

TECHNICAL LAMP REFERENCES

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GLOSSARY OF TERMS

AlGaAs: One of the material systems for manufacturing LEDs that produce light in the red and amber portions of the visible light spectrum.

AlInGaP: The Light-Emitting Diode (LED) chip technology containing Aluminum, Indium, Gallium and Phosphorous to produce red, orange and amber-colors.

Alternating Current (AC): Electrical current in which the direction is reversed at regular intervals or cycles; in the U.S. the standard is 120 reversals or 60 cycles per second. (See Direct Current).

Ambient Temperature (Ta): The air temperature surrounding the device.

Ampere (Amps): The SI unit measuring the intensity of electrical current flow.

American National Standards Institute (ANSI): The organization that coordinates voluntary guidelines and standards for the electrical and other industries.

Arc Gap: The distance measured between the electrodes of an arc discharge lamp (HID lamp).

Ballast: A device used to provide the starting voltage and regulate the current to discharge lamps, including Fluorescent, Metal Halide, and High Pressure Sodium.

Ballast Types for Fluorescent Lamps:

Instant Start: A type of Fluorescent lamp ballast that applies high voltage across the lamp with no preheating of the cathode.

Preheat: A Fluorescent lamp type that requires a starter, which enables the electrodes to be properly heated before allowing the ballast to supply the correct current flow.

Rapid Start: A type of Fluorescent ballast that applies a low filament voltage to preheat the cathodes. Simultaneously, a starting voltage (lower than that used in instant start ballasts) is also applied to strike the arc. When the cathodes are hot enough the lamp will strike.

Ballast Factor: The percentage of rated lumens from the same lamp using a commercial ballast as compared to an ANSI reference ballast. A ballast factor of .94 means the commercial ballast produces 94% of light produced by an ANSI reference ballast operating same lamp. The ballast factor can be referred to in the catalogs from Fluorescent ballast manufacturers.

Base: The physical end of the lamp that inserts into the lamp socket or holder.

Black Body / Black Body Radiator: An object that absorbs all electromagnetic radiation falling on it. Because it reflects no light, a black body appears black. As a black body is heated to incandescence, it radiates light in a sequence of colors, from red to orange to yellow to white to blue, depending on its temperature. This color sequence describes a curve within a color space, known as the black-body curve.

Black Body Curve: A curve within a color space describing the sequence of colors emitted by a black-body radiator at different temperatures.

Burn Position: The position in which lamps are designed to be operated. Often designated by the position of the lamp base. BU = Base Up, Horiz = Horizontal.

CSA (Canadian Standards Association): The CSA International certification mark, recognized in Canada, the U.S. and around the world, provides increased assurance of quality and safety.



Candela (cd): The measuring unit of luminous intensity of a light source in a given direction. A light source may have different intensities depending upon the given direction which the measurement is taken. The old measurement equated to the amount of light produced by a standard candle.

Candlepower (cp): Luminous intensity expressed in candelas. Typically used in measuring the luminous intensity distribution of a reflector lamp or lighting fixture.

Case Temperature: The temperature measured at the LED package or case.

CE Mark: Formerly known as the EC mark, the CE mark signifies that a product meets the conformity standards for products sold in the European Economic Area (EEA). The CE stands for "Conformité Européene," which is French for "European Conformity."



Chromaticity of a Color: The quality of color that includes its dominant or complementary wavelength, purity, hue, and saturation. Independent of luminance or brightness.

Color Rendering Index (CRI): An index from 0-100 measuring a light source's ability to render color accurately. Sodium lamps can have a CRI as low as 22, while tungsten Halogen lamps can have a CRI as high as 100. Any lamps rated above 80 CRI tend to be of good color rendering.

Correlated Color Temperature (CCT) or Color Temperature: A scientific measurement of the balance of wavelengths making up any "white" light. The unit of measurement is in Kelvin(K) which determines the warm or cool appearance of a light source. The lower the color temperature, the warmer or more yellow is the appearance. The higher the color temperature, the cooler or bluer is the appearance. Typical color temperatures are 2800K for Incandescent, 3000K for Halogen, 4200K Cool White Fluorescent, and 5000K daylight Fluorescent and Metal Halide.

Current: A measure of the rate of flow of electricity, expressed in amperes.

Daylight: Generally defined as having a correlated color temperature of 6000K or higher.

Direct Current (DC): A type of electrical current and distribution by which electricity flows in one direction through the conductor. Battery operated systems are typical DC applications. (See Alternating Current).

Dichroic: "Two Color"; Often referred to in lighting as the dichroic coating applied to glass filters and glass reflectors to change or control the color of light passing through the lighting fixture or lamp.

Die: Also known as Chip: the active light emitting semiconductor compound.

Dimmable: A lamp that has varying lumen output controlled by dimming device.

Directional Light Source: A light source that emits light only in the direction it is pointed or oriented.

Discharge Lamps: See High Intensity Discharge Lamp (HID).

Efficacy: The measured effectiveness at which lamps convert power (measured in watts) into light (measured in lumens). Also see Lumens Per Watt.

Ellipsoidal Reflector: A reflector designed to converge light so that the beam is focused to a single point. This often results in the reduction of light trapped within a lighting fixture.

ETL Listed Mark: See Intertek Testing Services (ETL).

Federal Communications Commission (FCC): The FCC mark ensures the product complies with the necessary requirement to avoid interference with radio frequencies.



Filament: A tungsten wire that when heated electrically generates radiation in the visible, infrared and ultraviolet ranges.

Fluorescent Lamp: A low-pressure mercury discharge lamp in which an electric discharge of ultraviolet energy excites a coating of phosphor on the lamp glass and transforms some of that energy to visible light. Fluorescent lamps are manufactured in many different forms including linear four foot T8 lamps, U-shaped and Coiled Compact Fluorescent lamps with integrated ballasts. Fluorescent lamps typically require a matching ballast to operate the lamp properly.

Footcandle (fc): A unit of illuminance. One footcandle is equal to one lumen per square foot (lmft²); see Lux. A lighting designer would use a measure of footcandles at the work surface to determine the proper illumination level for office lighting.

Forward voltage: LEDs are current driven devices. If an external current is passed through the device, a forward voltage will be developed across the diode.

Frequency: The number of times per second that an alternating current system reverses from positive to negative and back to positive, expressed in hertz (Hz).

Goniophotometer: A photometric device for testing the luminous intensity distribution, efficiency, and luminous flux of luminaires.

Halogen Lamp: A higher pressure, high temperature incandescent lamp containing Halogen gas that recycles tungsten back onto the filament surface. The Halogen cycle allows for higher efficacy, higher color temperature, and longer life cycles than incandescent lamps.

Heat Sink: A part of the thermal system that conducts or disperses heat away from sensitive components, such as LEDs and electronics.

Hertz (Hz): A unit of frequency equal to one cycle per second (see Frequency). The U.S. standard is 60 Hz.

High Power LED: A high power LED, sometimes referred to as a power LED, is one that is driven at a current of 350 mA or higher.

High Intensity Discharge Lamp (HID): A high pressure lamp in which high intensity light is produced by an electrical arc source. General terminology for Mercury lamps, Metal Halide lamps, High Pressure Sodium lamps, High Pressure Xenon lamps, or any other high intensity arc discharge source.

Ignitor: A ballast component that produces enough voltage to cause the initial arc to form across electrodes in HID lamps.

Illuminance: The concentration of luminous flux on a surface. Measured in Lux (lx) or Footcandles (fc).

InGaN LED: LED (Light-Emitting Diode) semiconductor material system containing Indium, Gallium, and Nitrogen to produce green, blue and white-colored LED light sources.

Initial Lumens: The luminous output of a new light source. Quantity of light output measured after 100 hours of operation using controlled system characteristics.

Integrating Sphere: A device used for a variety of optical, photometric, or radiometric measurements.

Inrush Current: The current generated during the initial start up of a lamp system. Inrush current can be several times higher than the operating current of a lamp.

Instant Start: See Ballast.

Intertek Testing Services (ETL): Originally a mark of Electrical Testing Services, the ETL Listed Mark now signifies that the lamp has been tested to meet North American safety standards by Intertek Testing Services.



Instant Start: A type of Fluorescent lamp ballast that applies high voltage across the lamp with no preheating of the cathode.

Junction Temperature: Junction temperature, noted as T_j, is the temperature of the LED's active region.

Kelvin: A unit of color temperature measurement. (See Correlated Color Temperature).

Kilowatt (kW): A measure of electrical power equal to 1000 watts.

Kilowatt Hour (kW/hr): 1000 watts of electricity used for one hour. A unit of measure that utility companies utilize for billing purposes.

LCL: (See Light Center Length).

LED: A solid state lighting device. (See Light-Emitting Diode).

LED Array: An assembly of LED packages or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of an LED driver.

LED Chip (Chip): The light producing semiconductor device that may or may not be incorporated into an LED.

LED Driver: An electronic circuit that converts input power into a current source — a source in which current remains constant despite fluctuations in voltage. An LED driver protects LEDs from normal voltage fluctuations, over voltages, and voltage spikes.

LED Light Engine: An integrated assembly comprised of LEDs or LED arrays, LED driver, and other optical, thermal, mechanical, and electrical components.

LED Luminaire: A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit. The LED based light emitting elements may take the form of LED packages, (components), LED arrays (modules) LED Light Engine, or LED lamps. The LED luminaire is intended to connect directly to a branch circuit.

GLOSSARY OF TERMS

Life, Average Rated: Average life is a value for life expectancy based on laboratory tests using controlled system characteristics measured in hours where 50% are still operating.

Light Center Length (LCL): The distance between the center of the filament or arc tube and the reference plane (usually the bottom of the lamp base).

Light-Emitting Diode (LED): A Light Emitting Diode (LED) is a solid-state semiconductor device that converts electrical energy directly into light. On its most basic level, the semiconductor is comprised of two regions. The p-region contains positive electrical charges while the n-region contains negative electrical charges. When voltage is applied and current begins to flow, the electrons move across the n-region into the p-region. The process of an electron moving through the p-n junction releases energy. The dispersion of this energy produces photons with visible wavelengths.

Lumens: The international unit of measurement for light. A measurement of total quantity of light output from an electric lamp in all directions for a given unit of time. (See Initial Lumens and Mean Lumens)

Lumens Per Watt (LPW, Lm/W): Efficacy; Lumen output divided by lamp watts consumed.

Lumen Depreciation: The decrease in lumen output of a light source over time, until failure.

Luminance: Photometric brightness, luminance is a measure of the flux emitted from, or reflected by, a relatively flat and uniform surface. Luminance may be thought of as luminous intensity per unit area. Candelas per square meter (cd/m^2).

Luminous Intensity: (See Candela) (cd).

Lux (lx): An international metric unit of luminance. One lux is equal to 1 lumen per square meter (see footcandle). $1 \text{ lx} = 1 \text{ lumen per square meter (lm}/\text{m}^2$).

Material System: The material, such as aluminum indium gallium phosphide (AlInGaP) and indium gallium nitride (InGaN), used within an LED to produce light of a specific color.

Maximum Overall Length (MOL): The end-to-end measurement of a lamp.

Metal Halide Lamp: A member of the high intensity discharge light source family. The light from this source is produced by the radiation from mercury, together with halides of metals such as sodium, scandium, indium and dysprosium. Metal Halide light sources typically require a matching ballast to operate the lamp properly. Metal Halide lamps are available in single-ended and double-ended varieties. Lamp design varies from tubular to elliptical shapes.

MOL: (See Maximum Overall Length).

Nanometer (nm): A unit of length equal to 10^{-9} meter. It is the preferred unit of measure for light in the visible and ultraviolet regions of the energy spectrum.

NTSC Color Space: The range of colors within the CIE Chromaticity Diagram included when combining phosphor based RGB sources in CRTs such as televisions and computer monitors.

Neodymium: A rare earth metal used in reflector and glass coatings to help reduce the yellow light emitted by the lamp.

Ohms Law: Volts x Amps = Watts

Operating Current: Steady state current consumed by a lamp at rated watts.

Operating Position: (See burn position).

Organic Light-emitting Diodes (OLED): Organic Light-Emitting Diodes (OLEDs) are based on organic (carbon based) materials. In contrast to LEDs, which are small point sources, OLEDs are made in sheets which provide a diffuse area light source. OLED technology is used in display applications such as cell phones and PDA screens.

P-N Junction: An area on an LED chip where the positively and negatively charged regions meet. When current is applied, the electrons move across the n region into the p region. The process of an electron moving through the p-n junction releases energy. The dispersion of this energy produces photons with visible wavelengths. In short, the area on a chip where light is produced.

Parabolic Reflector: A smooth surfaced, curved reflector formed in the shape of a parabola which focuses all the light at the focal point to create a parallel beam.

Phosphor: An inorganic chemical compound processed into a powder and deposited on the inner glass surface of certain discharge lamps. Phosphors absorb short wavelength ultraviolet radiation, transforms it and emits it as visible light.

Phosphor Conversion: This is the process by which photons from an LED chip are converted to a different color. White LEDs and some colored LEDs are made using phosphor conversion.

Picograms Per Lumen-Hour (pg/lu-hr): A measure of the amount of mercury in a lamp per unit of light delivered over the life of the lamp.

Planckian Black Body Locus: The line on the CIE Chromaticity Diagram that describes the color temperature of an object when heated from approximately 1,000K to more than 10,000K.

Preheat: (See Ballast).

Rapid Start: (See Ballast).

REACH: Reach stands for Registration, Evaluation, Authorization and Restriction of Chemicals. This is a directive of the European Union created for the purpose of regulating chemicals that can cause harm to one's health and the environment. The REACH Compliance mark signifies that the product meets the standards of this regulation.



Remote Phosphor: A phosphor conversion technique in which photons from a royal blue LED pass through a phosphor material that is not attached to the LED chip.

RGB Color Model: An additive color model in which red, green, and blue light are added together in different proportions to produce a broad range of colors, including white.

RGB White: A method of producing white light by combining the output from red, green, and blue LEDs.

RoHS (Restriction of Hazardous Substances) (Directive 2002/95/EC): Also known as Lead-Free, this initiative originated in the European Union. A product is considered compliant and receives the RoHS Compliant mark when the proper standards are met for restricted materials.



SMDs: Surface-mount LEDs.

Solid-State lighting: A description of the devices that do not contain moving parts or parts that can break, rupture, shatter, leak or contaminate the environment.

Spectral Distribution: The distribution and intensity of spectral energy of a lamp. Concerning the lighting industry, the UV, visible and IR regions are most important. Visible and UV light are most often measured in nanometers while IR light is most often measured in micrometers.

Thermal management: Controlling the operating temperature of the product through design, examples includes heat sinks and improved airflow.

Thermal Resistance (K/W): The property of a material's ability to conduct heat.

Trigger Start: A circuit used to eliminate the starter and start the preheat lamp almost instantly. In this circuit each electrode is connected to a separate winding in the ballast so the electrode is continuously heated.

Tungsten: A heavy metal used in wire filaments and electrodes. Also known as Wolfram.

UL (Underwriters Laboratories): An organization that tests equipment for electrical and fire safety. Qualified products display the UL Mark.



Ultraviolet (UV): The portion of the electromagnetic spectrum in which the longest wavelength is just below the visible spectrum, extending from approximately 4nm to approximately 400nm.

Voltage: The force or the pressure of electricity. For incandescent and Halogen lamps, voltage generally refers to the line voltage of which the lamp should be connected. For HID, Fluorescent, and Low-Voltage lamps, the voltage generally refers to the operating voltage which the lamp is connected to a power supply (ballast or transformer) after it has warmed up.

Watt: A unit of electrical power used to indicate power consumption.

Wavelength: Distance between two successive points of a periodic wave. The wavelengths of light are typically expressed in nanometers (nm), or billionths of a meter.

Xenon, High Pressure: A short-arc discharge lamp which Xenon gas is contained in a hard glass or special quartz capsule with a high pressure atmosphere. This includes lamps used for searchlight, followspots, and medical applications. Xenon is a heavy, colorless, chemically inactive, monatomic gaseous element.

SAFETY & HANDLING

TUNGSTEN HALOGEN & INCANDESCENT LAMPS

- DANGER! Halogen lamps operate at extremely high temperatures that can cause serious physical injuries and property damage.
- Only use Halogen lamps in Halogen-approved fixtures. Fixtures should fully contain any parts of the Halogen lamp upon the event of a lamp burst.
- Do not use Halogen lamps in close proximity of paper, cloth or other combustible materials that can cause a fire hazard.
- Lamps are very fragile. Do not drop, crush, bend or shake them. Vibration or impact will cause filament breakage and short lamp life.
- Do not touch the Halogen bulb surface or inside reflectors with your bare hands. Oils from skin can lead to breakage or shorten the life of the lamp. Use clean gloves or lint-free cloth for installation and removal.
- Clean any dirt, oil, or lint away from the lamp with alcohol and a lint-free cloth or tissue. Any foreign particles or materials on the bulb surface can cause hot spots on the bulb and result in lamp failure.
- Never touch the lamp when it is on, or soon after it has been turned off, as it is hot and may cause serious burns.
- Do not look directly at the operating lamp for any period of time; this may cause serious eye injury.
- Always turn off the electrical power before inserting, removing, or cleaning the lamp.
- Affix the lamp securely in the socket. Improper installations will cause electrical arcing, overheating and short life to lamp and socket. Replace lamp holders and sockets when necessary.
- Keep the temperature of the Halogen lamp seal below 350° C.
- Keep the temperature of the Halogen bulb wall above 250° C.
- Keep the temperature of the Halogen lamp bulb wall below 800° C.
- Make sure lamps of specified wattage and voltage are only used in appropriately rated fixtures. Unspecified use will lead to short lamp life, breakage and overheating of fixture.
- Lamps should not be operated beyond the total rated voltage. Avoid the use of dimmers that may drive your lamp over its rated voltage.
- Operate the lamp only in the indicated burn position. Failure to do so will lead to overheating and shortened lamp life.
- Use an external fuse when required.
- Do not allow one lamp to directly expose another. This may lead to overheating and shortened lamp life.

FLUORESCENT LAMPS

- Fluorescent lamps operate at high surface temperatures that can cause serious physical injuries. Turn power off and allow adequate time (approximately 10 minutes) for the lamp to cool before attempting replacement.
- In order to avoid the risk of electrical shock, make sure the power to the fixture is turned off when replacing a lamp. Hold compact fluorescent lamps by the lamp base.
- Lamps are very fragile. Do not drop, crush, bend or shake them. Fluorescent tubes may shatter with considerable force when broken.
- To ensure that the lamps remain in the sockets for the duration of the operation, make sure that the fixture's sockets are not worn prior to installation of the lamps. If the lamps are installed in worn sockets, the lamps could fall out of the fixture during operation.
- Never operate a lamp above or below its rated current voltage.
- Electrical connections should be clean and in good condition. Replace lamp holders and sockets when needed. Affix the lamp securely in the socket. Improper installations will cause electrical arcing, overheating and short life to the lamp and socket.
- Do not look directly at the operating lamp for any period of time; this may cause serious eye injury.
- Fluorescent lamp use is not recommended in extreme weather conditions. Excessive cold/warm temperatures dramatically affect starting, lamp life and lumen maintenance.

METAL HALIDE & HIGH PRESSURE SODIUM DISCHARGE LAMPS

- ANSI Type **E** = Enclosed Fixture Required
Lamps that are enclosed fixture rated should only be operated in an enclosed fixture that safely contains all lamp parts in the event of a lamp burst or rupture. These lamps operate at a high internal pressure and at high temperatures which can emit harmful ultraviolet light if the outer glass bulb is broken. A lamp may burst causing physical injury and property damage unless protective safety glass is used with the fixture. Use fixture that meets requirements per UL standard #1572.
- ANSI Type **O** = Open Fixture Rated
Lamps that are open fixture rated are suitable for operation in open fixture designs. These types of lamps typically feature UV protective quartz and a secondary shroud surrounding the arc tube to prevent the scatter of glass in the event of a burst.
- Metal Halide discharge lamps can emit ultraviolet radiation that may be harmful to eyes and skin. Metal Halide discharge lamps that are not open fixture rated, should only be used in enclosed fixtures with ultraviolet absorbing filter glass. Do not operate these lamps if the ultraviolet absorbing filter glass is broken or not installed.
- Metal Halide discharge lamps should only be operated with the compatible ballast, rated fixture (open/closed, wattage), and socket. (See lamp specification page for ballast information).
- Only operate the lamp in its designated operating position. (See lamp specification page for lamp operation position)

METAL HALIDE & HIGH PRESSURE SODIUM DISCHARGE LAMPS (Continue)

- Metal Halide lamps should be turned off for a minimum of 15 minutes per week.
- Lamps should never be operated beyond their rated useful life. The risk of a lamp burst increases with lamp age, temperature, improper operation and improper handling. Replace the lamp at or before the end of its rated life. Group relamping is always recommended.
- Never bump, drop, apply excessive stress, or scratch the lamp. This could cause the lamp to burst! Do not operate any lamps with any traces of scratches, cracks, or physical damage.
- Never operate a lamp above or below its rated current or voltage. This may cause the lamp to leak or burst.
- Always turn off the electrical power before inserting, removing, or cleaning the lamp.
- Clean any dirt, oil, or lint away from the lamp with alcohol and a lint-free cloth or tissue. Dirt or other contaminants will affect light output and may cause the lamp to overheat and decrease lamp life.
- Electrical connections should be clean and in good condition. Replace lamp holders and sockets when needed. Affix the lamp securely in the socket. Improper installations will cause electrical arcing, overheating and short life to lamp and socket.
- Never touch the lamp when it is on, or soon after it has been turned off, as it is hot and will cause serious burns. Lamps should be allowed to cool for a minimum of ten (10) minutes after the lamp is turned off.
- Do not use lamp in close proximity of paper, cloth or other combustible material that can cause a fire hazard.
- Do not look directly at the operating lamp for any period of time; this may cause serious eye injury.

(Hg) - CONTAINS MERCURY. Manage in Accord with Disposal Laws

Metal Halide, Fluorescent and High Pressure Sodium discharge lamps contain Mercury. USHIO realizes the importance of lamp recycling and we encourage all lamps to be properly disposed of in order to help preserve the environment and our Earth's precious natural resources. Please refer to your local environmental laws regarding disposal and recycling of Mercury containing lamps. To learn more about lamp recycling requirements in your area, you can contact your state environmental authorities or visit www.lamprecycle.org.

R - NON SELF-EXTINGUISHING LAMP

WARNING: This lamp can cause serious skin burn and eye inflammation from shortwave ultraviolet radiation if outer envelope of the lamp is broken or punctured. Do not use where people will remain for more than a few minutes unless adequate shielding or other safety precautions are used. Lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. Complies with the USA Federal Standard 21 CFR 1040.30 and Canada Standard SOR/80-381.

SOLID-STATE LIGHTING / LED LAMPS

- In order to avoid the risk of electrical shock, disconnect or turn off power to the fixture prior to lamp installation or servicing.
- Allow lamp to cool before handling.
- Do not open lamp. No user serviceable parts inside.
- Fully enclosed or recessed fixtures must contain proper ventilation for those lamps that are not approved for fully enclosed fixtures.
- Reliable Operating temperature is -4° F to 113° F.
- USHIO LED devices comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.
- Any modifications to the product will void the warranty.