

ECOSENSE[®]

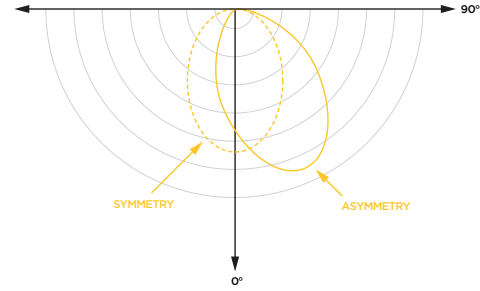
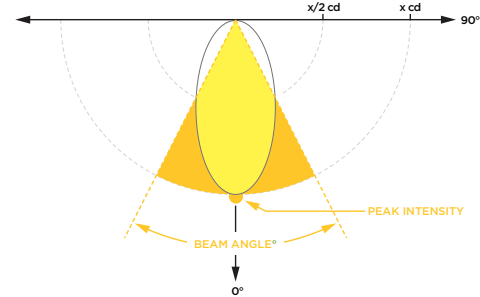
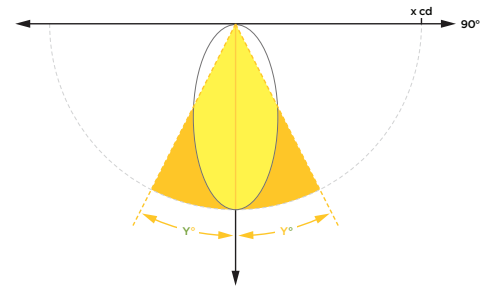
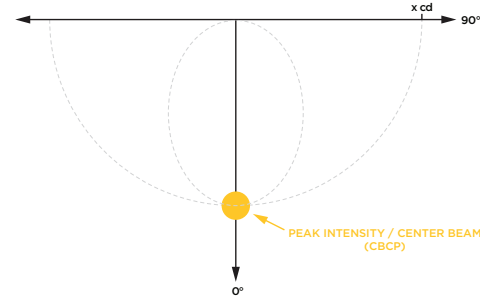
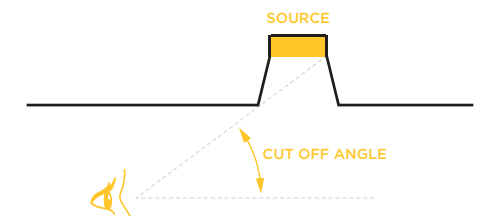
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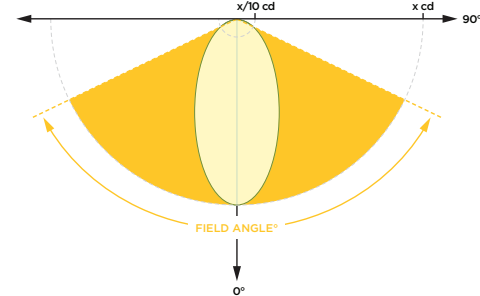
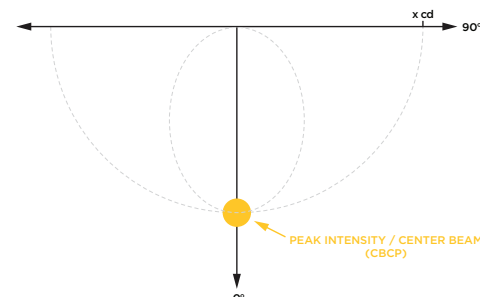
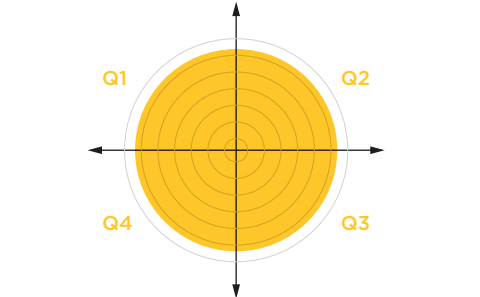
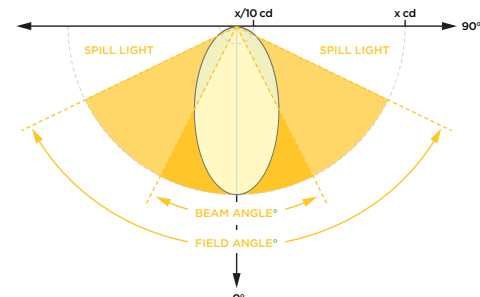
LIGHT MEASUREMENT UNITS

UNIT	ABBREVIATION	EQUATION	DEFINITION
CANDELA	cd	$1\text{cd} = 1(\text{lm}/\text{sr})$	The SI unit of luminous intensity. One candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} Hz and has a radiant intensity in that direction of $1/683$ watt per steradian.
FOOT CANDLES	fc	$1\text{fc} = 1\text{lm}/1\text{ft}^2$	Non-SI unit of illuminance, measuring luminous flux per unit area
KELVIN	k		The kelvin is often used in the measure of the color temperature of light sources. Color temperature is based upon the principle that a black body radiator emits light whose color depends on the temperature of the radiator. Black bodies with temperatures below about 4000 K appear reddish whereas those above about 7500 K appear bluish. Color temperature is important in the fields of image projection and photography where a color temperature of approximately 5600 K is required to match "daylight" film emulsions.
LUMEN	l	$1\text{lm} = 1\text{cd} \cdot 1\text{sr}$	The luminous flux emitted into unit solid angle (1 sr) by an isotropic point source having a luminous intensity of 1 candela
LUX	lx	$1\text{lx} = 1\text{lm}/1\text{m}^2$	SI unit of illuminance, measuring luminous flux per unit area
STERADIANS	sr		A unitless value that expresses solid angle. Is used in threedimensional geometry, and is analogous to the radian which quantifies planar angles.

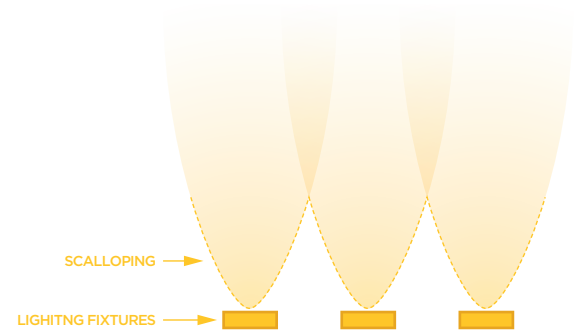
LIGHT MEASUREMENT TERMS

UNIT	ABBREVIATION	SYMBOL	DEFINITION
ILLUMINANCE	lx	E	Luminous power incident on a surface
LUMINANCE	cd/m ²	L	Luminous power per unit solid angle per unit projected source area
LUMINOUS EFFICACY	lm/W	η	A ratio between the lumens generated and the power consumed
LUMINOUS EFFICIENCY	%	∇	A measure expressed as a percentage that shows how the fixture's physical characteristics will affect how much light will leave the fixture. These include: fixture design, the reflectance of its materials, lamps/LEDs, optics, power supply and other material such as a lens or louver is used.
LUMINOUS EMITTANCE	lx	M	Luminous power emitted from a surface
LUMINOUS ENERGY	lm•s	Q	The perceived energy of light or the radiant energy factored by the sensitivity of the human eye
LUMINOUS FLUX	lm	Φ	The radiant power (is the total radiated power in watts, also called radiant flux) factored by the sensitivity of the human eye
LUMINOUS INTENSITY	cd	I	A measure of the wavelength-weighted power emitted by a light source in a particular direction per unit solid angle
SOLID ANGLE	sr	Ω	An object's solid angle in steradians is equal to the area of the segment of a unit sphere, centered at the angle's vertex, that the object covers

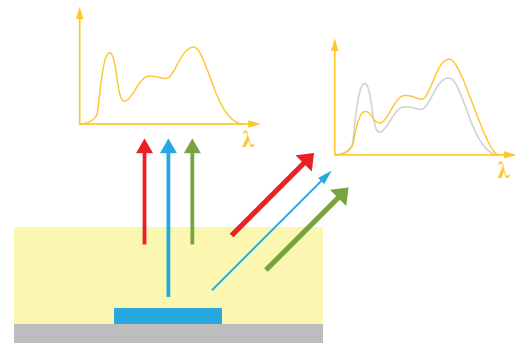
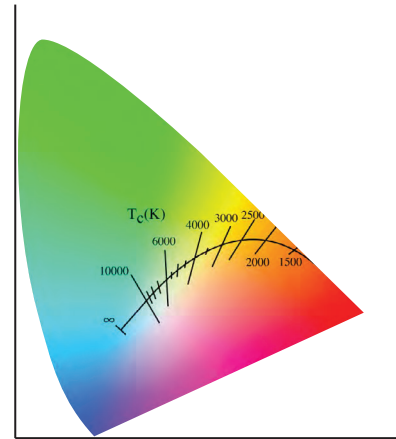
TERM	DEFINITION	
ASYMMETRY	Denotes that 2 or more quadrants have differences in the candela distributions	 <p>A polar plot showing light distribution with concentric circles representing intensity levels. The distribution is skewed to the right, with a dashed line indicating the symmetric portion and a solid line showing the actual asymmetric distribution. Labels 'SYMMETRY' and 'ASYMMETRY' point to their respective parts. The vertical axis is labeled 0° and the horizontal axis is labeled 90°.</p>
BEAM ANGLE	The angle at which the candela intensity drops to 50% of the peak intensity	 <p>A polar plot showing a beam of light. The beam angle is indicated by a dashed line forming a cone. The peak intensity is at the center (0°). The beam angle is defined as the angle where the intensity drops to 50% of the peak. Labels include 'x/2 cd' and 'x cd' on the horizontal axis, 'PEAK INTENSITY' at the center, and 'BEAM ANGLE°' for the cone. The vertical axis is labeled 0° and the horizontal axis is labeled 90°.</p>
BILATERAL SYMMETRY	Denotes equal light intensity at adjacent quadrants (quadrants 1=2 & 3=4, or 2=3 & 4=1)	 <p>A polar plot showing a beam of light that is symmetric about the vertical axis. The beam angle is indicated by a dashed line. Labels include 'x cd' on the horizontal axis, 'y°' for the beam angle, and the vertical axis is labeled 0° and the horizontal axis is labeled 90°.</p>
CANDELA DISTRIBUTION	A curve (can be displayed or plotted in polar or cartesian coordinates) showing the variation of luminous intensity of a source on a plane through the luminous center	
CBCP	Center beam candle power - refers to the candela value at nadir (directly below the fixture)	 <p>A polar plot showing a beam of light. The center beam candle power (CBCP) is indicated by a red dot at the center (0°). Labels include 'x cd' on the horizontal axis, 'PEAK INTENSITY / CENTER BEAM (CBCP)' at the center, and the vertical axis is labeled 0° and the horizontal axis is labeled 90°.</p>
CUT OFF ANGLE	The angle measured off the horizontal at which the source is visible	 <p>A diagram showing a light source (a rectangular block) on a surface. The cut off angle is the angle measured from the horizontal to the top edge of the source. Labels include 'SOURCE' for the block and 'CUT OFF ANGLE' for the angle. An eye icon is shown looking at the source.</p>

TERM	DEFINITION	
DIFFUSED LENS	Describes any lens that widens the beam angle and/or obscures the source image. This can be accomplished by adding geometry to the surface of the lens or by adding a bulk diffuser to the material itself.	
FIELD ANGLE	The angle at which the candela intensity is 10% of the peak intensity	
LUMEN OUTPUT	Amount of lumens coming out of a light source	
NADIR	The direction perpendicular to the primary emitting surface of a light fixture	
PEAK INTENSITY / CENTER BEAM	<p>The point at which the highest candela intensity is located. Also referred to as Center Beam Candle Power (CBCP).</p> <p>Unit of Measure: Candelas (cd)</p>	
ROTATIONAL SYMMETRY	Equal light intensity in all quadrants at relative locations (quadrants 1=2=3=4). Within quadrants, all points have equal intensity.	
SPILL LIGHT	Total lumens that fall outside the field angle cone which is <10% of the peak intensity	

TERM	DEFINITION
GLARE	Powerful and uncomfortable concentration of light from a fixture that can leave the lasting impressions in vision
SCALLOPING	The pattern that is created when a cone of light intersects with a surface
MULTIPLE SHADOWS IN THE BEAM	When using multiple light sources, such as multiple LEDs in one fixture, multiple shadows can be cast from one object being illuminated
SHADOW	A shadow is a region where light from a light source is obstructed by an opaque object
STRIATION	A phenomenon which exaggerates the contrast between edges of the slightly differing shades of gray, as soon as they contact one another, by triggering edge-detection in the human visual system
UNIFORMITY RATIO	A ratio of the largest and smallest foot-candle value on a plane. Typically refers to luminance values on a surface.



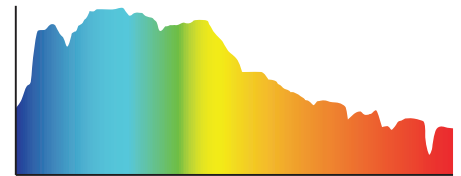
TERM	DEFINITION
CCT	<p>Correlated Color Temperature - used to define the position on the Black Body Curve for White Light</p> <p>Unit of Measure: Kelvin (K)</p>
CCT SHIFT OVER POWER INPUT	As the input power for a fixture decreases, the CCT of the light source will become slightly warmer in color
CCT SHIFT OVER TIME	Over time, the CCT of an LED may shift due to curling (shift to blue) or delaminating (shift to yellow)
COLOR OVER ANGLE (COA)	<p>Color varies as a result of the angle by which it exits the LED. At large angles the optical path of blue light is larger leading to more absorption and a spectrum with less blue light and more phosphorconverted (yellow) light. Mid power LEDs routinely have worse color over angle performance than high power LEDs, and different manufacturer's versions of high power LEDs have a wide variations in color over angle performance as well.</p>
COLOR VARIATION	DUV noticeable to the human eye. Generally considered to be anything greater than 0.004 DUV for any observer, or greater than .002 DUV for a trained observer.
DUV	<p>The most accurate metric to describe the color shift of a light source is $Du'v'$-that is, the change in $u'v'$ coordinates on the International Commission on Illumination (CIE) 1976 ($u'v'$) chromaticity diagram, which is the most visually uniform diagram of a light source's color. Color shift can be caused by physical changes to the LED package that reconfigure the ratio of blue pump to phosphor emission. Different LEDs can vary considerably in terms of their color stability, and some of the problems in this regard that were observed in earlier versions have been corrected in newer LED packages. One thing that's certain is that color shift is not an inevitable outcome for LED lighting products.</p>
LED COLOR CONSISTENCY	A measure of the color variation over angle. Also reference Color Over Angle (COA).



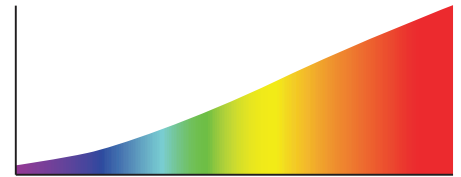
TERM	DEFINITION
LUMEN MAINTENANCE	Lumen maintenance compares the amount of light produced from a light source or from a luminaire when it is brand new to the amount of light output at a specific time in the future. Useful lifetime estimates for LED lighting products are typically given in terms of the expected operating hours until light output has diminished to 70% of initial levels (denoted L70 life) for a given operating Temperature. <i>EX: 100,000hrs at L70 at 25C</i>
MACADAM ELLIPSE	In the study of color vision, a MacAdam ellipse is a region on a chromaticity diagram which contains all colors which are indistinguishable, to the average human eye, from the color at the center of the ellipse. ANSI recommends that lamp (light source) manufacturers stay within 4 MacAdam Ellipses. A 1-step MacAdam ellipse defines a zone in the CIE 1931 2 deg (xy) color space within which the human eye cannot discern color difference. Most LEDs are binned at the 4-7 step level, in other words, you certainly can see color differences in LEDs that are reportedly the same color.
PHOSPHOR COVERED BLUE LEDS	The typical method for creating a white light emitting LED - to coat a blue LED chip with yellow phosphor. The blue + yellow spectra sum to white light output (cool white). Red phosphor is added to the yellow phosphor in order to create a warm white LED.
SDCM (STANDARD DEVIATION OF COLOR MATCHING)	SDCM has the same meaning as a "MacAdam Ellipse"

SPECTRAL POWER DISTRIBUTION (SPD)

A Spectral Power Distribution is a graph of the radiant power per unit area at each wavelength of a given source and provides a visual profile of the color characteristics of a light source

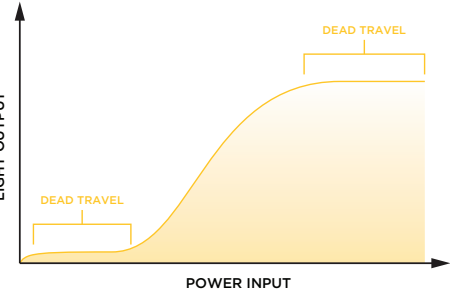


DAYLIGHT



INCANDESCENT

DRIVER AND DIMMING PERFORMANCE TERMS

TERM	DEFINITION	
DEAD TRAVEL	The point(s) at which the light level stays the same, as you reduce/increase the dimming level on a dimmer	
DROP OUT	Drop out occurs where the light turns off (or “drops out”) as you move decrease the dimming level, although you have not reached the bottom of the dimmer. This is common due to the fact that different dimmer models have different values for their lowest, low end voltage. A very common way to control Drop Out is to set the low end trim higher than the drop out point. Some dimmers lowest low end level might fall below the fixture support dimming range.	
FLICKER	A flickering light source is one where its brightness level is unsteady or fluctuating and is noticeable by the human eye	
POP-ON	The Pop-on effect results when the LED fixture does not turn on at its very lowest light level and the dimming level must be increased in order for the light to turn on. It is common practice in the industry to set the trim on the low levels of the dimmer in order to prevent instabilities. Low end trim could be set high enough to guarantee no pop-on behavior. Some dimmers can also be locked to turn on at a preset level. This is a level that could be set higher than the required pop-on threshold.	
POPCORNING	Popcorning is a behavior experienced when turning on of a group of fixtures and individual fixture in that group turns on with noticable delays	
SHIMMER	A form of flicker that could be perceived as less annoying, or noticeable, but is still for unsteady or fluctuating light	
SOFT OFF	The slow fade off of the light output when the fixture is turned off	
SOFT ON	The slow fade on of the light output when the fixture is turned on	