VERSION 1.0

LED 101

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This guide is intended to give you an understanding of the general lighting process. It is a learning tool only, and is in no way, meant to be substituted for training in lighting and electronics.

The Altman Lighting Spectra Par provides a wide color palette for stage washes and general illumination.

At Vincent Lighting Systems, we strive to help our customers upgrade their lighting systems as they integrate LED lighting into their theatrical and architectural lighting systems. This guide presents some of the basic knowledge that will be helpful as you consider transitioning from traditional light sources to LED luminaires. Building on the lessons available in our Lighting 101 and 102 documentation, LED 101 addresses the details of understanding LED lighting fixtures, powering LED lights, and controlling them.

OVERVIEW & HISTORY

Given the continuous development of LED technology, it is now possible to rely entirely on LEDs for your stage lighting and architectural lighting system. Early LEDs easily replaced many wash lights including scoops and PAR cans.

The Philips Strand Lighting PL Fresnel offers soft pools of light with a great range of colors.

Soon thereafter, technological advancement allowed LEDs to replace incandescent CYC lights and borderlights. Most recently, the state of LEDs has reached the point where they readily replace ellipsoidal reflector spotlights and Fresnels. They've even infiltrated moving lights, which previously employed high-intensity discharge lamps almost exclusively. More and more options for LED architectural lighting having emerged. Now all of your wall washes, downlights, and cove lighting applications can be addressed with LED fixtures. This development is providing a number of benefits to those adapting to LED. In addition to power saving, LEDs are making architectural lighting systems more exciting with the ability to add color, but also more flexible with variable color temperature controls that allow you to create the warmth (or coolness) desired for any event or use of the space.

POWERING LEDS

The Philips Strand Lighting Contact Relay Panel is a great option for distributing power used for LED lighting fixtures in architectural or stage lighting applications.

In the days of dimmers and incandescent lamps, the typical power and control scheme consisted of a control console or architectural control station communicating to a dimmer cabinet via analog or digital signals (0-10v, AMX, DMX, and numerous proprietary control signals). Modules inside the cabinet increased or decreased the voltage delivered to each circuit, which dimmed the lights connected to that circuit. While some LED lighting fixtures, particularly those designed for architectural lighting, are mains dimmable (compatible with some specific dimmers, usually ELV type), the majority of stage lighting LEDs require a constant voltage power source.

Even where architectural lighting is concerned, a constant voltage fixture typically delivers better dimming performance without the sudden pop-on and pop-off caused by the LED driver (a microprocessor within the fixture) being deprived of the minimum operating voltage. While control consoles and architectural wall stations are still employed as the user interface, an LED system requires controls to communicate to a relay cabinet and to each fixture. The

relay cabinet replaces the dimmers, but rather than providing a modulated or fluctuated voltage, the relays simply switch power on or off as needed.

CONTROL SIGNAL DISTRIBUTION

Philips Strand Lighting Network nodes allow for simple circuit designs with flexible output options.

As LED fixtures require a DMX or other digital control signal (ARTnet, sACN), control signals must be distributed throughout the system. In smaller systems, this is accomplished by directly distributing DMX universes, employing DMX splitters where branches are required. Larger and more complex systems will benefit from network-based distribution. Networked control offers the most flexibility, as multiple universes may be distributed across a single run of CAT6 Ethernet cable. Network switches split and distribute the data to branches throughout the venue or building.

DMX control data is translated to IP network data for transmission, then received and returned to DMX signals at network nodes near the fixtures. In an IP-based data network, customizable control outputs can be created from multiple DMX universes at network output nodes. This allows fixtures patched to two separate DMX universes to respond to a single customized universe.

FIXTURE MODES AND DMX

Under DMX control, every DMX device must be given a starting address. This number (between 1 and 512) determines to which DMX channels a fixture will respond. In a simple RGB wash light, as few as 3 channels may be required. For example when set to a starting channel of 10, DMX channel 10 would control the red LEDs, 11 would control the green LEDs and 12 would control the blue LEDs. A slightly more sophisticated fixture might also offer a master dimmer where an additional DMX channel would be required to control the overall proportionate output of the other 3 channels. As an inherently 8-bit protocol, designers complained of jittery DMX dimming performance in early LED lighting fixtures. Adding a second control channel to an attribute raises the resolution to 16 bit performance and smooths the stepping of dimming performance.

Every attribute or feature of an LED lighting fixture is managed via a DMX control channel. Beyond the fixture's master dimmer and basic color functions, other features will require additional channels. Some fixtures dedicate one or more feature variables to a single channel, such as an intensity effect channel where DMX values between 0-10% represent standard function, 11-30% represent a dimmer ramp up

effect (where the rate of the effect is controlled by adjusting the channel value within that range), a ramp down effect from 31-60%, and a strobe effect from 61-100% (with the same rate control method as the other two dimmer effects). Some fixtures offer a higher degree of control by providing the effect selection on one channel, and the rate determination on another channel, thus offering smaller steps within a wider range of strobe or ramp speeds. Zoom controls, the ability to widen or narrow the beam, will also be controlled via additional control channels. 16-bit zoom resolution will require 2 channels, although 8-bit modes often provide the full zoom range in the bottom 50% of the controlled channel with effects populating the top 50% (functioning similarly to the intensity effects described above), additional channels may be employed depending on the range and complexity of built-in effects and macros. In the case of profile LED spotlights, most fixtures will feature a focus control which can often be addressed as a single channel 8 bit function, or a 16 bit 2 channel feature. LED powered moving lights will require many additional channels to access attributes such as position control (pan and tilt), static color wheels, static and rotating gobos, beam filters, or any other built in apparatus. Depending on the selectable fixture personality, many of those attributes could optionally be controlled in 8 or 16-bit modes. Most LED lights also feature color macros. In some cases these are a range of 5-10 static colors which manufacturers have deemed as useful, commonly used colors. Some fixtures allow for custom colors to be saved into the macro memory. Many also allow for rate controlled playback of multiple colors or even multi attribute scenes which can be saved and triggered by applying specific DMX values on the control channel corresponding to the fixture's color macro feature.

FIXTURE PROFILES

The fixture profile maps a control channel to each fixture attribute, allowing you to access the features of the LED lights using user-friendly tools. Once you've determined the preferred fixture personality, it's time to fire up the control console and patch your fixture to the correct fixture profile and starting address. Most consoles are shipped with an extensive list of fixture profiles already saved into their libraries, though it may be necessary to download new fixture libraries for new-to-market fixtures or less common brands of lights. Often a fixture profile editing tool is available to create your own profiles if you can't wait for the console manufacturer to generate a profile (most do so for free and usually in less than 24 hours). Those tools include various color picking mechanisms that include choosing a color from familiar gel colors, using a mouse to click on a color within a spectrum palette, even sampling color from a photograph. It also allows you to custom mix or fine tune color by turning encoder wheels for each color of LEDs in your fixture. You'll also have access to strobe controls so that you can set the intensity, duration, and speed of effects using percentages, time in seconds and RPM, respectively. This makes operation and programming far more intuitive than trying to remember which DMX values would provide the intended result.

COLOR MIXING WITH LEDS

For many years, color was only achieved in LED fixtures by the mixing of separately colored LEDs. Now that phosphor development has advanced so far as to create usefully bright white LEDs, we are beginning to see a resurgence of subtractive color filtering as well. Subtractive filtering is the color filtering technique that has existed for many decades before. The polycarbonate and dyed polyester filters that have been used over the last century still work on white LEDs, although your color choices may change as you adapt to the differing color temperature and spectral composition of LEDs. Automated LED fixtures equipped with white LED's are currently employing the CMY filtering that was originally developed for metal halide and high intensity discharge sources. This system introduces varying tints of cyan, magenta, and yellow dichroic filters to mix the desired color by absorbing unwanted wavelengths and allowing others to pass.

Rosco Braque Cube LED lights feature additive color mixing to fill a wide variety of lighting applications.

Additive color mixing has been a staple and benefit of LED lights. The simplest color mixing system in LEDs is referred to as RGB. Red, Green and Blue LEDs can be combined at varying intensities to alter the combined color output. One drawback is that this system has limited success in mixing a usably bright and aesthetically pleasing white light.

Manufacturers began to update their fixture line up to include RGBW systems, which add white LEDs to the array. While the RGBW color system extends the palette of LED lighting, some designers still found them to be too cool. The answer was the RGBA color system, adding Amber LEDs instead of white. This color system delivers extended warmth to the palette, although it typically can't match the pale tones of RGBW. In an effort to deliver the best of both worlds, the manufacturers introduced RGBAW-based LED fixtures, which allow designers more precise control of color temperature. In fact many LEDs for TV and Motion Picture lighting employ amber and white LED's to give lighting designers a wide range of white light from warm tungsten to cool daylight and beyond. Another drawback of the simple RGB system was the color limitation. Designers could not produce some of the vivid colors to which they had become accustomed, while using gels on incandescent lights. Manufacturers have found varying solutions to the problems usually by adding additional colors of LEDs to their products. Lights containing Lime LEDs have been more successful at generating more brilliant yellows and oranges. Fixtures with Deep Blue and Royal Blue LEDs are able to mix deeper, more saturated shades of blue. Some have even gone so far as to include UV LEDs. While UV light has often been used by itself for blacklight effects, it can create stunning, rich colors when mixed into stage washes.

WANT TO LEARN MORE?

Every lighting system is unique in its intention, scale, and capabilities. Combined with information provided in our Lighting 101 and 102, this information can be used to identify and address your needs with a basic knowledge of LEDs. From spotlights to wash lights and varying degrees of color control, there are many options to address lighting challenges. Please call the friendly staff at Vincent Lighting Systems for any additional questions or help selecting the perfect LED lighting package for your school, church or theater. Just as no two performances are exactly alike, there is no one proper way to light a stage or performance area. Think about all of the different performances that exist: lectures, concerts, operas, musicals, dramas ... Now think about all of the places where these performances can take place: tents, theatres, churches, arenas, even outdoors. Fortunately, there are simple lighting design techniques that can help even beginners to get proper lighting for their productions. This guide will give you an overview of the jargon, techniques and ideas used to light a performance.

ABOUT VINCENT LIGHTING SYSTEMS

RELIABLE

Vincent Lighting Systems provides reliable entertainment and architectural lighting and rigging products that are inspected, maintained and tested for compliance with industry standards prior to delivery. Our reputation for reliability is backed with a commitment to providing on-time delivery, a personal equipment operation guarantee and after-hours project, rental and production support.

PROFESSIONAL

Every customer of Vincent Lighting Systems can count on a dedicated team of certified and degreed lighting professionals with an accumulated 500+ years of industry expertise, all fully focused on delivering the utmost professional experience.

CREDIBLE

Since 1978, the award-winning professionals at Vincent Lighting Systems have met the needs of entertainment and architectural lighting customers with the broadest range of equipment and products from more than 100 industry manufacturers. We have managed more than 10,000 projects and productions, including specialty architecture, bridges, theatres, schools, houses of worship, weddings and corporate events.