HEY! WHAT DOES THIS SPEC MEAN?

NanoLumens®

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The prospect of purchasing commercial digital display solutions is daunting, in no small part due to the complexity of ever-changing industry jargon. The fluidity of many of the industry's most common –yet most confusing- specifications can make the precise definitions of these terms quite difficult to pin down. With this guide however, we hope to do exactly that: nail down these concepts with concrete definitions so consumers can confidently counter sales speak with specificity.

Organizations who make the decision to purchase a large-format LED display solution are not simply buying a piece of technology off the shelf. They are partnering with a manufacturer like NanoLumens to arrive at a fully customized solution that is built to fit a specific space and serve a specific purpose.

Creating this perfect visualization solution requires a manufacturer to know what exactly a customer is looking for but in many cases these desires can be hard to articulate because industry vernacular is so malleable.

Following the initial decision to purchase a display, a customer will likely establish a few things up front, like viewing distance, pixel pitch, display size, and intended use. Each of these metrics are fairly easily understood and they work in tandem to set the basic dimensions of each display project. Where the project path goes from there can get a lot more nuanced. We've found that even if primary specification discussions were productive, the confusing technical language that dominates secondary conversations can derail even the most promising projects.

This is why we have created this guide; to finally pin down the confusing specifications that have long avoided concrete definitions. Equipped with the knowledge you'll find within these pages, consumers and manufacturers alike will be able to move towards stronger long term relationships because they will at last be speaking the same language.

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First Things First: There’s No Singular Authority

Before diving into the specifics about display specifications, what customers need to realize first is that there is no real governing body judging how specifications are created, claimed, and tested, so manufacturers can pretty much say anything. With no authority monitoring what display providers can and cannot claim, customers have to shoulder this fact-checking responsibility themselves. There are a few steps in this process. First, the absence of regulated standardization within the industry does not preclude the existence of informal but commonly-met benchmarks. For each display metric, customers should learn these benchmarks and use them to set their initial expectations. Next, customers should research the intricacies of each specification so they can smoothly counter sales speak with actual knowledge. The final step is to request that manufacturers test and prove their claims. To get this process started, let’s begin by dissecting one ubiquitous industry term: diode lifespan.

Diode Lifespan

The first thing a customer should know about the lifespan of a diode is the commonly-met benchmark. Here, the industry standard is 100,000 hours, which translates to roughly 11 years and five months. That number means that operating at 100% brightness, full white, 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. A few display manufacturers have started to advertise that there’s no need to pay up for displays with diodes guaranteed to last 100,000 hours when the 50,000 hour lifespan of their diodes is plenty good enough. You should look skeptically at this claim but it can indeed be true in certain cases. 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 and 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 characterization would portend. All we’re saying is if someone advertises that 50,000 hours is all you need, take that with a grain of salt.

The 100,000 (and 50,000) hour rating is set by the suppliers who create diodes and then sell them to manufacturers, who subsequently assemble them into the full-size displays you see out in the field. During this assembly process, manufacturers will often reduce the maximum brightness levels of these diodes. They do this because LED displays almost never need to run at full brightness in the field and setting a reduced upper brightness bound upon assembly helps extend the point in time at which the diode’s brightness will degrade to half of its original maximum. In other words, the diodes are designed to last 100,000 hours until degrading to half brightness but by artificially capping their brightness once assembled into a display, manufacturers extend this lifespan and decrease the fail rate of the diodes while not materially reducing performance. Most large-format LED displays rarely operate in the field at even 50% brightness, so this 100,000 hour benchmark exists mostly to indicate the lifespan of a diode under uncommonly rigorous usage patterns. Capping maximum diode brightness upon assembly and then operating the display at a lower brightness is a common best practice to maximize the lifespan and efficiency of a display.

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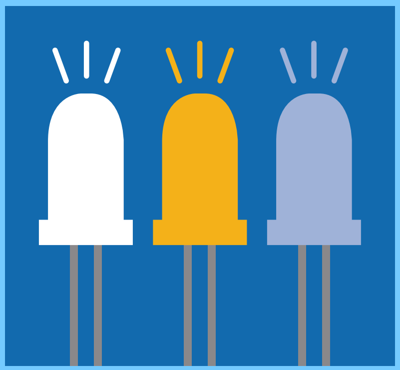
WHAT IS A DIODE?



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

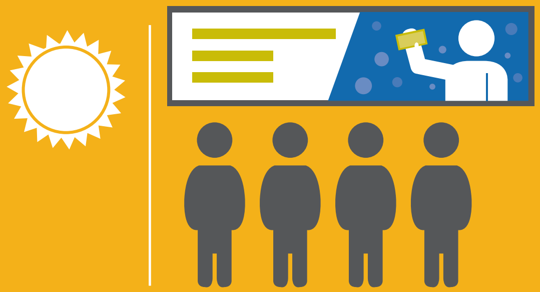
Brightness

With the knowledge that diode lifespan is intrinsically tied to brightness, customers should next develop an understanding of how display brightness works. 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 home television runs around 300 nits, give or take. 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 proven bright enough. This can lead them to desire the brightest possible LED solution but in truth that is rarely necessary. In most large-format LED applications, even in high bright cases, 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 and NanoLumens allows our customers to fully customize virtually any brightness level they may desire. 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 maximum and more efficient 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 also compromises the grayscale of the display.

How Ambient Light Affects Your Display

The more ambient light in a display space, the brighter the display needs to be in order for viewers to really see it. If you are considering an outdoor display, be aware that in order for viewers to see it properly during daylight hours, it needs to have a minimum rating of 5,000 nits.

If your business requires an indoor display, the recommended brightness of your display will vary based on the space. Consider how much light is present during your highest-traffic hours.



"One of the challenges of Arizona State University's display location was the intense sunlight that pours in during the afternoon. It was necessary to find a technology that could remain vibrant in that environment. This NanoLumens display can literally outshine the Arizona sunset!"- *Kris Jonson of Level 3 AV.*

Grayscale

Grayscale is the industry term used to indicate 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. This scale is a product of the display's bit depth but it is based on the display running at full brightness, so the further from full bright a display goes, the worse the grayscale quality will erode. For example, a display with a maximum brightness of 7,000 nits turned down to 1,000 will exhibit much worse grayscale than a display with a maximum brightness of 2,000 nits turned down to 1,000, even if the displays have the same bit depth. The reason for this has to do with how the displays are powered.

Grayscale indicates 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.

When judging our grayscale quality against those of competitors, we import onto each display the same photo depicting twelve trees in a field vanishing into the fog. We do these sorts of comparisons for the same reason Best Buy tunes all their televisions to the same channel: when the content is the same, differences stand out more visibly. The picture of foggy trees functions as an ideal litmus test for grayscale quality for a pair of reasons. First, it is a fairly 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.

PRO TIP!

When at full brightness, the width of the electrical pulses providing power to each diode is at its widest. The reason these diodes are powered by pulses of energy and not a constant, uninterrupted flow is to maximize the power of each driver (read: power) chip and reduce the number of fail points within the system. These pulses are so fast and so frequent that humans cannot perceive the downtime when the diodes are unpowered. When brightness is decreased, so too are the length and number pulses the driver chip is able to complete. With shorter and fewer pulses, there are fewer stops on the scale between full black and full white, meaning fewer grays, and thus, fewer color tones. The resulting images on a display will exhibit banding, the blocky grades of colors that appear when tones don't transition smoothly. This is often seen in darker shots with lots of similar colors, like a sunset for example, or in blown out bright shots, like a blue sky.

Bit depth

While the brightness of the display plays a major factor in grayscale quality, grayscale is determined more fully by a display's bit depth, as mentioned earlier. The bit depth of a display is essentially a representation of its processing capacity. All content shown on digital displays is part of a digital file. These binary digital files are compressed into pieces of data known as "bits" so they can be more efficiently stored and transferred. These bits are either a 1 or a 0. The term bit depth refers to the number of bits used to display the color channels of red, green, and blue, for each pixel in a given LED display. An 8-bit display can create over 16 million colors, while a 10-bit display can create over a trillion.

Most people can only perceive about 10 million colors, so the industry standard for digital displays and cameras is a bit depth of 8 bits. High-end photography, cinema, and gaming can require higher bit depths to prevent any banding in over- or underexposed parts of their content, but for most purposes, 8 bits will be sufficient. Increasing bit depth will increase the number of colors your display can show, but it will also require greater energy consumption and greater processing power from your software.

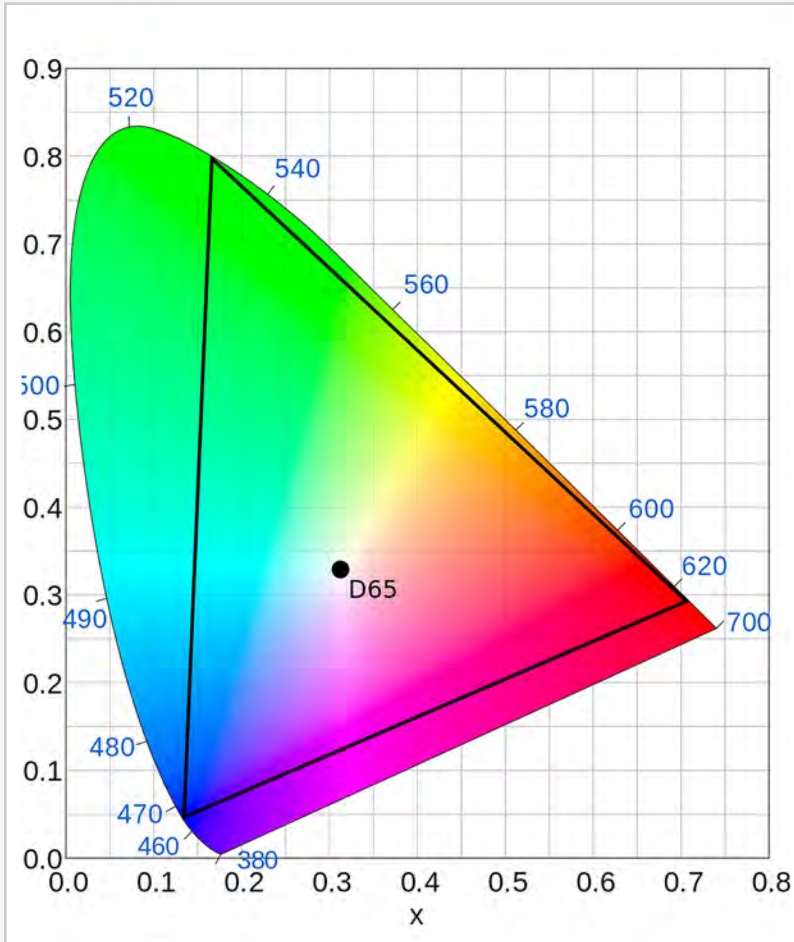
DO THE MATH

If a display has a depth of 8 bits, that means there are 8 bits of data storage available for each color channel, spanning the range between 00000000 and 11111111. There are 256 possible variations within that range and three color channels that possess that range, meaning an 8-bit display with red, green, and blue channels in each pixel is capable of showing 256 x 256 x 256 possible color combinations, a number that totals to be 16,777,216. Greater bit depth expands the range of possibility for each color channel and in doing so exponentially increases the number of potential color combinations. For example, a 10-bit display can create 1,024 shades per channel and thus 1,073,741,824 possible combinations.

▲ Color Space

While grayscale quality controls the tonality of your colors and bit depth controls the number of colors your display can possibly create, the color gamut of a display determines the spectrum within which all those colors exist. To explain how color gamut, or color space, works, let's start simple: there is only a certain range of colors that are perceptible to the human eye. To scientifically differentiate between the colors in this range, you need to introduce math. To graphically represent the finite differences between colors, as it is most easily stated in layman's terms, the International Commission on Illumination (CIE) created through a series of experiments a 2-dimensional graph that plots color based on chromaticity (a product of hue and saturation) on the X axis and brightness (also called luminance) on the Y axis. This was first created in 1931, and is thus commonly referred to as the CIE 1931 Chromaticity Diagram. The diagram, as seen below, graphically represents the visible color space.

Within the range of colors we can perceive, as plotted in the 1931 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 and manufacturers. The first baseline color gamut for digital content was established in 1990 and dubbed Rec. 709. As the first standard gamut introduced, it covers the smallest portion of the visible color spectrum and is met by nearly every digital display product. As time went on and technologies improved, content creators demanded greater color space to show their work, so display manufacturers improved their technology to keep up. The newest standard gamut is called DCI-P3, and it was first published by the Society of Motion Picture and Television Engineers (SMPTE). DCI-P3 is wider and richer than Rec. 709. The next generation color space is called Rec. 2020, but right now few if any digital technologies are able to reproduce it.



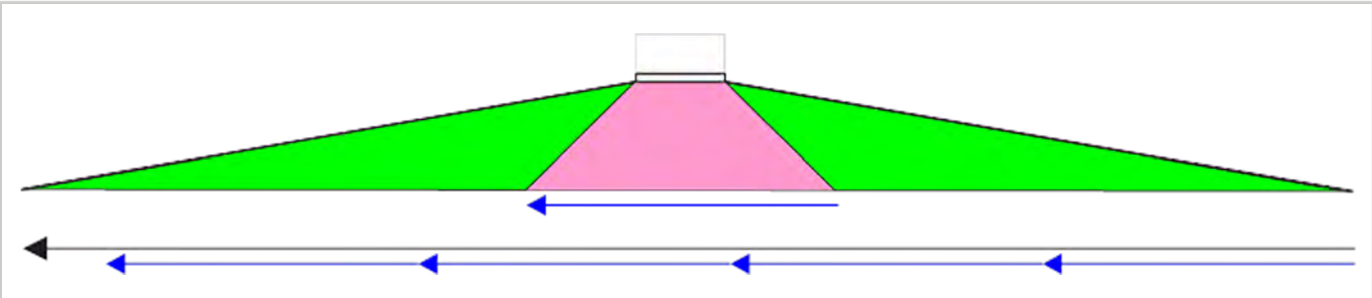
Digital displays are getting better and better at recreating the colors of real life, pushing their native color spaces closer and closer to the limits of the visible color space. Still, less than half of people can even tell the difference between Rec. 709 and DCI-P3, so as long as brand's signature colors are represented true to form, displays used for basically anything other than cinema can get away with the common Rec. 709 gamut.

▲ White Point

Often tethered to color space, the white point of a display determines its color temperature. White point settings are determined based on the Kelvin scale. 6,500 Kelvin, abbreviated as D65, is the most common setting. One white point isn't inherently better than another and the reason to choose one white point over another depends nearly entirely on use case and use environment. This specification can be adjusted as needs change and customers should make sure the white point they request aligns with their intended display environment.

▲ Off-Axis Viewing

Many of the aforementioned terms regard what an audience sees but off-axis viewing governs where an audience sees. 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 is able to 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, or 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 cleanly 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. This extra time is precious. 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.



In order to be effective, content needs to be seen. The better the off-axis ability of a display, the longer its content will be viewable, and the more likely it will be to influence audience members.

Miscellaneous Other Terms

Beyond the major secondary specifications detailed above, there are further, more nuanced terms that customers can dive into if they feel so inclined. Without dedicating too much time to these more granular details, here are a few brief descriptions.

Fill Ratio

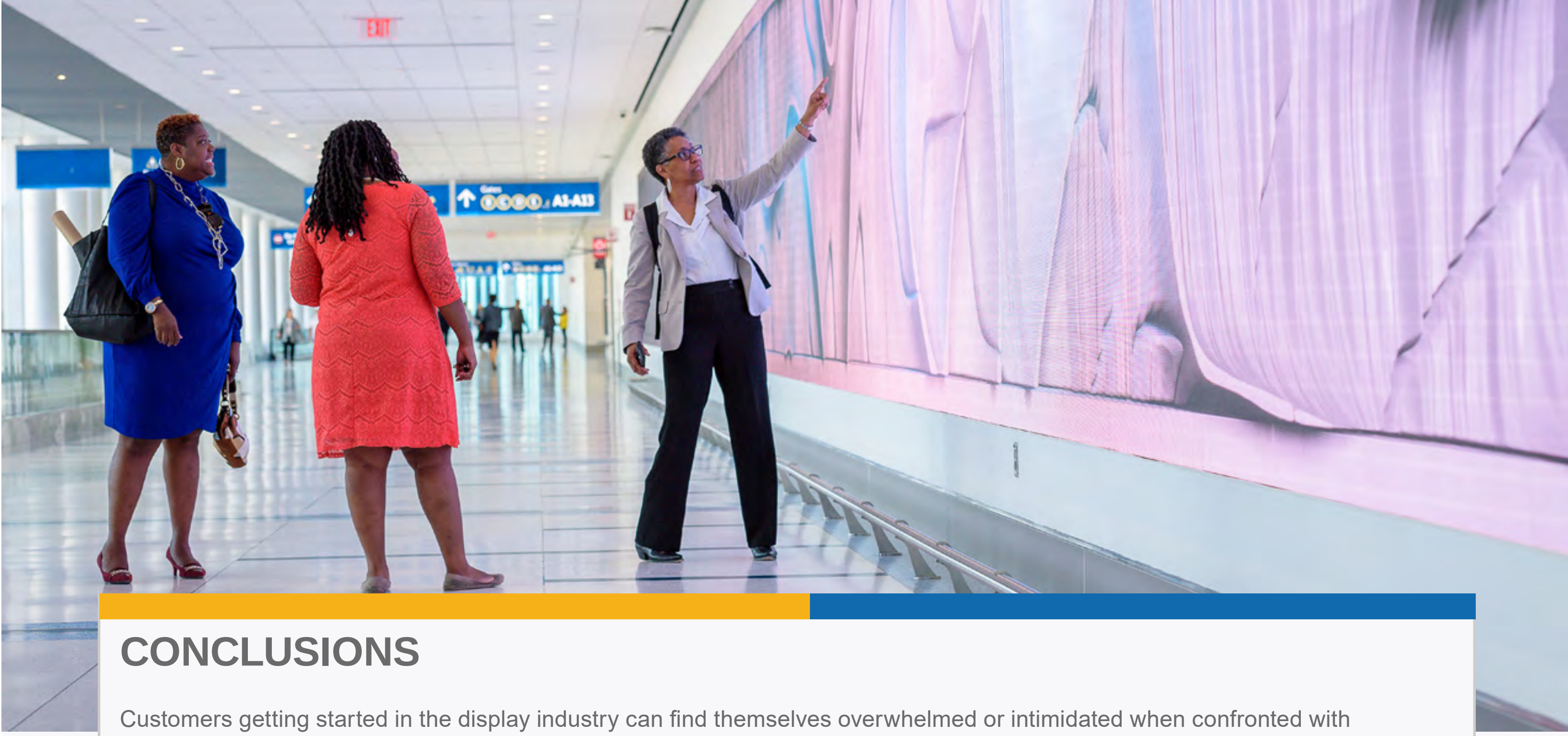
Often confused with pixel pitch, which is the distance between the centers of adjacent pixels, fill ratio is the blank space between the closest edges of adjacent pixels. Essentially, it measures the empty space of the display. A lower fill rate can make the pixel pitch seem smaller without actually 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 against which the pixels can stand out. Lower fill rates often correspond with larger pixels, all else equal, and the larger a pixel is the more expensive it will be.

Frame Rate

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. A common frame rate is 24 frames per second (fps) but customers should expect their digital display be able to process around 60 fps. Some newer processors can 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. One BTU is roughly 1,055 joules. 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.



CONCLUSIONS

Customers getting started in the display industry can find themselves overwhelmed or intimidated when confronted with confusing industry jargon. If you found this paper helpful but would like to further bolster your LED fluency, you might be interested in learning more about pixel pitch. We've got a really helpful paper on that subject available right here.

In the large-format LED display industry, it's commonly said that you get out what you put in. With that in mind, it is quite prudent for customers to figure out what manufacturers are putting into their display, for only then can customers really understand what they'll get out of it. To help polish your display knowledge, browse through our deep vault of informative white papers here, including "What is Pixel Pitch and Why Does It Matter?".

NanoLumens®
PUTTING THE WORLD ON DISPLAY

Headquartered in Atlanta, Georgia, NanoLumens partners with clients to create uniquely compelling, interactive LED visualization solutions that take the guesswork out of owning a display network. As the fastest growing visualization company in the US, our experiential LED displays exceed the imaginations of global clients in retail, transportation, corporate, gaming, higher education, sports and arenas, and houses of worship. Through world-class proprietary technology, NanoLumens displays are ultra-thin and lightweight, energy efficient and available in any size, shape or curvature. NanoLumens solutions are proudly designed and assembled in the United States of America and come backed by an industry-leading six-year warranty.

NanoLumens®

THE WORLD'S TOP BRANDS

Creating displays impactful enough to deliver a truly immersive experience for your space takes more than technology. Now featured in leading companies worldwide, NanoLumens combines a powerful visual display platform with an unparalleled team of visual communications professionals that empowers companies to produce engaging experiences.

ANY SIZE, ANY SHAPE, ANY CURVATURE

The foundation of our LED displays is the Nixel™, our patented digital building block that gives our visualization solutions the flexibility to match your design requirments.

INDUSTRY LEADING WARRANTY

Our six year, Nixel™ to Pixel Warranty backs your display from corner to corner, down to the individual pixel. This includes all parts and controller devices. We guarantee displays are free from defects from the date of shipment.

COMMITTED TO US MANUFACTURING

Designed, assembled, and supported in the USA, our products are Trade Agreements Act Compliant (TAA –19 U.S.C. §§ 2501-2581).

AWARE® - DISPLAY MANAGEMENT

The future of visualization technology will move far beyond the display itself. Success will be found by those companies who bring intelligence to the marketplace. Our hardware-based, software-as-a-service display management system combines support functions with interactive content, live video feeds, remote diagnostics, and audience communications.