Basics of LED Lighting Control

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Introduction

Most lighting specialists would agree that LED-based solid state lighting (SSL) is reaching its prime time as a super nova of lighting technology revolution in the 21st century. The LED lighting offers many undisputed benefits including the widely known superior energy efficiency, but the technology is still facing various challenges on its way toward maturity and total acceptance.

Though the superior energy efficiency of LED lighting technology is a proven fact, the compatibility between LED light sources, driver type, and controls is still a challenging issue for many lighting designers and engineers. If improperly or inadequately specified, claimed performance will suffer and may lead to numerous complaints from unsatisfied, annoyed customers.

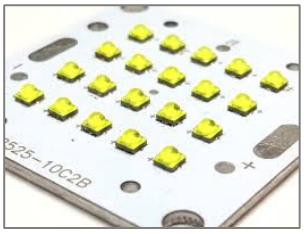
It is not always feasible to set up mock-up installation with performance testing to prove the superiority of LED lighting to the customer. Thus, lighting designers and engineers should look for LED lighting and control manufacturers who have done necessary testing and can provide technical support and services to ensure a successful LED lighting project that can meet the goal of sustainability.

LED lighting technology is rapidly advancing to achieve better performances in many aspects, and it is very important to realize how the LED can be controlled to deliver optimum performance to the end user with significant energy savings. To help lighting specialists better understand LED lighting and control, this document highlights some basics of LED lighting control, including applicable controls, factors to be considered, product compatibility and selection by considering the rationale for choosing a particular control device. Hopefully, this will lead to an energy efficient lighting system with optimum control that meets project requirements and yields satisfied customers.

The LED lighting and controls described in this article refer to ambient lighting in the general illumination of living and/or working spaces, and not task or accent lighting for commercial or decorative purposes, such as signage, theater, RGB, garden, display, or building façade. Also, all fixtures and lamps for control are built with DC-based LEDs.

About LED Lighting

LED lighting is typically referred to as a combination of **LED module**, **LED driver** and **enclosure**. LED module is an electronic device mounted with single or multiple LED chips in many different forms also known as LED Array, LED Engine, LED Tape, or LED Board. LED driver is a power supply device designed to convert the line-voltage AC power to specific DC power for LED module operation. The enclosure of LED lighting not only provides space for the assembly of the LED module and driver, but also performs as an important component to dissipate the heat generated by the LED module.



1. What is LED?

LED, an acronym of Light Emitting Diode, is a semiconductor based electronic device that emits light when an electrical current passes through the leads. LEDs are available across the visible colors (red, amber, green, blue…), ultraviolet (UV), and Infrared (IR) wavelengths with lumen outputs ranging from 10 lumens up to 200 lumens per watt (LPW). The invention of efficient blue LED and the development of high brightness LED have created the predominant use of LEDs in general lighting and illumination that is seen today.

2. Types of LED lighting?

There are two distinct types of LED lighting commonly seen in the market

LED lamps and **LED fixtures**

LED lamps typically have specific screw-in sockets or plug-in pins meant to replace the incandescent, CFL, or halogen lamp. Most LED lamps have integral drivers, but some may require external drivers. The driver determines whether the LED lamp is dimmable or not, and also the dimming performance. In general, dimming control of an LED lamp with integral driver is not recommended as it could very likely result in various compatibility problems due to different, and ever-changing electrical designs of integral drivers. No manufacturer can guarantee that the driver electronics will always remain unchanged in future productions of their LED lamps, not to mention that end users may purchase replacement LED lamps with different integral drivers made by other manufacturers. For this reason, please note that dimming control mentioned in this article does not apply to LED lamps with integral drivers.

LED fixtures typically refer to lighting devices which contain specific LED modules and drivers within an enclosure. Some fixtures may have external drivers that are remotely connected with the LED modules. Fixture manufacturers usually offer the same fixture with different driver options to support different control technologies or requirements. LED fixtures have countless form factors created for different applications, and the design innovation seems to have no limit.

3. LED drivers

LED chips are inherently electronic components that require additional electrical devices to convert the line-voltage AC power to specific DC power for the operation of LED chips. These electrical devices are generally referred to as LED drivers, and some are capable of interpreting specific control signals to dim the LEDs accordingly. It is the responsibility of the fixture manufacturer to choose an adequate driver type to match the electrical and control requirements of the LED module used in the fixture.

Depending on the electrical output, LED drivers are generally classified into **Constant Voltage (CV)** or **Constant Current (CC)** type. Always bear in mind that CC and CV drivers are NOT interchangeable, and it is the electrical requirements and the design of the LED load that determines which driver is appropriate. More details about the LED drivers will be introduced in a later section.

LEDs vs. Legacy Lighting

The growing popularity of LED light sources is rooted in impressive energy savings, longer service life, and flexible fixture design options. No one would ever expect that a single lighting technology can be so widely used in almost any application.

For residential lighting, a 12W LED lamp can now produce light output equivalent to or better than that of a 60W incandescent lamp, deliver 50,000 hours claimed service life (compared to 8,000 hours for compact fluorescent lamps and 3,000 hours for halogen lamps), and generate less heat. For commercial and industrial buildings, the LEDs can easily replace fluorescent and HID light fixtures from office to warehouse. For outdoor lighting, a 100W LED streetlight can provide better quality light with higher color rendering than the conventional, yellowish 350W HPS lamp and deliver all the advantages mentioned above.

These advantages clearly ensure a bright and strong future for LEDs, but there are still challenges associated with using LEDs to meet market expectations. As compatibility between LED light source, drivers and controls plays a critical role in a successful project, the best strategy for selecting an LED product is a broad approach that takes into consideration a variety of factors.

Why Control Matters?

It is a proven fact that LEDs are more energy efficient due to physical facts and operation principles. Simply using LED lamps or fixtures can indeed reduce energy consumption and operating costs of an updated building while meeting the latest building energy codes. So why worry about controlling the LEDs? The reasons are exactly the same as why we control the legacy lighting -- to maximize energy savings, extend service life, enhance flexibility, increase productivity, and provide a safe, comfortable environment for all building occupants. Proper control not only can bring out all the good features of LED lighting, but also help ease the possible weakness, such as reducing the ambient air temperature and junction temperature of LED chips through effective bi-level dim control. Lower ambient and junction temperatures can effectively prolong the service life of lighting class LEDs with quality hardly depreciate at all.

A wide range of control options are available for LEDs -- from manual switching, dimming, occupancy sensor, to a centralized lighting control system -- to achieve the purposes as mentioned above. Regardless of the control option chosen, it is important to work with a professional product manufacturer who can assure compatibility and performance, eliminating many of the common concerns and issues that are seen with LED installations.

Many have already learned this fact, which is “**not all LEDs are created equal**”. The same is true when it comes to drivers and controls. While there is an uncountable number of LED lighting manufacturers flooding the market, not all of them are familiar with the various control solutions and the application requirements. **Controls which work for legacy lighting may not work for LEDs.** If there is any incompatibility between devices, the result can be a situation in which the LED never turns off completely, flickering, pop-on or drop-out. It is best to ask an LED lighting manufacturer about available control options prior to specifying the products. Poor designs can be very annoying, leaving the end-user with the negative perception of LED lighting.

LED lighting without proper control is a good job half way done

1. Manual ON-OFF Switch Control

Line voltage switching has been the most basic form of lighting control. For LED lighting, conventional "manual on-off" switching can hardly be considered the best energy efficient control, especially for areas that require conditional lighting with daylight available and/or occasional occupancy. Unlike the fluorescent light source, hours of continued operation does not do any good for LED lighting. On the contrary, periodical dim or power-off can help dissipate the heat generated and lower the operating temperature. It is a proven fact that better thermo management and a lower operating temperature are positive factors to support longer service life for LED lighting.

For most LED lighting projects, manual on-off switch control should be considered only if no other control is suitable.

2. Dimming Control

Dimming control not only can help create an environment with desired ambiance for specific purposes in residential/commercial/industrial lighting, but also effectively reduce the energy consumption. Not all lighting is capable of dimming control, LED is no exception. Theoretically, all LEDs can be dimmed through controlling the energy passing through the LED chips. Unfortunately, this is not the case in real world applications. Due to the wide variety of LED lighting product types, not all LEDs are dimmable, and even the dimmable ones may be limited in dimming range and compatibility.

Therefore, dimming LED lighting is still technically challenging as different LED lamp/fixture designs may require specific dimming technology, and dimming performance can vary greatly from manufacturer to manufacturer, or even in different fixtures from the same manufacturer. **In general, dimming capability of LED lighting is primarily determined by the LED driver.**

Depending on the electrical components employed, many control options can be applied to dim the LED lighting. The most commonly used dimming control technologies in the lighting industry are 0-10V, DALI, PWM (Pulse Width Modulation), and Phase-cut (leading/trailing edge). Always check with the fixture manufacturer for the dimming control technology requirements of the LED driver.

In term of energy saving, LED is considered one of the best light sources for dimming control. Dimming LED, similar to the process with fluorescent sources, could save energy at nearly 1:1 ratio. This means that if you dim an LED down to 50% of light output, you save almost 50% of the associated energy use. Though it is true that LEDs are already very energy efficient compared to almost any legacy light source, a good dimming control can definitely save more energy while delivering an environment with desired ambiance.

Proper control helps improve energy efficiency and prolong service life of LED lighting.

Dimming LEDs also makes them run at lower operating temperature which helps extend the service life of the electronic components in the driver, as well as the phosphor in the LEDs. This will greatly prolong the operational life and quality of the LED light source. There is ongoing research that will better quantify the relationship of dimming LEDs and lifetime extension. The question remains, how to effectively and intelligently provide the required dimming?

Market survey results show that dimming controls of areas for non-specific occupants are mostly operated in set-and-go format. This means manual adjustment of dimming level is not a common practice for these areas. Therefore, occupancy sensors with automatic bi-level dimming capability is becoming a popular control option of LED lighting for parking garages, emergency staircases, public exits and entrances, elevator halls, atriums, and corridors. Talk to a professional manufacturer who offers sensors for bi-level dimming control to take advantage of this energy savings technology on your next project.

3. Occupancy/Vacancy Sensor Control

Occupancy sensors have been used for general lighting control since 1990's to stop wasting energy on unneeded light. By utilizing specific sensing technology, primarily Passive Infrared (PIR), the occupancy sensor will turn on the connected light automatically when it detects the presence of an occupant. A delay timer will hold the light on and the delay will be reset if sensor detects motion before the time elapsed. Most occupancy sensors are designed with an ambient light sensor (ALS), also referred to as photocell or photo sensor, to inhibit switching on the light if ambient light level is higher than the threshold set. However, market study reveals that more than 70% of occupancy sensor controlled lighting with ambient light level setting is falling short of their full energy savings potential due to lack of natural daylight or unawareness by the user of the ALS option.

Vacancy sensors are a little bit different from occupancy sensors in the ON-control. Unlike occupancy sensors, vacancy sensors are programmed to NOT turn on the light when sensing the presence of an occupant unless a light-ON signal input is manually activated, such as a push-button or control command. In the same manner as occupancy sensors, the vacancy sensor will turn off the light automatically after the delay time elapsed. Case studies show that vacancy sensors have better energy saving performance than occupancy sensors. Thus, specific energy codes, such as CA Title 24 and ASHRAE 90.1-2010 encourage using more vacancy sensors.

Depending on the mounting option, typical occupancy sensors can be classified into the following types;

Fixture Integrated – this type of sensor can be assembled with the fixture via proper design of the enclosure, or attached with the fixture via available knock-out. The sensor normally controls lighting of the host fixture. Occupancy sensor integrated light fixtures are receiving more popularity due to factory prewired and programmed settings which make the installation of sensor embedded lighting the same as a conventional fixture.

It is important to realize that the detection coverage of an occupancy sensor varies with design specification, environmental conditions and mounting height. Consult with the sensor manufacturer for clarification of the detection coverage area for your specific installation.

Ceiling Mount – this type of sensor can be mounted on the ceiling in various options, such as flush, surface or with junction box. Specific mounting bracket may be required to support the desired mount. Check with the sensor manufacturer to ensure the desired mounting option is available, as not all ceiling sensors can be mounted in various options.

Like fixture integrated sensors, the detection coverage of ceiling mounted sensors also varies with design specification, environmental conditions and mounting height. Some PIR based occupancy sensors provide changeable lens options with distinctive coverage for different mounting heights. Optical changeability has widened the application of ceiling mounted sensors, both for indoor and outdoor lighting.

Also, ceiling mounted sensors with remote programmable control and settings are becoming available in the market. These advanced occupancy sensors enable programming and selection of settings, such as ambient light level threshold, delay time, sensitivity, control mode, high/low dim level…etc. while operating a handheld device from a position on the floor. For an area with a large number of occupancy sensors that require different settings, remote programmable sensors will surely help reduce the time and cost in sensor commissioning.

Wall Mount – this type of sensor is designed to be mounted at a certain height on the wall, preferably in a corner area. Wall mounted occupancy sensors can be mounted above reach to prevent potential sabotage. Some sensors are supplied with mounting brackets to enable multi-directional sensor angle adjustment to achieve optimum detection coverage.

Due to the difficulty of having line voltage power supply available at every ideal sensor location and compliance of electrical installation codes, most wall mounted sensors are operated by low voltage power supply from an associated power pack, which also provides switching control of the connected light or load.

Wall Switch – this type of sensor is designed to be mounted with gang box in the wall. In the North American market, most wall switch sensors feature a similar appearance in order to fit NEMA standard gang box and wall plate cover. Retrofit installation is common practice for wall switch sensor. Various sensing technologies may be used in different wall switch sensor. Passive Infrared (PIR) is considered the primary and the most popular one in the market. To increase occupancy sensing capability, dual technology sensor is receiving more popularity through combining a secondary sensing technology with the primary PIR sensor. Ultrasonic Doppler (US) is widely used as the secondary, but High Frequency Doppler (HFD) is considered a better secondary technology for a dual technology sensor.

Wall switch sensors in North American market are generally available for single or dual pole control. Some newly developed sensor feature programmable control modes for wider applications and better user satisfaction. For wall switch sensors installed at public places, sabotage of the Fresnel lens has been a common issue due to public accessibility. Utilizing sensors with a stronger Fresnel lens design that can better withstand sabotage may help reduce service calls.

In addition to the typical on and off switching, some newly developed occupancy sensors provide different bi-level control modes to achieve better energy efficiency and occupant satisfaction. Considering all technical advantage of LEDs, the occupancy sensor with multiple control modes may well be an ideal control partner of LED lighting. With quality project planning and engineering done by professionals who have a good understanding and experience with occupancy sensor control and application, energy saving performance and customer satisfaction can well exceed the expectation.

4. Selecting proper control

With an understanding of the main controls available for LED lighting, selecting proper control is an important key of creating an energy-efficient lighting control project. Specific control can be selected, and should be selected by taking the factors, including type of fixture/lamp, space function, and occupancy rate into consideration. The following tips are provided as guidelines for control selection.

Type of fixture/lamp

The controllability of LED lighting is determined by the driver used. In general, most LED lamps with integral drivers are not always compatible with existing dimmer. For the non-dimmable LEDs, occupancy sensor or manual switch for on/off control might be the only available control option.

Space function

Function of space should also be considered while determining the proper control option. For example, bi-level control occupancy sensor with programmable dim output will be an ideal option for the places like parking garages, emergency staircases, public exits and entrances, elevator halls, atriums, and corridors that require optimum level of constant lighting for safety and yet still can provide high level of lighting as required upon occupancy. Many case studies prove its impressive energy saving performance while providing optimum level of lighting for public safety and security surveillance.

Occupancy rate

The occupancy rate is also an important factor while selecting the control option. In general, the lower occupancy rate, the better for occupancy sensor control. For example, the energy saving performance of an open office controlled by occupancy sensors may not be as good as the warehouse.

Factors to be considered

Some important issues should be carefully considered prior to offering LED lighting control to customers. If you have doubts or questions about the availability of product, or technical control capability of a product, look for a manufacturer or manufacturer's representative who can help you through the design and product selection process.

1. What is the project type – retrofit or new construction?

Every project will have its own signature and requirements which will determine the applicable control and product selection. New construction projects provide more freedom and flexibility in lighting design, control options and product selection. Quality and sustainability are normally two major concerns. Retrofit projects are often limited to certain types of LED lamps, fixtures, and control options. Budget control and Return on Investment (ROI) are two common concerns for system owners. In commercial reality, retrofit projects still represent the majority of the LED lighting market today.

Retrofit Project	New Construction
● Limited fixture type selection ● Challenging control option selection ● ROI can be too long with poor design ● Easier to quantify savings performance ● Majority of business opportunity	● More freedom in fixture selection ● Control option can be less challenging ● Quality and sustainability are important ● Easier to execute budget management ● Limited new construction market

2. What type of LED lighting will be used – integral or external driver?

Unlike legacy light sources which have distinctive form factors, LED lighting is available in almost any form factor with different electrical designs. One can have an integral driver, another one with the same form factor may require an external driver to provide specified DC power. Always check the electrical specification of the LED lighting to determine if the driver is integral or external.

For ease of retrofit or replacing legacy lighting, many LEDs are supplied with integral drivers which virtually determine the controllability. Without professional dimming compatibility test, most line voltage powered LED lamps meant to replace standard incandescent or screw-in CFL should better be considered as non-dimmable; thus, on-off switching control by manual switch or occupancy sensor may be the best option.

Some LED lighting manufacturers offer different driver options on the same fixture to support different control options, such as dimmable vs. non-dimmable. Some may even accept a special order for a fixture built with a specific driver that includes the desired controllability.

For spaces that require control of multiple fixtures in single or multiple modes, LED fixtures powered by external drivers provide better flexibility in design and engineering. However, such a design requires selecting an optimal driver with sufficient power output and required controllability.

Integral Driver	External Driver
● External dimming is unlikely available ● Requires dimmable driver for dimming ● Retrofit favorable with ease of installation ● Specifying driver may be necessary	● Better flexibility in design and engineering ● Multi-fixture dimming control is possible ● Easier to design creative lighting system ● Requires selecting optimal driver for LEDs

3. What type of driver is used – Constant Current or Constant Voltage?

Theoretically, all LEDs require a "driver" to supply the specified power for operation. Depending on the power output format, there are two types of drivers, CC and CV, available for LED fixtures. CC type driver provides constant current (typically 175mA, 350mA, 525mA, 700mA, 1A…) DC power with variable voltage, and CV type driver provides constant voltage (typically 12V, 24V, 30V, 36V, 48V…) DC power with variable current for specified wattage of LED operation.

In general, CC type drivers are used more in single lighting fixture integration due to ease of electrical design, and CV type drivers are often used for low voltage LED lighting with ease of group connection in parallel control.

Like LED lighting, not all "drivers" are created equal in quality and specification. The long-life benefits of LEDs will be reduced if the driver cannot support an equally long operational life. Moreover, poor quality drivers can also damage the control devices due to exceptionally high startup inrush current while switching on. Look for a manufacturer with a good reputation in driver design to ensure a good quality LED lighting system.

Constant Current	Constant Voltage
● Used for single fixture integration ● 0-10V dimming control is typical ● Verify current output and maximum load	● Used for low voltage LED lamps ● Easier for multiple lamp/fixture control ● Check that voltage meets fixture specification

4. Is dimming control available – Dimmable or Non-dimmable?

The driver practically determines the "dimmability" of LED lighting. To dim LED lighting powered by CC driver, the driver itself must be "dimmable" in electrical design that provides proportionally lower current output via certain control, such as 0-10V, DMX, DALI…etc. For LED lighting powered by CV driver, dimming can be achieved by connecting a PWM (Pulse Width Modulation) controller to regulate the duty cycle of energy applied to the LED lighting.

Applying LEDs to incandescent dimmers with traditional forward or reverse phase-cut control may not only result in poor lighting performance, but could also reduce the control life. Since proper dimming control can help prolong the service life of LEDs, it is important to know if the LED lighting is dimmable or not, and then ensure applicable dimming control.

Among all available dimming control options, 0-10V is becoming a common dimming control for single or multiple LED lighting fixtures. Worth mentioning, most typical 0-10V dimmable drivers can only be dimmed from 100% (10V) down to 10% (1V) as the lowest point. It may be necessary to provide a control switch or relay to turn the light completely off, if desired, when ambient light exceeds a certain level.

In summary, the driver determines the achievable dimming range and the best possible performance of the LED lighting. The control determines whether or not the best possible performance is realized in the application.

Dimmable	**Non-dimmable**
● Dimming helps extend the life of LEDs significantly ● Verify the dimming control capability of the driver ● Is the controller capable of performing the required dimming control ● Is complete shut-off available	● Only on-off switching If control

5. Is occupancy sensor control applicable?

More and more case studies prove that occupancy sensor control can boost the energy efficiency of LED lighting to a maximum level, especially for areas with low or uncertain occupancy. In addition to the typical on-off switching, some occupancy sensors enable the user to experience greater energy savings through dimming. Dimming options are typically factory pre-programmed and easily selected by the user by setting dip switches.

With proper planning of occupancy sensor control in new construction, many traditional wall switches for manual lighting control of public areas can be eliminated, and replaced with wall sensors.

Despite many proven positives, occupancy sensing control is yet to receive high market acceptance. Improper sensor positioning and settings are common issues that lead to unsatisfied user experience. Look for a sensor manufacturer who is capable of providing technical consultation, application advice or design support that will rectify any installation issues and help ensure a successful occupancy sensing based lighting control project.

6. How many fixtures/lamps will be controlled – Single or Multiple?

Depending on the design of LED fixture, the control option applied for single and multiple fixtures should be approached differently. For single fixture control, the applicable control should be determined in accordance with the driver’s dimmability and the desired performance.

If multiple fixtures will be controlled by one controller, more factors should be considered which may affect the reliability and availability of multi-fixture control. All control devices have a respective maximum load. It is not as simple as dividing the rated maximum load by the wattage per LED fixture to arrive at the number of fixtures which can be controlled on a circuit.

As mentioned in the previous section, some LED drivers could have very high startup inrush current while switching on. The accumulative startup inrush current during power on of multiple fixtures could cause a very strong negative impact on the controller, potentially shortening its service lifetime.

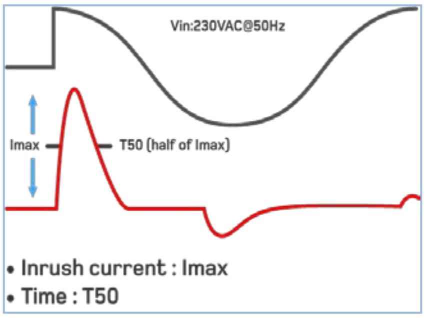
If 0-10V dim control on multiple fixtures is desired, the maximum number of fixtures that can be controlled by a single 0-10V control source should be carefully calculated. This calculation should be based on the maximum current supply from control voltage and the control current consumption of each dimmable fixture. Excessive fixture control could result in malfunction of the control device or unstable dimming output.

7. Impact of Inrush Current

Inrush current is the instantaneous input current drawn by an electrical load when first turned on. Different types of lighting do not experience the same amount of inrush current. The level of inrush current is mainly determined by the nature of load. In general, switching on the resistive load (incandescent, halogen light) will generate much lower inrush current than the inductive load (fluorescent light), and the capacitive load (LED light) which will result in the "highest" inrush current among all commonly used lighting.

The high inrush current (HIC) associated with switching LEDs has become a major concern in the lighting control industry. It refers to the exceptionally high input current that flows into the LED driver to charge the capacitors on the input side, during the initial start-up. Typically, the inrush current is a very short surge duration (normally measured in microseconds), but the peak current could be **more than 100 times** that of rated operating or steady-state current. Though very short in duration, the inrush current of switching on an LED driver can overwhelm the rated current capacity of the load switching component, such as a power relay, thus fusing the contacts over time and leaving the load permanently on. The inrush current could also trip the MCB (Miniature Circuit Breaker).

The figure shows the nature of the inrush current and its peak, Imax. T50 is the time duration in which the inrush current pulse is equal to 50% of Imax. It shows an example of inrush current (Imax) and T50 time for a typical LED driver. The inrush current and the duration are determined by the electrical design of the LED driver, which may differ from manufacturer to manufacturer and from model to model. The peak inrush current also depends on the exact moment of switching, during the alternating cycle.



If there are a number of LED drivers in an LED lighting fixture, and or if there are a number of such LED lighting fixtures on one circuit, the maximum inrush current peak and it's duration could be additive. However, it is not an exact mathematical calculation; i.e. for "N" drivers connected in parallel does not equal exactly "N" times the inrush current for one driver or N times the duration for one driver. It depends on the impedance of each driver and the line impedance. The line impedance has a significant effect on the peak and duration of the inrush current. As this current duration is very short, sophisticated instruments with very high sampling rates need to be used for exact measurement of the actual inrush current of the circuit. Check with the manufacturer of the LED driver to obtain data of maximum inrush current to help select the proper control device.

For **selecting a MCB** as circuit protector, a general recommendation is to select a **C-type** MCB with the highest current rating available that is allowed by the circuit cable size. The MCB needs to have sufficient time for the inrush current to clear, without creating a nuisance by tripping on powering up. MCBs operate by tripping open on detection of an overload or short circuit condition. The tripping point relates to the magnitude of electrical energy being passed – and this in turn depends significantly on both the inrush current peak value and its time duration. Accordingly, an MCB could be tripped either by a high peak of short duration, or a lower peak of longer duration.

If **occupancy sensors, daylight sensors** or other electronic devices are required to provide automatic on/off switching control of LED lighting, the inrush current could easily cause these control devices permanent failure. Many sensors and control devices have limited space to accommodate heavy duty switching components designed to sustain the impact of excessive inrush current. Some sensors and control devices are designed with zero-crossing switching control which may be good enough for traditional resistive and inductive loads, but fall short for capacitive loads like LED lighting, especially on low cost LED lighting with poorly designed drivers.

To endure the exceptionally high inrush current from switching LEDs, sensors that feature Hybrid Switching control are a better choice. Hybrid Switching is a robust load switching technology that employs a solid state relay in conjunction with an electromechanical relay to control the load from HIC. Test results indicate sensors with Hybrid Switching control can reach an expected number of switching cycles, while other conventional sensors fail within a couple of hours or days. Ask the manufacturer of sensors and control devices about the expected life cycle of switching LEDs to better ensure customer satisfaction.

Product Compatibility & Selection

LED lighting technology is indeed making great strides in many aspects, and more LED lighting products are available for replacing virtually any fixture type. To achieve optimal performance, select or specify a combination of compatible LED light sources, drivers and controls that meet the project requirements. This has becomes a challenging task considering how fast products are evolving to offer better performance with lower cost.

To complete a successful LED lighting control project, the following are listed as general guidelines.

1. Driver determines the controllability of LEDs

The driver is very important to controlling the LED lighting. Specify the desired control option by realizing all the positives and negatives. Carefully select a quality driver which can meet the required controllability and specifications. A holistic understanding of the LED driver can help ensure correct product selection.

2. Better control brings higher satisfaction

LED control technologies are improving, control options are expanding, experiences and knowledge are accumulating, so this arena is under thorough exploration by the lighting control industry. By choosing the right products, it is easier than ever to provide customers with a quality LED lighting and control system that brings higher satisfaction by exceeding expectations.

3. Future serviceability should be stressed

LED products are evolving at a speed that no other lighting technology has ever experienced. With improved product performance and reduced market price, the serviceability of LED light products deserves proper attention among the industry. Today's hot selling products may quickly vanish tomorrow which leaves the system with limited serviceability. The future serviceability should be taken into account on behalf of the customer while selecting the products.

Conclusion

Controlling LED lighting has become a major technical challenge, a combined source of confusion and sometimes frustration, but it is also an excellent opportunity for all lighting professionals to reach a higher level of success in business. The benefits of this revolutionary lighting technology are evidenced by the fast growing rate of adoption by the lighting industry and end-users alike. Every lighting professional should realize that using LEDs without the correct understanding of controls can easily lead to faulty designs which result in negative experiences and customer dissatisfaction.

LED fixtures and controls can use the same, advanced control technology, but that does not necessarily mean they will perform well together and provide reliable, smooth lighting control performance. Due to lack of unified control standards, there is no guarantee that even a standard control technology, e.g. 0-10V, will produce a consistent performance among different fixtures. The control standard only speaks to basic compatibility. The only way to ensure the performance is to conduct performance testing on the LED lighting and controls. Keep in mind that the influence and impact of some electrical characteristics, such as inrush current, cannot be easily determined by the specifications from an individual LED lamp or fixture manufacturer. Choosing a solution that features better control performance with proven results will always be the best option.