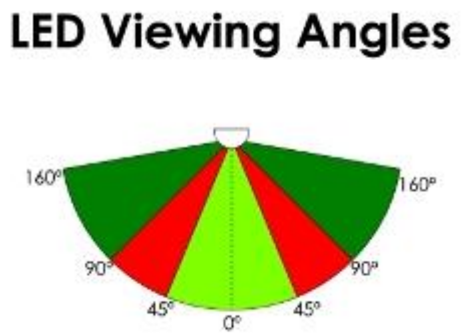
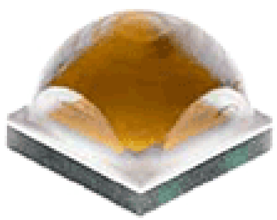
WHAT IS AN LED VIEWING ANGLE?

In other words, the viewing angle tells you the space covered by the “cone of light” prior to losing half of its peak illumination level. It is simply a measure of the position where the intensity of the LED light spread reaches 50% of its maximum brightness.



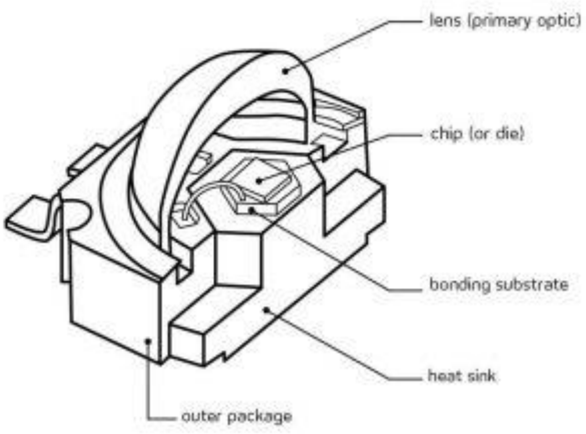
LED Optics Explained



When we think of an LED optic, we tend to think of a clear plastic lens that is placed on top of the LED itself to focus or spread the light. If this is your thought process, you’ve gone too far. Lets take a step back and look at the LED itself. See that small protective dome over the diode? That is actually called the primary optic which serves to protect and shape the output of the small diode. The light from the LEDs primary optic is still too broad for most applications, lacking intensity over distance. This is why most LED fixtures use secondary optics (lenses, reflectors, TIR optics, etc.) to collect all that light and magnify its intensity towards the target.

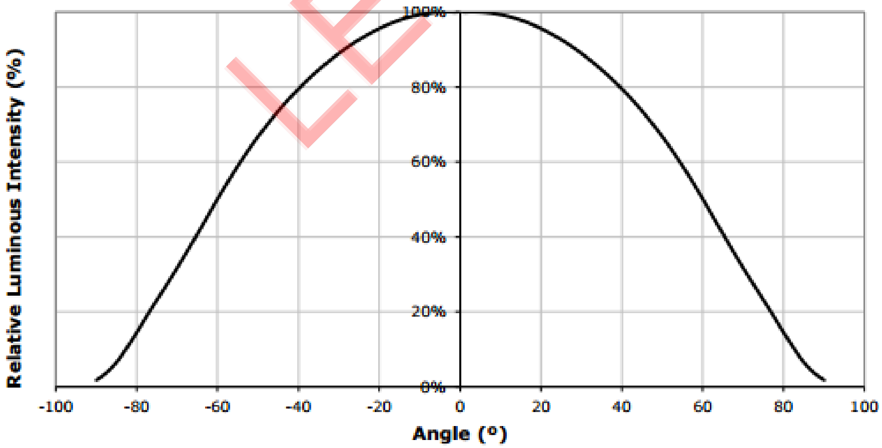
Creating lenses and reflectors for LEDs (solid-state lighting) is much different than just scaling them down from other light sources. This might seem like a logical way of creating them, as LEDs have much smaller form factors than other light sources, but they also differ in how they emit the light. As you can see from incandescent bulbs, they illuminate in 360 degrees, but LEDs are directional lighting, illuminating only 180 degrees. This is attributed to the design of an LED, as you can see, a light emitting diode consists of one or more die, mounted on a heat-conducting material, with the primary optic enclosing the die. Therefore, the maximum angle LEDs can emit is 180 degrees as the substrate is on the back side of the die.

Typical LED Package



The Primary Optic
Typical spatial distribution is what manufacturers use to describe the light coming from an LEDs primary optic. This basically means the shape or spread of the light from the center of the diode. As we talked about earlier, LEDs face in one direction, so imagine a line running straight down from the center. Spatial distribution is measured in degrees from this center point.

Let's take the Cree XP-G2 for example, which is rated at 115 degrees, meaning the beam will extend 57.5 degrees on either side. Just because it is rated for this, does not mean you get the entire lumen output of the LED across the whole spectrum. The light will be stronger the closer you are to the center, like other point of light sources. Take a look at the 'Typical Spatial Distribution' graph of the XP-G2, a graph like this will be on the emitters data sheets, which can be found on all LED product pages on the site.



Along the center axis, the LED emits 100% of its relative luminous intensity and will lose intensity the farther away you move from the center. Say we are running a Cool White Cree XP-G2 at 350mA, we know from the data sheets that at this drive current, the LED will give off 139 Lumens, it's rated output, at the central axis. At 30 degrees from center, the output of the LED drops to 125 Lumens. Going down the distribution curve at 40 degrees, the output reaches only 111 Lumens. This continues to drop until at 57.5 degrees you are only getting about half the lumen output at 70. It is obvious when you are losing this much light output over the spectrum, that a secondary lens or optic is needed to intensify that light and use the brightness and efficiency of LEDs to their full capacity.

LEDs Need to Focus

High power LEDs are constantly improving and becoming smart options for a wide range of applications. As we have stated above, for a lot of these applications, such as interior spot/down lighting, street lighting, architectural lighting and spot lighting, the emitter and primary optic on their own cannot deliver enough intensity to the target surface. We dove into emitters output above but another way of describing it is that emitters give off a Lambertian light distribution. This basically means that the brightness to an observer is the same, regardless of the observers position. If you have ever seen a bare emitter light up, you can see this instantly. Even if you are far to the side, you can still see that the light source is extremely bright, it will probably even bother your eyes to look at. The problem is that this light is just thrown out there with nothing harnessing the rays.

Secondary optics are used to collimate the light rays into a controlled beam that will bring that full intensity to the area you need. Collimated light rays spread in parallel, although it is impossible to make the light perfectly parallel because of diffraction and the finite physical size of the bare emitter. It is important to note that the smaller the light source (emitter), the more effective the process will be.

In describing how a certain secondary optic or lens can collimate a beam, we often look at the viewing angle or full width half maximum (FWHM). FWHM is the angular width of the beam when the intensity at the edge is half the intensity in the center of the beam. This is a helpful way to classify optics, but it doesn’t take into account the differences between certain optical platforms (different sized diodes). It is good to know that optics with identical viewing angles can differ quite a lot in intensity and quality of the beam depending on the emitters optical design. On the optics pages on our site, we try to list all the different angles and FWHM for each LED we carry.

Secondary optics are not only made to collimate the light, sometimes they are used to improve color uniformity and light distribution within the targeted area. Choosing the appropriate optic or lens depends on the application. Reflectors and TIR optics are used in many different applications and both have advantages and disadvantages.

Size Matters

The ratio of size of an LED to the size of the optic determines beam angle. If you want a narrow beam coming from your LED than this requires a smaller emitter or larger optic. Smaller emitters will limit the output while larger optics will really push the limits of injection molding. It is important to really know what you are looking for (most light, even spread, etc.) in pairing LEDs and optics together for your application.

What is a beam angle?

A beam angle is the angle of light that spreads across the floor when a ceiling light fixture is turned on. It can also be referred to as a beam spread. And having the right type of beam angle can give your building the right type of ambience and visibility. But for any commercial setting there are things that you are going to want to take into consideration.

Things to Consider:

Building Type

It is important to take into consideration the building type where you plan on installing the light fixtures. Not only will it tell you how many fixtures you are going to need but also which beam angle. Because depending on the height of the ceiling your beam angle can change affecting the illumination and visibility. For example, a warehouse with high ceilings will need a light bulb with a different beam angle than a retail store.

Number of Light Fixtures

If you have a 50,000 square foot building, how many lumens will give you your desired brightness? The industry standard, used for general lighting purposes for a commercial space, is 70 foot candles per square foot. Foot candles is a unit of illumination that is equivalent to one lumen per square foot.

You also want to make sure that you make a lighting layout design plan if you want to have specific areas brighter or dimmer than others.

Types of Lighting:

- **Task Oriented Lighting** – used in areas that need high productivity and are well lit.

- **Accent Lighting** – this type of lighting highlights a certain space or object.
- **General Lighting** – makes occupants feel safe and comfortable.

So how do you figure out how many light fixtures you will need?

1. First multiply the area of your building and the industry standard to get a number in lumens.

50,000 (length x width) x 70 foot candles = 3,500,000 lumens (Lumens total)

2. Then multiply the total lumens by the constant 1.40. This number is calculated by adding the light loss factor (.75) and the coefficient of utilization (.65) together. You should always take this into consideration when calculating total lumens for a specific space.

1.40 x 3,500,000 (Lumens total) = 4,900,000 lumens (Second Lumen total)

3. Lastly you want to add your lumen total and additional lumens together. This will show you the total amount of lumens needed to brighten up your commercial space.

3,500,000 (Lumens total) + 4,900,000 (Second Lumen total) = 8,400,000 lumens

Height of Ceilings and Light Fixtures

The reason that you want to make sure of your ceiling's height is to make sure that the beam angles are overlapping. If you don't you may end up with a dark, dim area in your building. Overlapped beam angles will ensure that light is fully covering your space and will prevent injury.

The standard height of a ceiling is around 7.87 to 8.86 feet so a wider beam angle, 60 degrees or more, should be sufficient. If your ceiling height is more than 8.86 feet than you are going to need a narrow beam angle which is less than 45 degrees.

In either case you need to accommodate for your ceiling's height to ensure that you have a bright work space. When you're working with high bay lights in an industrial setting, for example, that has a high ceiling an easy fix would be to use reflectors that can better disperse the light accordingly and make the beam angle more narrow.

What are the different beam angle types?

Since there are quite a few different beam angles some manufacturers have decided to simplify it a little bit. Beam spread is identified by putting them into one of the three groups: narrow, medium, and wide.

Different Angles:

- Very Narrow Spot (< 7 degree)
- Narrow (5 – 15 degree)
- Spot (16-22 degree)
- Narrow Flood (23-32 degree)
- Flood (32-45 degree)
- Wide Flood (45-60 degree)
- Very Wide Flood (>60 degree

(*Note*: These are the beam angle for one bulb type (MR16). Remember that the bulb type can vary depending on your application.)

What is the difference between a floodlight and a spotlight?

The main difference between a floodlight and a spotlight is that a floodlight has a very wide beam while spotlights are narrower.

Floodlights are good for illuminating driveways, warehouses, or parking lots. Spotlights, on the other hand, are great for displaying objects, architectural details, and landscape features.

Lumens vs Beam Angle:

When we don't get the beam spread that we want for our room or for our products, we may think that it is because the bulb is not bright enough.

Lumens are responsible for the brightness of a light bulb. So while you might think you are not getting the right type of ambience or angle for your application just remember that one of the factors you need to take into consideration, is the height of the ceiling. The lumens or brightness of the bulb is not going to change due to the ceiling's height, the beam angle however will change.

Degree of Light	From 5 Feet Away	From 10 Feet Away	From 15 Feet Away	From 20 Feet Away
10	0.9 feet wide	1.8 feet wide	2.7 feet wide	3.6 feet wide
15	1.35 feet wide	2.7 feet wide	4.05 feet wide	5.4 feet wide
20	1.8 feet wide	3.6 feet wide	5.4 feet wide	7.2 feet wide
25	2.2[illegible] beam angle chart	4.5 feet wide	6.75 feet wide	9 feet wide
40	3.6 feet wide	7.2 feet wide	10.8 feet wide	14.4 feet wide
45	4.05 feet wide	8.1 feet wide	12.5 feet wide	16.2 feet wide
60	5.4 feet wide	10.8 feet wide	16.2 feet wide	21.6 feet wide
90	8.1 feet wide	16.2 feet wide	24.3 feet wide	32.4 feet wide
120	10.8 feet wide	21.6 feet wide	32.4 feet wide	43.2 feet wide

To be sure that you have the right angle and number of lumens you can check the manufacturer's box.