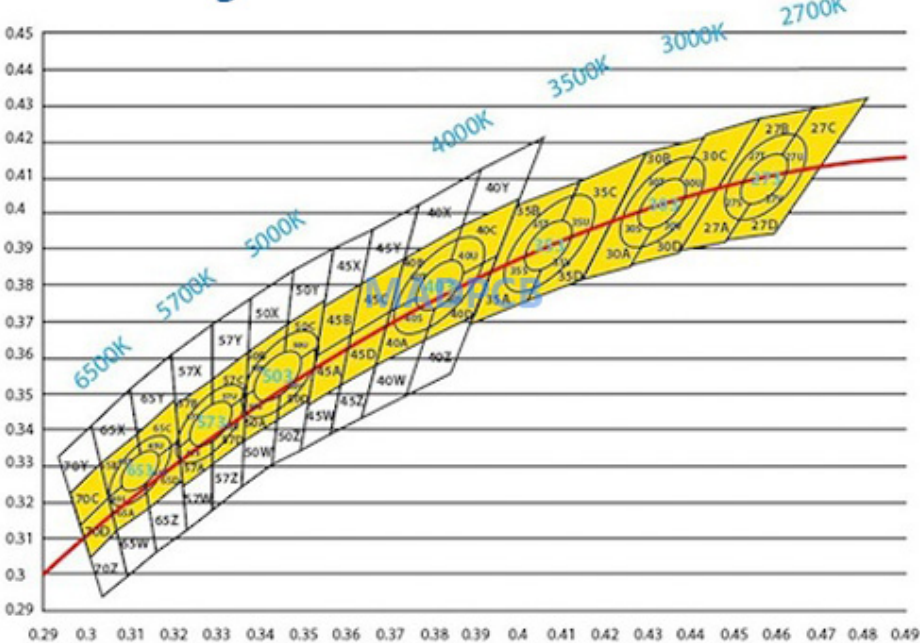




ANSI NEMA LED BINNING STANDARD

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LED Binning



ANSI NEMA LED BINNING STANDARD

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Introduction

Daylighting, Light-class LEDs are driven by application requirements and industry standards. In 2008, ANSI and NEMA collaborated to establish a binning standard for LED manufacturers called ANSI/NEMA C78 377A, also known as “Specifications for Chromaticity of Solid-State Lighting Products”.

This Technical Bulletin briefly explains the LED binning process, which is the focus of ANSI/NEMA C78 377A and illustrates why this standard should be important to both manufacturers and lighting engineers. In many high-end LED light PCB assembly (<https://madpcb.com/pcb-assembly-services/>), customers require certain LED bins for LED components sourcing (<https://madpcb.com/components-sourcing/>). In this PCB blog (<https://madpcb.com/blog/>), MADPCB (<https://madpcb.com/>) will tell you all about LED binning.

LED Binning Definitions

The technique that LED manufacturers have developed to classify their LEDs is called LED binning. LEDs are placed into similar categories, or bins, with each category defined by similarity in lumens, colors, and forward biased voltages. LED binning according to colors is based on the CIE 1931 Chromaticity Diagram (from the international Commission on Illumination) and a series of quadrilaterals that are imposed upon the Chromaticity Diagram (see Figure 1). Those quadrilaterals identify regions of noticeable differences in color. Within each of these individual quadrilaterals, the human eye cannot perceive any color difference. Therefore, LED manufacturers indicate the coordinates of their LED on the chromaticity diagram, and end-users can reliably use this information to select the correct color light for specific applications.

(<https://madpcb.com/wp-content/uploads/2016/09/LED-Binning.jpg>)

LED Binning

LED Production

To understand binning, it is helpful to review the production of LEDs. Manufacturers receive LED chips known as blue chips, which are groups of similar LED chips packed and glued to blue discs. LEDs are first unpacked manually, then picked and placed automatically onto plastic packages. After alignment, a gold wire is attached between every chip, at which point phosphor is applied on top of the LED chips to convert the blue light emitted from the chip to white light. Each LED is then scanned and verified for the appropriate color temperature, and phosphor is manually added or removed as needed so that the color matches the specification. Protective polycarbonate casing is then attached on top

of the underlying chips. The product is tested for air voids, and silicon will be manually added to fill these voids as necessary. Finally, heat is applied to cure the silicon material within the LED. When the quality control is finished, the binning process begins.

LED Binning Process

LEDs are first introduced into the hopper of a sorting machine and then lined up to enter into a spectral radiometer. Each LED product is then individually measured and sorted by lumen output and color into prescribed ranges. LED suppliers create their own standard sets of lumen bins and provide clear information on the expected lumen performance of each of their bin ranges. This way, luminaire manufacturers can easily select the bin (or set of bins) that best meets their needs using the lumen coordinates based on the Chromaticity Diagram. Smaller bin sizes maintain a tighter control of color variation and are consequently more desirable.

Why LED Binning is Important?

Binning is important for luminaire manufacturers to specify and control LED color output, since these factors have significant impact on performance, cost, and lead-time. Lighting engineers and designers are also encouraged to familiarize themselves with the manufacturer's binning process and applicable engineering standards like ANSI/NEMA C78 377A to ensure quality LED products are installed.

In Turkey PCB Assembly (<https://madpcb.com/turnkey-pcb-assembly/>) job, we always meet some BOMs (<https://madpcb.com/glossary/bom/>) provided by customers with some LED SMDs specified with Bin Code (Binning), which will be soldered onto their PCBAs. What "bin" means, how you read the codes, why it matters?

LED components vary from each other during production. Their difference can manifest in color, forward voltage, and flux. The binning practice has been designed to maximize effective utilization in the production of LEDs. This practice is important for both luminaire manufacturers and end-users alike. The term ANSI, stands for American National Standards Institute, this institute has little to do with the meanings and workings of binning in the field of Solid-State Lighting.

Why is LED Binning Needed?

There are multiple reasons why the LED industry cannot do without binning.

- One of the LED-to-LED differences after production, is their maximum current and power. As the variations between individual LEDs are big, the current needed to power one LED, might overload another. For this reason, the first selection made to divide LEDs is applied forward voltage.
- Also, the color of light might vary drastically per LED die. In many applications a multitude of LED components are used to create a single lighting image. Because of this, the LEDs cannot vary too much in color from their neighbors.

In both brightness, color consistency and efficacy, for certain application, standards exist. One example is the European standard for traffic signal coloring (EN12368 – Standard for Traffic control equipment and signal heads). Without binning it would be impossible to produce a lighting solution based on LEDs that would fall within regulation for each individual component.

Different LED bins

Some bins might consist of LEDs within a certain maximum forward voltage that can be applied safely. Another Bin might consist of LEDs that emit light within a certain minimum and maximum wavelength or flux.

An example of a BIN based on light emission, might be LEDs with a minimum wavelength 544 and a maximum wavelength of 550 nm. Before this selection can be made, the max. forward currents need to already have been determined and separated.

When after the determination of light output, there is still a need for color separation, this can be done, but only when the former separations have already been made.

Each LED manufacturing brand divides LEDs by different standards and therefore has different binning, but because very often product lines are developed for similar purposes, binning of different brands is never far apart. LED manufacturers are always looking to create ever more specific bins for specific applications.

CREE created the Easywhite binning, which is a white LED bin that is aimed at improving LED-to-LED color consistency. In this particular bin the margins for fluctuations between LEDs are very small.

As opposed to Easywhite, which aims at color consistency, CREE's truewhite bins is an alternative bin that generates white light using red and yellow LED color mixing. This bin is particularly aimed at halogen replacement applications, as this light is more yellow and warm than most LEDs.

Very often the title of a bin describes the type of light the LEDs emit. For example, Osram describes its white LED bins as cool white, neutral white, and warm white, and provides you with each of the bins measurements specifics. This is now done by most LED manufacturers.

The types of bins are often subdivided in numbers. For example, the table below shows LED bins divided by maximum and minimum dominant wavelength, and a number is added per range.

Bin code Minimum Dominant Wavelength (nm) Maximum Dominant Wavelength (nm)

Bin Code	Min Dominant Wavelength(nm)	Max Dominant Wavelength(nm)
1	390	395
2	395	400
3	400	405
4	405	410
5	410	415
6	415	420

Binning at Operating Temperatures

- It was Philips Lumileds who first upped the standard binning measurement temperature from 25°C to 85°C.
- Up to that point, the quality of LED lighting or the durability of a chip severely decreased as working temperature rose.
- When measuring at 85°C, the results are much closer to real life use of the component, making the numbers much more useful.
- Binning now almost always happens at 85°C

Binning Diagrams

A binning diagram shows the geometry on the CIE 1931 color spacing scale. In order to specify chromaticity of specific LEDs, the geometric regions are arranged along the Black Body Locus (or BBL). The diagram shows color variations for both CCT and tint. The tint indicates the distance of the Correlated Color Temperature of a specific measured LED to the Black Body Locus.

Binning Codes

Each LED manufacturer uses a specific setup for their binning codes. Knowing how these codes are made up and how they indicate the characteristics represented in each LED bin, is very important when choosing your LED package.

For most LED products, the manufacturers release a Binning and Labeling guide, which is highly recommended when choosing a LED type.

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