Nanolumens®

Mastering the Language of LED

A layman's guide to LED

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Show of hands... who's an expert on all things LED? Well, if you're like most, you're probably scratching your head to figure it all out, and asking yourself, "What in the heck does this mean?" Let's face it, the jargon, and product specifications can be overwhelming.

We're here to help take the stress out of purchasing your LED displays with a thoughtful guide containing concrete definitions. Whether you're a designer, architect, integrator, or end user... choosing the right technology can be daunting.

With this guide, we hope to help narrow down the details to more digestible pieces, and help you make a purchase that's best for your application. Be sure to check our Pro Tips throughout this guide for additional insight. If you are considering a LED display solution, please don't simply rely on the display technology component.

For Nanolumens, it's very much about creating a partnership to design fully customizable solutions that are built to suit the environment and planned with a specific goal in mind. Discussions centered around the buying process will often highlight things like viewing distance and angles, pixel pitch, display size, and intended use. Each of these elements work in tandem to create your one-of-a-kind LED display solution. Together we can transform any environment into an immersive and engaging experience.

"When considering your next display solution, consider a long-term solution. Nanolumens' LED product line-up has an outstanding lifespan. Being able to offer designers long-term solutions and the freedom to unbox their creativity is simply awesome!"

Jammie Proctor
Director, Sales Engineering
Nanolumens

No Standards

Before we dig into specifics about display specifications, what customers need to recognize is that there are no standards when it comes to LED. Unlike standard LCD screens that have a standard VESA pattern, LED has no standards. All LED panels are not created equally, and the absence of regulated standardization within the industry does not preclude the existence of commonly used benchmarks. Customers therefore must do their own due diligence and research the intricacies with regards to these LED specifications so they can make a knowledgeable purchase. The final step before any purchase should be a request of the manufacturer to test and prove their specification claims. In this guide, we demystify the characteristics and language used in the AV industry when referring to LED displays.

Charlestown Square - Charlestown, Australia

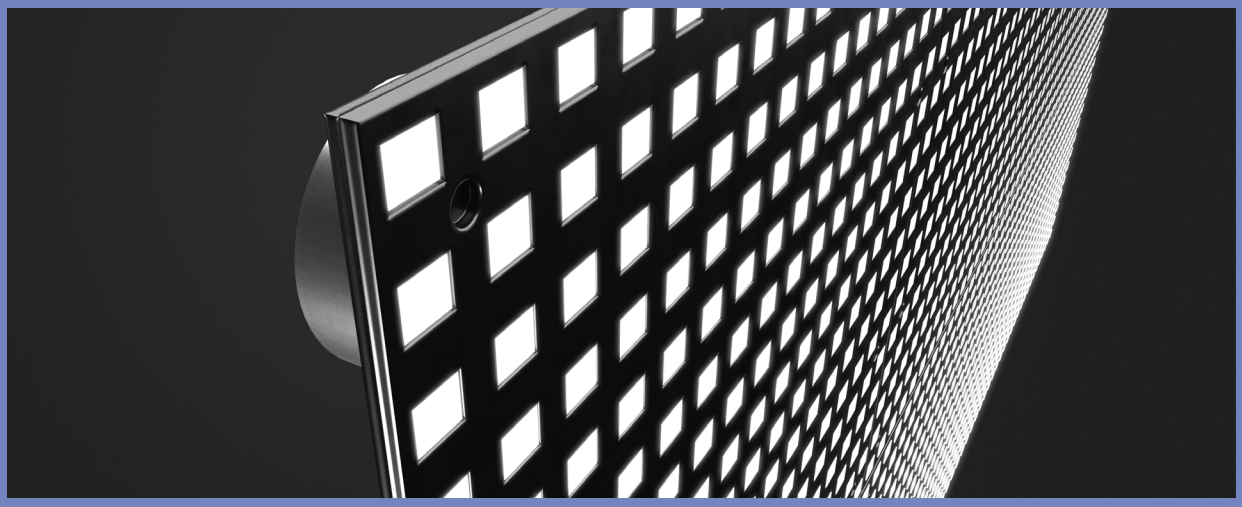
Definitions Pertaining to Environmental Conditions

Diode Lifespan

We mentioned benchmarks and no standards previously, and here is one commonly met benchmark you can bank on from LED manufacturers – Diodes. In its purest definition, a light emitting diode, or LED, is essentially a small light bulb. But unlike typical incandescent light bulbs, it does not contain a filament, thus making it far more efficient. An LED also has a longer lifespan, lasting approximately 50,000 to 100,000 hours for a high-quality LED – or about 2.5 to 11 years. Here the industry standard is commonly set as 100,000 hours, which roughly translates into 11 years and 5 months. Meaning that if you run that display at 100% brightness, full white, for 24 hours a day, 7 days a week, a diode will last 100,000 hours until its brightness degrades to 50% of the level it met on Day 1. Manufacturers will claim that there's no need to pay more for displays, with diodes guaranteed to last 100,000 hours when the 50,000 hour lifespan of their diodes is plenty. Buyers beware! We caution you to look closely at these types of claims. In some cases, it is a true statement. If a customer plans to use their display sparingly or they are particularly concerned with cutting costs, shorter lifespan diodes can prove a decent option. Displays rarely operate at their peak brightness and diodes with a lifespan of 50,000 hours can be perfectly viable in smaller scale boardroom or corporate settings. Still, a less robust diode with a shorter lifespan is going to exhibit a higher fail rate, meaning it may need to be replaced even more quickly than its 50,000-hour description. All we're saying is... if someone advertises that 50,000 hours is all you need, take that with a grain of salt.

What is a Diode?

A light emitting diode, or LED, is essentially a small light bulb, but unlike incandescent light bulbs, it does not contain a filament, thuse making it more efficient. An LED also has a longer life span, lasting approximately 50,000 to 100,000 hours for a higherquality LED - or about 5.5 to 11 years.



Brightness

Now that you understand the characteristics of a diode's lifespan, the next element of the equation is brightness. In the digital display industry, brightness is frequently measured in "nits," with one nit being equivalent to one candela per square meter (cd/m2), representing the SI unit of luminance. For reference, a typical LCD display, like a computer screen or TV, is approximately 300 nits. Commercial LED displays on the other hand range in brightness from roughly 750 nits in small scale indoor applications to 10,000 nits+ in huge outdoor installations. Many customers turn to LED because alternative digital display technologies have not yet proven bright enough. Bright is not always the best though! In most large-format LED applications, even in high bright cases (think outdoor and in bright sunny areas), 1200-1500 nits is sufficient. The intended use case for your display should serve as a guide for the brightness level you require from your diodes.

Nanolumens allows our customers to fully customize to virtually any brightness level they require. While NanoLumens is capable of producing outdoor LED displays with soaring brightness levels, we often find the best solution for most indoor installations is a smaller, sharper, product with a lower brightness and optimized energy usage. In any case, keep in mind going for a display with a brightness maximum well beyond the intended regular usage level not only leaves customers paying for performance they don't need but as the brightness is cut back, it also compromises the grayscale of the display.

Key Takeways

1. In most indoor environments a targetbrightness of 600 to 800 nits will provideexceptional ability and still allow you to turn the display down.

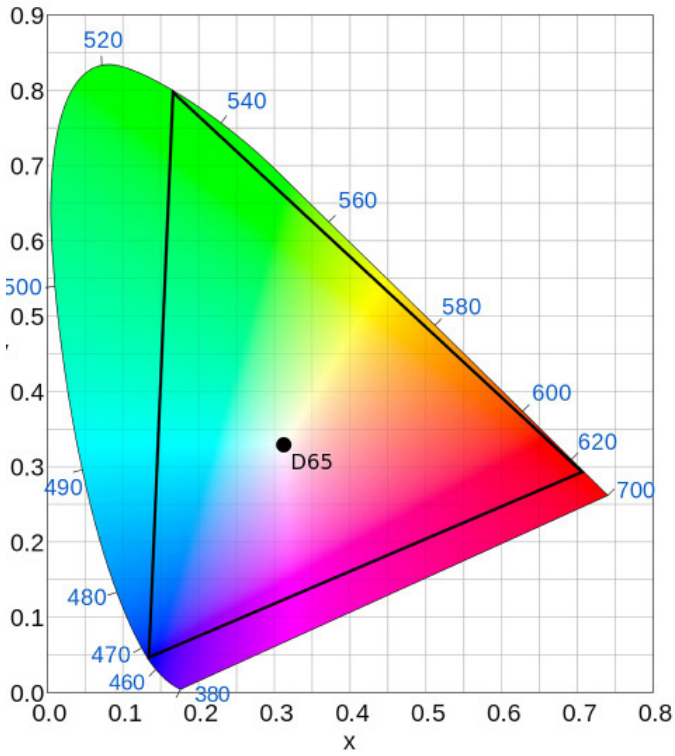
2. Ask about the Diode lifespan rating. A true 100,000 hour life span should be rated at 100% output not at a reduced output.

3. If you have an environment wheresunlight is directly on the display or inextremely bright areas, then you shouldconsider higher brightness ranges at 1000 nits and up.

Definitions pertaining to the Displays' visual performance

Color Gamut

Bit depth refers to the number of colors your display can create; the color gamut of a display determines the spectrum existing within all those colors. In layman's terms – it's how many color variations of green, blue, or red you can produce. More colors mean sharper colors and colors matching more closely to real life as you truly see them. A tighter color gamut will look muddled and dull where a larger color gamut will start to look crisp and lively. Within the range of colors we can perceive, as shown in the diagram, there are smaller subsections of colors that digital displays can recreate. These subsections were standardized at the urging of content creators, who wanted uniformity in the way their content was displayed across varying display technologies. As technologies improved, content creators demanded greater color space, so display manufacturers enhanced their technology to keep up. Color gamut follows standards such as the commonly known Rec. 709 (Standard TV) and the larger DCI-P3. Specifications are usually written to reflect what percent of the standard the display will meet, for example 96% DCI-P3. This means that the display will produce 96% of the DCI-P3 color standard where another display may produce 99% of the standard; the 99% display will produce more colors than the 96%. Ultimately, less than half of people can even tell the difference between Rec. 709 and DCI-P3. If brand's colors are represented as expected, then most displays can get away with running the common Rec. 709 gamut.



Pro Tip

It is important to understand that just because a display can produce the gamut, it doesn't mean that you can take the full advantage. To take full advantage you would need the content produced in the matching format, and a player that can reproduce the content in the format, and finally a display which can display the content in the higher format. The next generation color space is called Rec. 2020 (Dolby vision), but currently very few digital technologies can reproduce it. So, the pecking order is Rec.2020 > DCI-P3 > Rec. 709 (Standard TV)

Bit Depth

While the color gamut determines how many colors you can display, bit depth determines luminescence levels of each color you can reproduce. Bit depth is shown as quantity of bits (ex. 8-bit, as we are on a digital domain). This means that for each color, you have 8 bits of range of brightness which in turn when mixed with the other colors determines the final color you see. For example, the color you see in a red shirt is comprised of pixels, those pixels are a mix of red, green, and blue for a final color.

Where this really comes into play is in gradients. Have you ever noticed on your TV when a nice sunset is displayed and you see bands in the gradient of the sunset – that is a factor of bit depth. For example, in the image below you will notice the gradient of the orange colors in the sunset. Each band represents a normalized value within each of those values which results in bands where, in contrast, your eye perceives an infinite bit depth, giving no steps just a solid gradient. Unfortunately, digital is converted and it can only be processed to a certain extent thus you are seeing the limitations of that.

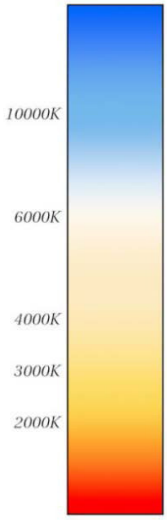
Pro Tip

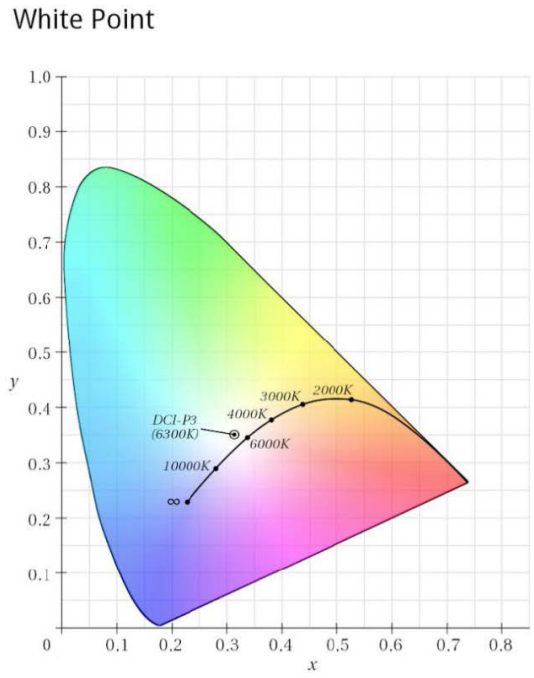
8-bit is considered "standard" bit depth and is what most of your cable TV is produced anPdh : prtrinogcs.ecosmsed in. The industry is moving forward from there and in the newer HDR realm is pushing up into the 10bit range as standard. Dolby vision is starting to push the next generation into the 12-bit range which is 16x the dynamic range of the 8-bit standard! Just like color gamut the content and end to end solution must all be able to support the standard you need. The weakest link in the chain will ultimately set the maximum capacity. For day-to-day use, 8 bit is more than sufficient, and in an environment where you would like to have a dynamic display 10 bit will be sufficient.

White Point

Often tethered to color space is the white point of a display determining its color temperature. White point settings are determined based on the Kelvin scale. 6,500 Kelvin, abbreviated as D65, is the most common setting. Just like the lighting in your home the lower the Kelvin the warmer (more orange) the image will look, on the opposite side, the higher the number the cooler it will look. LCD's for example usually run in the more blue tone space (higher K) so often times you may prefer a cooler white point. See the graph below as an example of this.

One white point is not inherently better than another, and the reason to choose one white point over another depends entirely on use case and environment or even subjective taste. Know that in most cases this specification can be adjusted as needed, and customers should make sure the white point they request aligns with their display environment or content need.

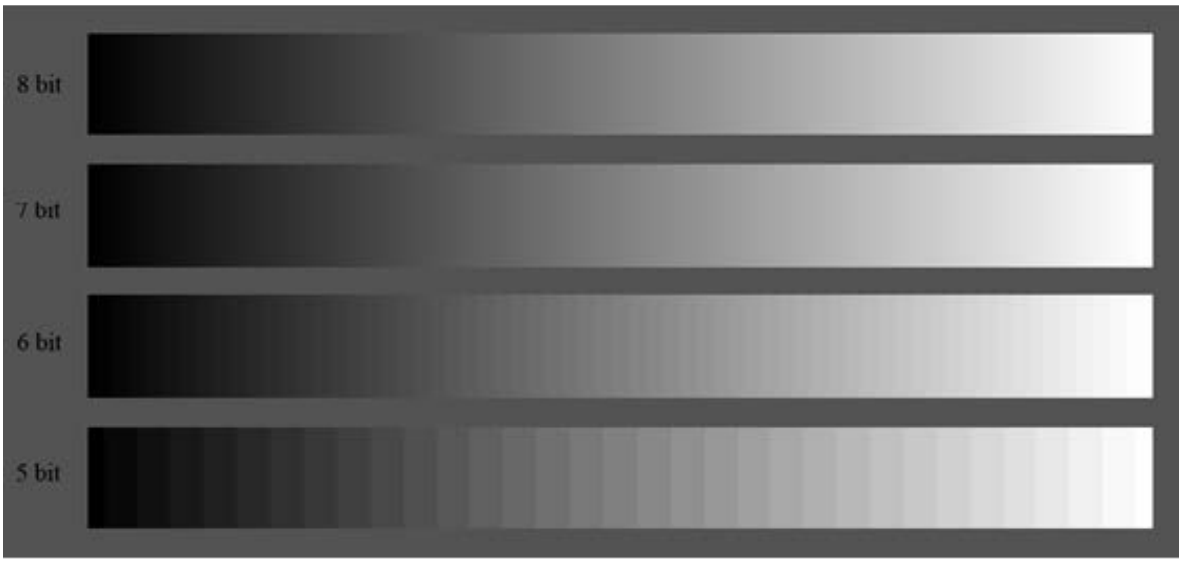




Grayscale

So now that we have covered the number of colors able to be produced and the brightness of each of those colors, grayscale is the industry term used to indicate how well a display differentiates monochromatic tones and it is a result of how well the display captures the range of grays between full black and full white. Layman's terms – how well it can dim those colors. Think of a person wearing a shirt, color gamut and bit depth determine how true to color that shirt is. Now imagine that shirt having a light shined on it in a dark room – the color didn't change but how the color is represented as it gets darker is a factor of grayscale. How many steps the display can create from 100% bright, down to complete black.

This is called grayscale because ultimately it is the handling of the blacks of the display. The higher the number the more levels of control the display has thus a better performance in gradients from full black to full white. In an ideal scenario, grayscale would be an infinite number of steps giving a perfectly smooth gradient. This performance characteristic is what gives the smoothness of color gradient and black detail in the display. In an extreme example of only 8 steps of grayscale (3-bits), the resulting images on a display will exhibit blocky blacks similar to a highly compressed file -This is often seen in darker shots with lots of shadows.



Pro Tip

When judging our grayscale quality against those of our competitors, we use the same photo depicting twelve trees in a field vanishing into the fog on both displays. These types of "shoot-outs" are common to compare how well a display differentiates separate tones of similar colors and it is a result of how well the display captures the range of grays between full black and full white. For the same reason Best Buy tunes all their televisions to the same channel: when the content is the same, color differences are more noticeable. The picture of foggy trees functions as an ideal litmus test for grayscale quality for a pair of reasons. First, it is a generic image and second, the foggy nature of the picture means that as grayscale quality changes, the number of trees visible changes as well. Customers should ask to see these comparisons too.

Off-Axis Viewing

Many of the terms we've covered interpret what an audience sees but off-axis viewing governs the optimal range for viewing the display. Off-axis versatility is crucial because LED displays are often not viewed by a stationary audience. As a viewer walks by a display, the amount of time he can see content is a function of the off- axis viewing capabilities of the display. For example, if a display only has an off-axis angle range of 90 degrees (45 degrees from center each way) a viewer will only be exposed to the content while he is within that range. Once he has moved beyond 45 degrees to the right or left of center, the display content is no longer clearly visible. In contrast, a display with a viewing angle range of 160 degrees, or 80 degrees from center each way, allows for over four times the total visibility. In the image below, the pink region represents the visible area for a display with a 90 degree off-axis angle range, while the green region represents the additional area that becomes visible for a display with a 160-degree range.

Why is Off-Axis Viewing Important?

The better the off-axis views of a display are, the longer its content will be viewable, and the more likely the content will be to influence spectators.

Key Takeaways

1. There are a lot of factors that come to the subjective viewing experience and often times the individual's opinion is more of a factor than hard specifications. As a buyer the standard levels (similar to the viewing of your cable TV) are 8-Bit Color and Rec. 709 color gamut. This will generally get you a great looking display. If you would like to do a shootout be sure to provide the same content, served from the same device (CMS, Computer, Blu-ray, etc.) so you can get an apples-to-apples comparison.

2. There is a lot of emerging technology like DCI-P3, Rec. 2020 color, and Dolby Vision standards. These are amazing techs that will prove to be the next "standard" level. The problem is to produce that quality you must be able to create content in that standard and have a way to play it back. If you don't, it's kind of like having a Ferrari and driving in a school zone. There are ways to produce these standards today, but ensure you are comparing the hard specs to validate how close to the standards you are getting as many are not 100%.

3. Content is an extremely important factor in the video performance of the display. A repurposed, or "just use this" piece of content can make even the best display look terrible. Plan to optimize any content you want to "pop" for the type of display. This minimal effort will often pay dividends in the final result.

Whew! We made it to the end...

Are you still confused, or has this guide helped make things a little less fuzzy? Our intent was to arm you with tools and resources to help make your LED purchase less confusing.

Remember to do your homework before buying any LED display product. Please reach out anytime to our team; we're happy to assist you and help you with your selection.

Don't hesitate to contact us at info@nanolumens.com with any questions regarding a project!

Miscellaneous Other Terms

Beyond the major specifications detailed above, there are a few other terms that are important. Without dedicating too much time to these more granular details, here are a few brief descriptions.

Fill Ratio

Often confused with pixel pitch, which is the distance between the centers of adjacent pixels. Fill ratio factors in as the blank space between the closest edges of adjacent pixels. Essentially, it measures the empty space of the display. A lower fill rate can make the pixel pitch seem smaller without changing it. A higher fill rate on the other hand can make the pitch seem wider but it facilitates a better contrast ratio because there's more black visible which the pixels can stand out. Lower fill rates often correspond with larger pixels, all else being equal, the larger a pixel is, the more expensive it will be.

Frame Rate (Refresh Rate)

For the most part digital displays will have this information in the specification and based on that information you can determine if it's something you need to worry about. The frame rate of a display indicates the number of frames per second a display can show. The higher the frame rate, the larger the digital file for the content will be and the greater demands it will place on your display. the standard 24 frames per second (fps) is used for most films. Why 24fps? It was chosen as the standard because it is the minimum frame rate that can produce decent sound quality and gives a movie that "movie" look. Customers should expect their digital display to be able to process around 60 fps. Some newer processors can even handle 120 fps but this sort of performance only really comes into play with sophisticated gaming and high-end cinematography.

BTUs

The British Thermal Units (BTUs) produced by a display is a product of the heat output efficiency of a display. One BTU is equal to the amount of heat needed to heat one pound of water one degree Fahrenheit. The efficiency of a diode and its circuitry determines the heat output of the LED driver board, while the efficiency and loading of the power supply determines the heat output of its components.

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About Nanolumens

Nanolumens is a US-Based LED design and manufacturer headquartered in Atlanta, Georgia. Nanolumens offers world-class displays across multiple market segments adding wonder to physical spaces. Nanolumens is a pioneer of the true curve technology and are committed to being better. With a bold and visionary team of experts Nanolumens will take your project, in all shapes and sizes, from concept to reality. Nanolumens brings your creative visions to life, leaving a first and lasting impression. We are LED! For more information, visit www.nanolumens.com