



# White Color Tuning

In Outdoor Applications

INVENTRONICS

Human Centric Lighting, or white color tuning, typically invokes images of classrooms, offices or hospitals, all of which are indoor applications. Not as common, but still in discussion is optimized color and intensity for specific outdoor applications as it relates to safety, light pollution and beautification or comfort in our cities and neighborhoods. The International Engineering Society (IES) holds an annual Street and Area Lighting Conference where latest research is shared often with seemingly contradictory results per application. This is because outdoor lighting solves several problems at once and will have a different ideal solution depending on the most critical pain-point for the site. Even after a research-backed solution is defined, the lighting is still subject to the end customers' own unique preference.

As research continues, cities change and preferences shift. The flexibility offered by white color tuning is positioned to have equally significant impact on outdoor lighting. Inventronics recognizes the challenge of using two power supplies to achieve a white color tuning solution. In support of advancing the lighting industry, they've created the new EUW series designed to meet the needs of outdoor applications. The EUW series provides two output channels with independent color temperature and intensity control. This paper highlights various outdoor white color tuning applications and follows with more information about how the EUW series works.

### Brief Summary of Color Tuning:

Color tuning allows users to adjust the temperature and intensity of lighting in a space. It is more intricate than dimming which only mutes or brightens the light output. Color tuning gives full control of the warmth (presence of yellow tones) or coolness (presence of blue tones) of the

light to mimic daylight and provides the ability to fine-tune the lighting per individual specifications (see Image 1). Color tuning can be adjusted by warm dimming, white color tuning or full-color tuning.

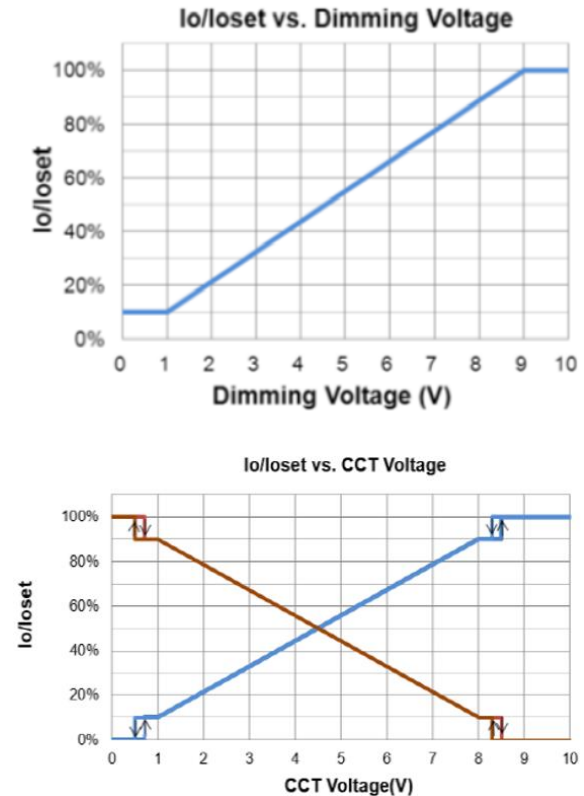


Image 1: Inventronics EUW Series Dimming Voltage vs. CCT Voltage Capabilities

### Outdoor Applications that Benefit from White Color Tuning:

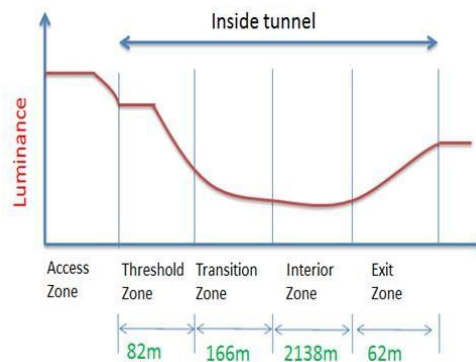
White color tuning could be beneficial to outdoor applications that are on during the day-needing more controls to mimic the lighting outside, such as tunnels and applications that are on at night and subject to priorities of the individual site such as area, landscape lighting and creative cityscapes. Below, the benefits are further explained for each one.

## Tunnel Lighting:

Driver safety is a large factor when it comes to tunnel lighting. Research has shown that inadequate lighting or dramatic changes to the lighting in tunnels causes a negative effect to the human eye as it tries to adapt to the color change and increases the possibility of traffic accidents. This is common in tunnels that utilize warm light over white light. According to Guidelines for Design Lighting of Highway Tunnels JTG/T D70/2-01-2014 (Guidelines-2014 for short), if the luminance difference between the inside and outside of the tunnel is greater than the human eye's adjustment range, then dark adaptation occurs which increases the risks for accidents. Image 2 is showing the transition of colors at the entrance of a tunnel to the middle of the tunnel and demonstrates the slowly dimmed light level to allow the driver's eyes to have time to adjust and therefore, improve driver safety. Image 3 is highlighting what is being utilized to achieve Image 2. White color tuning paired with the appropriate controls or sensors would allow the LEDs temperature and intensity to be adjusted according to the brightness outside to help reduce the dark adaptation at any time of the day or night. The lighting can also be adjusted to minimize the luminance if there are no vehicles in the tunnel to provide optimized energy savings.



*Image 2: Variations in the type of lighting in a tunnel achieved with white color tuning LEDs.*



*Image 3: Graph demonstrating the transition in the type of lighting in a tunnel achieved with white color tuning LEDs.*

## Landscape Lighting:

LED lighting has helped to transform garden, area and landscape lighting but white color tuning can take it much further. Cooler temperatures typically improve security, prevent trips and falls and help to highlight outdoor features while warmer temperatures are often more comforting in closer proximity to residential areas. Color tuning allows the user to set up dramatic scenes by changing the character of the light throughout an area with layered effects. For example, if you want cooler lights highlighting a large, towering tree and more subtle, warm lighting around smaller delicate trees, color tuning allows an easier method of tailored lighting effects (see Image 5). It also allows flexibility to adjust the color temperature more precisely after installation to make any adjustments needed. It would allow for cooler tones on cloudy or overcast days to mimic sunlight and allow for warmer tones at night.



*Image 5: Warm and Cool Lighting in a Park*

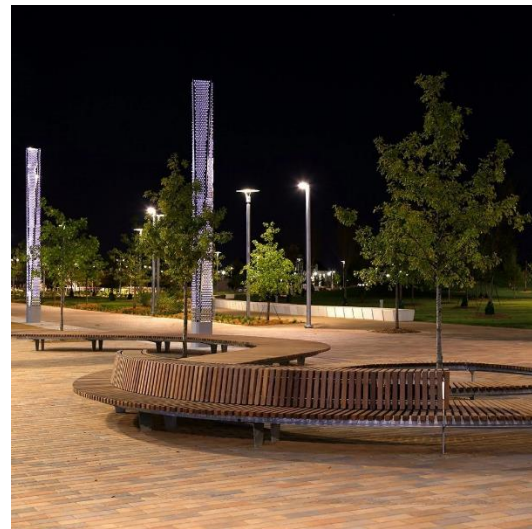
## Cityscapes:

Cityscapes are becoming more pedestrian oriented by providing more walkways, interactive environments, community-focused parks, outdoor promenades, malls and dining spaces. In these surroundings, it is important to apply the principals of design that support visibility, uniformity and using lighting to create art and visual interest.

Examples of some of these interactive cityscapes are below in images 3 and 4.



*Image 3: Promenade and shopping mall at night*



*Image 4: Community park at night*

These spaces can utilize white color tuning to create zones with different moods. A seamless transition between zones can be created slowly by blending the colors between the two points. This type of thoughtful design can turn these areas into an amazing experience for those visiting.

## Benefits of the EUW Series:

Inventronics EUW series is an IP66/IP67 rated dual channel driver that allows the user to change temperature and intensity independently and continuously. They allow the change of the lighting color temperature and intensity to provide comfortable lighting throughout different periods in one day to ensure safety and well-being. Users can change the CCT and intensity of the luminaires by the ratio of  $I_{warm}$  and  $I_{white}$  (see Image 6).

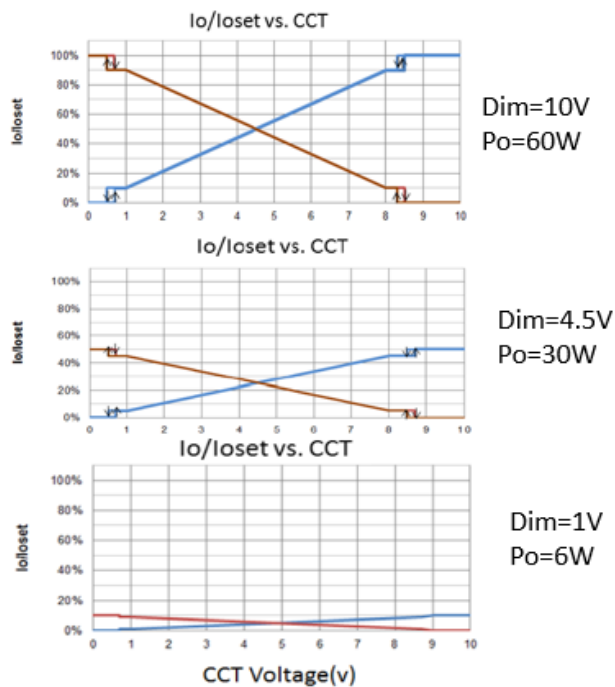


Image 6: Graphs demonstrating Color temperature is not changed when dimming and intensity is not changed when color temperature changes.

This is an important feature to simplify installation and provide an economical solution by reducing SKUs, materials and risk of incompatible connections or controls. Perhaps the most obvious benefit, but still worth noting, is that a color tuning driver allows luminaires to utilize a single driver instead of two. The main advantage to this

benefit is found in reduced shipping costs, reduced labor, and reduced materials. Shipping costs are reduced by limiting the number of LED driver boxes required to fill and order and the luminaire itself will be lighter. For example, where building 1,000 color tuning luminaires with two drivers each may have required 100 boxes, the same order could be fulfilled with only 60 boxes of color tuning drivers. Labor is reduced in mounting fewer drivers and managing fewer input and output connections. In the same example, the assembly team would have 500 fewer drivers to mount and 500 fewer AC connections and output common connections to parallel together. This reduces materials as the extra connectors and mounting hardware are no longer needed. In addition, the saved space also allows for the wiring and driver cavities to be made smaller, providing more flexibility in reducing the size of the luminaire (see Image 7).

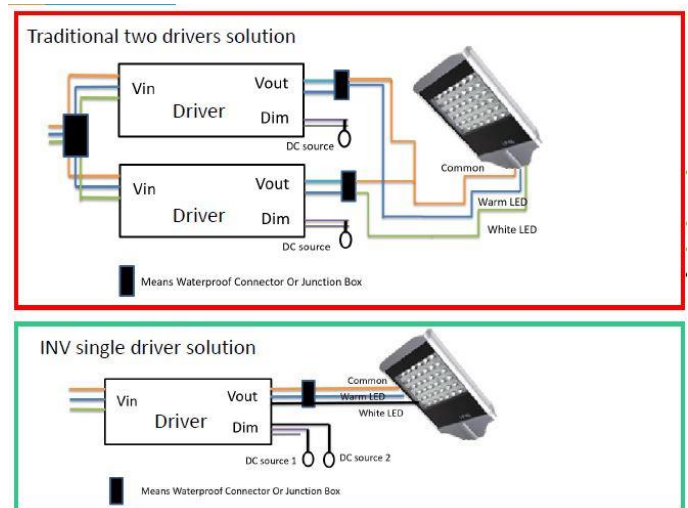


Image 7: Traditional two driver installation vs a single driver installation for tunable white lighting.

Outdoor applications such as those mentioned above are exposed to a harsher environment than traditional dual channel drivers are accustomed to. They may be subject to line voltage perturbations such as sags, swells and transients so the EUW utilizes a unique circuit to achieve a high level of common and differential mode protection. Their proprietary encapsulation process ensures no voids in material, protecting against breakdown and overall thermal performance inconsistencies.

### **Summary:**

While alternative two channel color tunable products are designed for inside environments like office, school or retail, the EUW series is designed for applications where the environment is more challenging such as tunnels, area and landscape lighting. White color tuning in outdoor applications opens the door to easier installation, reduced costs and the flexibility to precisely fine-tune the color and intensity without the need of excess LED strips. Inventronics is excited to provide this opportunity to the lighting industry and will continuously work to provide a wide portfolio of LED drivers designed for indoor, outdoor and industrial applications. To learn more about the EUW series, please visit our product page for [Outdoor White Color Tuning LED Drivers](#) or contact your [Inventronics sales representative](#) or [distributor](#).



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