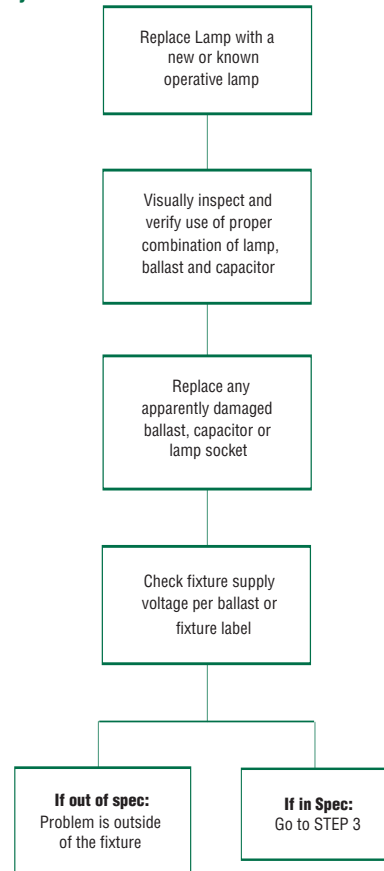
TROUBLESHOOTING

Lamp will not start (STEP 3)



TROUBLESHOOTING

Lamp Cycles



TROUBLESHOOTING

Measuring Line Voltage

Measure the line voltage at input to the fixture to determine if the power supply conforms to the requirements of the lighting system. For constant wattage ballasts (CWA, CWI), the measured line voltage should be within $\pm 10\%$ of the nameplate rating. For reactor (R) or high reactance (HX) ballasts, the line voltage should be within $\pm 5\%$ of the nameplate rating.

If the measured line voltage does not conform to the requirements of the lighting system, as specified on the ballast or fixture nameplate, the electrical problem exists outside of the fixture which can result in non-starting or improper lamp operation.

Check breakers, fixture fuses, photocells and switches when no voltage reading can be measured. High, low or variable voltage readings may be due to load fluctuations. **The supply voltage should be measured with the defective fixture connected to the line and power applied to help determine possible voltage supply problems.**

If the proper input voltage is measured, most HID fixture problems can be determined by measuring open circuit voltage and short circuit current.

Measuring Open Circuit Voltage

To determine if the ballast is supplying proper starting voltage to the lamp, an open circuit voltage test is required. The proper test procedure is:

1. Measure input voltage (V1) to verify rated input voltage is being applied to the ballast.
2. If the ballast has an ignitor [HPS, low wattage MH (35W to 150W) or pulse start MH], the ignitor must be

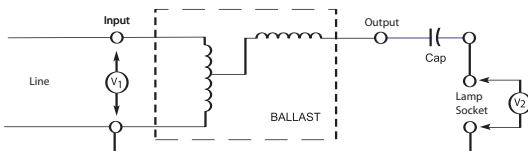
TROUBLESHOOTING

disconnected or disabled with a capacitor (1000 pF or larger) across the voltmeter input to protect the meter from the high voltage ignitor pulse. **Some ballasts have an integral or built in ignitor. If you are not sure if an ignitor is used put a capacitor across the meter for all open circuit voltage measurements.**

3. With the lamp out of the socket and the voltage applied to the ballast or the proper tap of the ballast with multiple voltage inputs, read the voltage (V2) between the lamp socket center pin and shell. Some lamp socket shells are split. Make sure connection is being made to the active part. The reading must be within test limits shown in table on page 38. Open circuit voltage must be measured with a TRUE RMS voltmeter to provide an accurate reading.
4. Constant wattage (CWA, CWI) ballasts have a capacitor in series with the lamp. If the capacitor is open there will be no open circuit voltage. Measure the voltage on both sides of the capacitor. If the voltage exists on the ballast side but not on the lamp side, **change the capacitor and re-measure the open circuit voltage at the lamp socket. If there is still no voltage disconnect the lamp socket from the ballast and measure open circuit voltage again. Once a voltage is measured test the lamp socket for shorts with an Ohm-meter or replace the lamp socket. An ohm-meter test is not conclusive as the test is at low voltage and the failure may be due to the open-circuit voltage.**

TROUBLESHOOTING

OPEN-CIRCUIT VOLTAGE TEST



OPEN-CIRCUIT VOLTAGE TEST LIMITS

	LAMP		RMS
	Wattage	ANSI Number	Voltage*
MERCURY BALLASTS	50	H46	215-270
	75	H43	220-275
	100	H38	225-285
	125	H42	230-290
	175	H39	200-290
	250	H37	210-295
	400	H33	210-285
	2-400 (Series)	2-H33	445-545
	1000	H36	385-465

METAL HALIDE BALLASTS	35/39	M130	205-290
	50	M110 or M148	235-300
	70	M85	200-270
	70	M98 or M143	205-290
	70	M139	220-280
	100	M90 or M140	210-315
	150	M81	215-265
	150	M102 or M142	180-300
	175	M57 or M107	275-355
	175 P.S.	M137 or M152	250-340
	200 P.S.	M136	215-330
	250	M58	270-345
	250	M80	215-265
	250 P.S.	M138 or M153	245-330
	320 P.S.	M132 or M154	240-310
	350 P.S.	M131	240-315
	400	M59	250-360
	400 P.S.	M135 or M155	235-340
	400 P.S.	M128	285-345
	2-400 (ILO)	2-M59	300-360
	450 P.S.	M144	235-340

TROUBLESHOOTING

	LAMP		RMS
	Wattage	ANSI Number	Voltage*
METAL HALIDE BALLASTS	750 P.S.	M149	305-390
	875 P.S.	M166	375-455
	1000	M47	385-485
	1000 P.S.	M141	370-475
	1500	M48	405-530
	1650	M112	420-510
	2000	M134	405-495

HIGH PRESSURE SODIUM BALLASTS*	35	S76	114-126
	50	S68	114-140
	70	S62	100-135
	100	S54	95-135
	150	S55	100-135
	150	S56	165-250
	200	S66	205-260
	250	S50	170-255
	310	S67	155-255
	400	S51	170-255
	430	SonAgro S145	180-220
	600	S106	200-265
	750	S111	200-245
	1000	S52	395-485

LOW PRESSURE SODIUM BALLASTS	18	L69	280-330
	35	L70	430-530
	55	L71	430-530
	90	L72	430-575
	180	L74	610-760

*Always disconnect the ignitor where equipped (typically used with metal halide <150W, pulse-start metal halide, and high pressure sodium) before measuring the output voltage of ballasts. High voltage starting pulses can damage commonly used multi-meters

As an alternative, this test may be performed by screwing an adapter into the lamp socket for easy access. Some lamp sockets have a split shell and an adapter assures good electrical connection.

TROUBLESHOOTING

Short Circuit Lamp Current Test

Do not be concerned about momentarily shorting a magnetic HID ballast output. They will not instantly burn up. An HID ballast is designed to limit current at the specified value range.

To assure that the ballast is delivering the proper current under lamp starting conditions, a measurement may be taken by connecting an ammeter between the lamp socket center pin and the socket shell with rated voltage applied to the ballast. If available, a lamp socket adapter may be used as described in the open circuit voltage test.

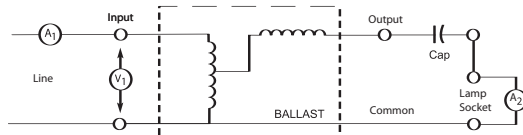
1. Energize ballast with proper rated input voltage.
2. Measure current with ammeter at A1 and A2 as shown in the diagram shown below.
3. Readings must be within test limits shown on page 41.

A clamp-on TRUE RMS ammeter may also be used to perform this test by placing an 18 gauge wire between the lamp and common leads of the ballast. When using a clamp-on ammeter for this measurement, be certain the meter is not near the ballast magnetic field or any steel object that may affect the reading.

The short circuit current test will also determine a defective capacitor in constant wattage circuits. A shorted capacitor will result in high short circuit current, while an open capacitor or low value capacitor will result in no or low short circuit current.

TROUBLESHOOTING

SHORT-CIRCUIT CURRENT TEST



SHORT-CIRCUIT LAMP CURRENT TEST LIMITS

	LAMP		Secondary Short Circuit Current
	Wattage	ANSI Number	
MERCURY BALLASTS	50	H46	.75-1.50
	75	H43	.85-1.50
	100	H38	1.15-2.00
	125	H42	1.60-2.60
	175	H39	1.90-3.30
	250	H37	2.60-5.00
	400	H33	4.55-7.10
	2-400 (Series)	2-H33	4.4-5.40
	1000	H36	5.50-6.70

METAL HALIDE BALLASTS	25/39	M130	0.40-0.80
	50	M110 or M148	0.65-0.95
	70	M85	1.10-1.40
	70	M98 or M143	0.70-1.25
	70	M139	1.05-1.40
	100	M90 or M140	1.00-1.65
	150	M81	2.10-3.00
	150	M102 or M142	1.60-2.90
	175	M57 or M107	1.50-2.00
	175 P.S.	M137 or M152	1.60-1.95
	200 P.S.	M136	1.80-2.70
	250	M58	2.00-3.00
	250	M80	3.20-4.00
	250 P.S.	M138 or M153	2.35-3.05
	320 P.S.	M132 or M154	2.90-3.70
	350 P.S.	M131	3.25-4.40
	400	M59	3.25-4.60
	400 P.S.	M135 or M155	3.25-4.60
	400 P.S.	M128 or M135	3.30-4.05
	2-400 (ILO)	2-M59	3.90-4.80
	450 P.S.	M144	3.85-5.10

TROUBLESHOOTING

	LAMP		Secondary Short Circuit Current Amps
	Wattage	ANSI Number	
METAL HALIDE BALLASTS	750 P.S.	M149	4.90-6.00
	750 P.S.	S111	9.20-11.70
	875 P.S.	M166	4.45-5.40
	1000	M47	4.70-6.40
	1000 P.S.	M141	4.60-6.90
	1500	M48	7.00-10.50
	1650	M112	7.80-9.60
HIGH PRESSURE SODIUM BALLASTS*	2000	M134	9.80-12.00
	35	S76	0.9-1.40
	50	S68	1.30-2.20
	70	S62	1.70-2.90
	100	S54	2.40-3.60
	150	S55	3.50-5.50
	150	S56	2.20-3.80
	200	S66	2.50-3.85
	250	S50	3.15-5.30
	310	S67	4.10-6.30
	400	S51	4.90-7.50
	430	SonAgro S145	6.00-7.40
	600	S106	6.85-10.50
	750	S111	9.20-11.70
LOW PRESSURE SODIUM BALLASTS	1000	S52	6.40-7.80
	18	L69	0.30-0.40
	35	L70	0.50-0.70
	55	L71	0.50-0.70
	90	L72	0.90-1.12
	180	L74	0.90-1.20

Capacitor Testing and Ballast Performance

1. Disconnect the capacitor from the circuit and discharge it by shorting the terminals or wires together.
2. Check the capacitor with an ohmmeter set to the highest resistance scale
 - If the meter indicates a very low resistance then gradually increases, the capacitor does not require replacement.
 - If the meter indicates a very high initial resistance that does not change, it is open and should be replaced.

TROUBLESHOOTING

- If the meter indicates a very low resistance that does not increase, the capacitor is **shorted** and should be replaced.

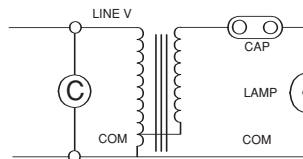
The ohmmeter method of testing capacitors will only determine open or shorted capacitors. The capacitance value can be tested by many available portable TRUE RMS meters having that capability, though a test using a dedicated capacitance meter is more conclusive.

The capacitance value will affect lamp performance of Constant Wattage ballasts in ways that cannot be determined by the ohmmeter method. **A capacitor may look good visually, but should be tested for capacitance value or replaced.**

The capacitor in a reactor or high reactance ballast circuits will only affect the ballast power factor and not ballast operation. Capacitor failure in these circuits will cause line supply current changes possibly causing circuit breakers to activate or fixture fuse failures.

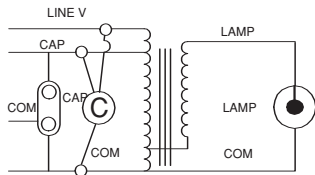
Ballast Continuity Checks *Continuity of Primary Coil*

1. Disconnect the ballast from power source and discharge the capacitor by shorting its terminals or wires together.
2. Check for continuity of ballast primary coil between the voltage input leads as shown below.

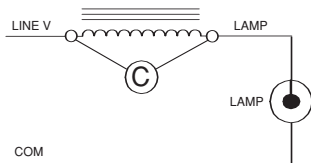


**Constant Wattage
(CWA, CWI) Type
Ballast**
Between Common and
Line leads
(CWA shown)

TROUBLESHOOTING



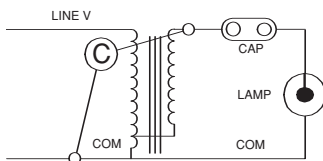
High Reactance (HX) Type Ballast
Between Common and Capacitor leads



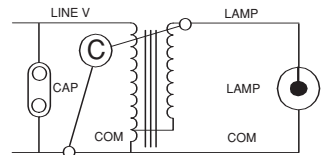
Reactor (R) Type Ballast
Between Line and Lamp leads

Continuity of Secondary Coil

1. Disconnect the ballast from power source and discharge the capacitor by shorting its terminals or wires together.
2. Check for continuity of ballast secondary coil between lamp and common leads as shown below.

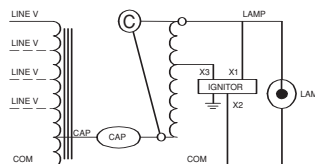


Constant Wattage (CWA, CWI) Type Ballasts not using Ignitors
Between Common and Capacitor leads (CWA shown)

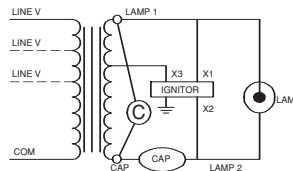


High Reactance (HX) Type Ballast
Between Common and Lamp leads

TROUBLESHOOTING



Constant Wattage (CWA) Type Ballast
Where Ignitors are used



Constant Wattage (CWI) Type Ballast
Where Ignitors are used

Ignitor Testing

Ignitors are used as a lamp starting aid with all high pressure sodium, low wattage metal halide and pulse start lamps.

Measurement of the starting pulse characteristics of an ignitor is beyond the capability of instruments available in the field. In laboratory tests, an oscilloscope equipped with a high voltage probe is used to measure pulse height and width. In the field, some simple tests may be performed to determine if the ignitor is operable. **It is first assumed that the lamp has already been replaced with a known operable lamp.**

1. Replace the ignitor with a known operable ignitor. If the lamp starts, the previous ignitor was either mis-wired or inoperative.
2. If the lamp does not light check the open circuit voltage and short circuit secondary current or refer to Flow Chart Step 3 on page 34.

TROUBLESHOOTING

Further Magnetic Ballast Checks

Probable Causes of Inoperable Ballasts

1. Normal ballast end-of-life failure
2. Operating incorrect lamps. Use of higher or lower wattage lamps than rated for the ballast may cause premature ballast end-of-life.
3. Overheating due to heat from the fixture or high ambient temperatures causing the ballast temperature to exceed the specified temperature.
4. Voltage surge from lightening or power source malfunction.
5. Mis-wired, pinched or shorted wires.
6. Shorted or open capacitor.
7. Incorrect capacitor for the ballast.
8. Capacitor not connected to the ballast correctly.

Probable Causes of Shorted or Open Capacitors

1. Normal capacitor end-of-life failure.
2. Overheated due to heat in the fixture or ambient temperature.
3. Capacitor mounted too close to ballast.
4. Incorrect voltage or capacitor value for ballast.
5. Mechanical damage such as over-tightened capacitor clamp.

Electronic HID Ballasts

Electronic HID ballasts present special troubleshooting challenges. The previously discussed procedures cannot be

TROUBLESHOOTING

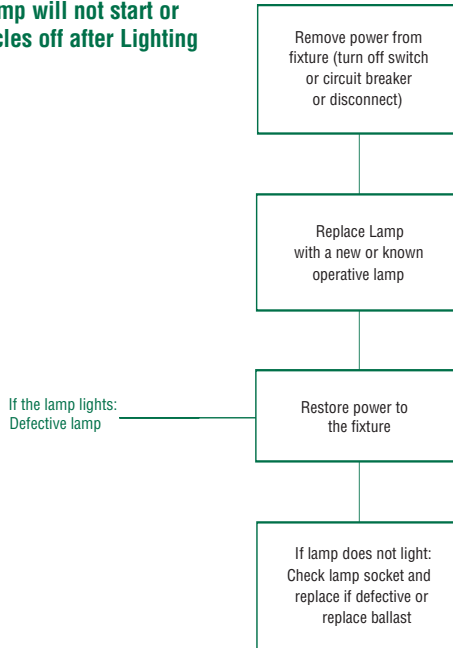
used to test electronic HID circuits. Electronic integrated circuit control limits reliable testing that can be performed in the field.

An energized electronic HID ballast will attempt lamp ignition by producing high voltage pulses for a specified time period, usually between 10 and 30 minutes. Consult the ballast label for specific times. **Unlike magnetic HID ballasts, momentary shorting either output lead of an electronic HID ballast to ground or each other will render the ballast permanently inoperable.**

Verify that there is voltage at the input of the fixture and the ballast before proceeding with the procedures of the following Flow Chart.

TROUBLESHOOTING

Lamp will not start or cycles off after Lighting



NOTE: After lamp extinguishes or is replaced, fixture power must be removed and restored to reset the electronics. Electronic ballasts are designed to shut down (remove power to the lamp) when irregularity occurs in applied power or a lamp fails to operate within specifications.

NOTES

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