

Tuning Behavior with Light: Tunable White in the Classroom

QUESTIONS

I have seen many other solutions go up to 6500K and some European studies going up to 7000K. Is there a specific reason that your solution stops at 5000K?

You have mentioned CCT and proximity to the Planckian locus and CRI. How about SPD?

For performance, please cover the audible portion - hum/buzz of lights and user interface (switches).

How does the color of light influence student behavior? What is the science behind it beyond the general acceptance that warm is relaxing and cool is enlivening? Does our visual system cause our endocrine system to release hormones based on color?

Does tunable white include both CCT and CRI values, or just CCT?

ANSWERS

The choice of CCT range for a Tunable White system considers many factors--efficacy, path, light quality, etc. First and foremost are the requirements for the application. The BLT troffer and our other "nTune" based products, we will offer two ranges: Productivity Range (3000K to 5000K) and Rhythm Range (2700K to 6500K). For the classroom application, we chose Productivity for the debut, as the main body of research focused in on this range. Additionally, it is important not to introduce extreme color temperatures, not traditionally found in an application--some designers/educators indicated going outside of Productivity would be too distracting. However, we know that the research will evolve and designers will want to explore--so they can choose Rhythm Range.

Think of the SPD for a given light source as the fingerprint--it uniquely identifies the makeup of the underlying colors it contains. Also note that, for a given white point, say 3000K on the BBL, there can be many different SPDs--those would be called metamers.

We agree that there should be an audible spec for drive circuitry and power conversion within a luminaire. It can be expressed in numeric terms--but we always check with our own ears!

This [link](#) provides you with the research that is available on this topic. It addresses this question. If more information is needed, please let us know.

The definition of Tunable White is a light source with the ability to "tune" both intensity and CCT independently of each other. Tuning CRI would, in my opinion, put the light source into another class. At Acuity Brands, we use the term "Optimized Spectrum" for this type of dynamic feature. This is a future concept, not generally being used in practice--but it will!



What if the visual effect when shifting from warm to cool doesn't follow the blackbody curve? What is noticeable and why is it negative?

Does color balancing in a fluent driver generate additional heat?

I'm interested in hearing about daylight harvesting and its role in tuning CCT. Are current sensors able to pick up CCT if properly programmed? Or will there be updates to sensor technology to accommodate this need?

I'm not sure I understand Handles of Control and Balance Colors in Luminaire.

Are "fluent" fixtures able to adjust their output over time to account for the age of the fixture and individual LEDs being out?

I would like to hear what is meant by "configuration of personality" on this slide.

Traditional light sources, halogen and incandescent, track the BBL as they are dimmed. Reproducing this effect in LED is quite difficult, so some approximations have been made. If the shift off the BBL is "too much", it is noticeable...especially if you are mixing LED and traditional sources in an installation. The BBL gets quite curved below 2700K, so sometimes avoiding going too warm will keep you out of trouble. But then the decision is whether it is enough for the application.

We as humans express color in abstract terms...purple, orange, even color temperatures like 3000K. Drivers that are fluent in color also listen to commands expressed in CCT values. The driver needs to translate from CCT to the LED drive levels. This is called the "Color Balancing" function. The Color Balancing function is resident in the driver's microprocessor and would not require any additional power consumption. Therefore, there is no additional heat or efficacy reduction.

Daylight harvesting systems are not yet ready to act upon CCT information. To do this, we will need ambient light sensors that measure the color point, and then we'd need controls systems that understand it AND know what to do with the information. We talk about re-writing control systems so that they are "fluent" in color. Daylight harvesting, using color information, is one of the reasons why we need that effort. We often joke that we wouldn't want to reproduce the outdoor CCT within our office when it is a rainy day outside!

Every luminaire has defined handles of control. Think of these as a slider that has a min and max plus values in between. In a traditional fixture, there is only one handle, and it is simply "intensity". Pretty obvious. For Tunable White, the best way to control is with two handles, "Intensity" and "CCT". A classic RGB fixture is controlled with three "direct" handles, one each for red, green and blue colors. In this example, you don't send "magenta" to the fixture, the user would need to know to send red and blue levels to make magenta--so this fixture is NOT fluent in color.

You are referring to what Acuity Brands calls Constant Lumen Output, and this is implemented in our nLight control system by enabling "n80." While technically possible, we have not yet enabled this feature for nTune.

Lighting fixtures can sometimes have "personalities", which are a set of features grouped together. This is a concept from stage and architectural lighting where the lighting designer may want to set up a light with different sets of control "handles" or possibly color gamut. This concept will become important in mainstream lighting as more dynamic behaviors are adopted. For the mainstream, imagine if you could have a single light that performed either Warm Dimming or Tunable White, and could be selected at time of setup--reducing SKUs and allowing additional flexibility in designing a space.



Please describe the difference between linear and logarithmic control.

What studies have been done that show the advantages of changing the lighting color temperature in classrooms, and which color temperatures are best for each environment?

Can we get 2 SDCM in tunable white ?

What research is being referred to? Please provide link to white paper, scientific article, research, etc.

As a teacher, I'm wondering how much bandwidth I need to know what scene to set in correspondence to the lesson/class activity.

Do you have plans to use PoE for future luminaires?

Does nTune have on-board color monitoring?

Is the nTune system capable of diurnal or circadian control?

What is your opinion of PoE lighting fixtures?

Linear and Logarithmic are two choices for dimming curves-- typically located in the driver. Imagine a slider on the wall, the dimming curve is how quickly (or slowly) the light dims as you move the slider down to the bottom. Often people want a nice graceful fade to zero, and logarithmic is a good choice for that. Linear is faster and possibly more abrupt as you dim the lights.

The great news is that there are a lot of consistencies within the research that is currently available. For example, all research agrees that warmer colors are better for individual focus tasks (such as reading) and cooler temperatures are better for increasing energy. However, there are inconsistencies as to which exact color temperature is best for each activity. For the most part, the recommendations range between 2700K and 6000K. For the Acuity solution, we decided to meet all of the research in the middle. This is why we offer 3000 (reading), 3500 (testing), 4200 (general) and 5000K (energy). This [link](#) provides the research that is available on this topic. It addresses this question. If more information is needed, please let us know.

Our nTune approach to make Tunable White uses the same reliable and consistent LEDs as our regular static white--we have the same bin-mixing algorithms and production standards. Therefore we can hit 2.5 SDCM comfortably.

This [link](#) provides the research that is available on this topic. It addresses this question. If more information is needed, please let us know.

The BLT nTune system is very intuitive and as a teacher it will be very easy for you to select color temperatures for different activities. The control panel that will be located on the wall has "pre-labeled" buttons that indicate each activity. When a button is selected the system automatically transforms to the corresponding color temperature. You can see an image of the control panel at this [link](#).

We see PoE as important and are exploring that. It is not mainstream yet.

The nTune system does not use color monitoring. Some advanced systems do use color sensors in their engine as an input to the algorithm that sets color. This is typically needed when using multiple direct colors (red, green, blue, etc.), as it is more difficult to achieve and hold a color point since those colors can shift with temperature. nTune uses a more simplified approach using white LEDs that are very stable and do not require calibration or on-the-fly retargeting.

The nTune system can be programmed to perform color temperature fades throughout the course of a day, mimicking the natural change in CCT that is experienced outdoors.

Personally, I love PoE and wish it was more common. Being a DMX guy, I am attracted to the high bandwidth that PoE would offer--but maybe we don't need that bandwidth as much as we want the digital networking and power. Let's see where this part of the industry goes.



Is there a plan to offer this fixture with Power over Internet?

More PoE requests, I am happy to hear that and we are exploring.

In Canada everything needs to be CSA approved. Is product recognized by them?

Yes! From the product data sheet: LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.

Explain nLight Air differences.

Note that nTune is not yet on nLight Air--our wireless version of nLight. You can imagine that wireless is very important to our push bringing dynamic to the mainstream, so please follow us for news on that.

What makes it HE (BLT)?

The BLT Series troffer (static white) comes in a High Efficiency version, this is achieved by running the electronics at optimal drive currents where the LEDs are most efficient.

How does the tunable white option on the BLT compare to the fixed CCT in terms of price? Is there an adder for tunable?

There is an adder for Tunable White as compared to the standard product. Please contact the [Acuity Brands Lighting rep](#) in your area for pricing.

Can the nTune feature work with daylight harvesting to match the exterior lighting color temperature?

The nTune based luminaires will all work with existing daylight harvesting methods that you've been using in nLight, but there is no CCT correction/compensation yet. This is being actively explored and will require the proper sensors and adaptations in the programming logic to handle the decisions that need to be made in the network.

Are there any other fixtures that will have tunable white as an option? What fixtures? How soon?

Acuity has a variety of Tunable White fixtures on the market right now. The nTune system, which uses nLight as the backbone network, debuted with the BLT Series troffer and was joined just last week with the new Rubik luminaire. There will be additional products released very soon that will help fill out the forms needed for any space. Please also look at the Juno products--Aculux and Indy-- as they both offer Tunable White on a variety of controls networks. And, of course, we have the Gotham EVO downlight that works on DMX using our Fresco controller (or any third party DMX controller).