DIMEZE™

Digital LED Dimmer for "Reliable and Simple LED Dimming Experience"

LED Dimming Technology – Feb 2016

Background

The following topics are formulated base on our customer interactions, which represent some of the most concerned topics related to LED Dimming. The info should be read with our product brochure & demo video clips.

Dimmable vs. Non-Dimmable

Question: "Can the dimmer also dim non-dimmable LED lamps?"

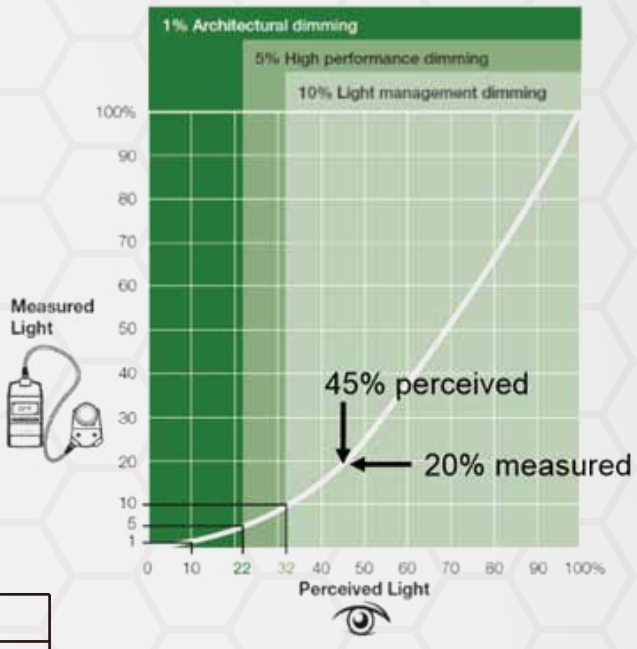
In a nutshell, dimmable LED lamps are capable of handling the input power reduction (as dimmer dims) and steadily reduce the LED driving current accordingly to produce dimming effect. However, non-dimmable LED lamps can't. Thus, dimmable LED lamps can be used in basic switch on-off circuity, but the reverse is usually not true. From our experience, grudgingly using a dimmer on non-dimmable LED lamps may somewhat reduce the brightness level, but eventually the lamps would misbehave (flickering even popping-up at low frequency) and switch-off.

Flicker-free vs. Flickering in LED Lighting

Compared to Incandescent & Fluorescent that we've been using, the flickering issue with LED is much more noticeable because LEDs exhibit very fast luminous response to minor fluctuations of the driving current. Thus, the quality of dimmable LED driver is always the first condition for reliable LED dimming. **"Flicker-free" LED drivers** refer to dimmable drivers that are designed for driving the LEDs at low brightness level. Then, the next question is "How low is low?" In case the driver doesn't support same lowest dimming level, deploy DIMEZE™'s MIN-LEVEL-SET feature for an acceptable solution.

Dimming Performance

Since not yet a ready market standard for dimming performance, any product with its brightness level adjustable can be termed as "Dimmable" product. For our discussion, we shall utilize the information from the IESNA Lighting Handbook 9th Ed. (right): At low levels, the human eye would enlarge the pupil to allow more light to enter the eye. This mechanism creates a difference between the **measured light** (by light meter) and the **perceived light** (by human eye). A lamp that is dimmed to 20% of its maximum measured light output is perceived as being dimmed to only 45%. For our discussion, we shall refer 20% or below of the maximum measured light to as **"Deep Dimming"**!



Basically, there are three types of Deep Dimming of particular interest:

Dimming	Measured	Perceived	Typical Applications
Architectural	1%	10%	e.g. Restaurant, Media Room
High Performance	5%	22%	
Lighting Management	10%	32%	e.g. Lobby, Atrium, Office

Correct understanding of the available dimming range of the LED products and customers' expected dimming performance is the key to the success of the dimming project!

Legend Tech International Holdings Limited©
www.legendtech.com.hk
sales@legendtech.com.hk

Deep Dimming vs. "Dimmable"

For AC mains powered LED dimmable lighting, the dimmer manipulates the AC waveform and powers up the LED driver. Using the same Philips Tune-able downlight with different dimmers (Philips SED-200A vs. DIMEZE™ DZ2G450DIAL), two very different dimming performance is shown here.
The immediate left photo shows the lowest dimming level by SED-200A, while the right photo shows deep dimming performance achieved by DIMEZE™ Digital LED Phase Dimmer, DZG450DIAL, the same dimmable downlight, this example of achieving the very different dimming performance with the same LED driver shows that dimmer is the critical factor for LED Deep Dimming performance.

Lowest Dimming level by PHILIPS SED-200A

Deep Dimming Performance by DIMEZE™

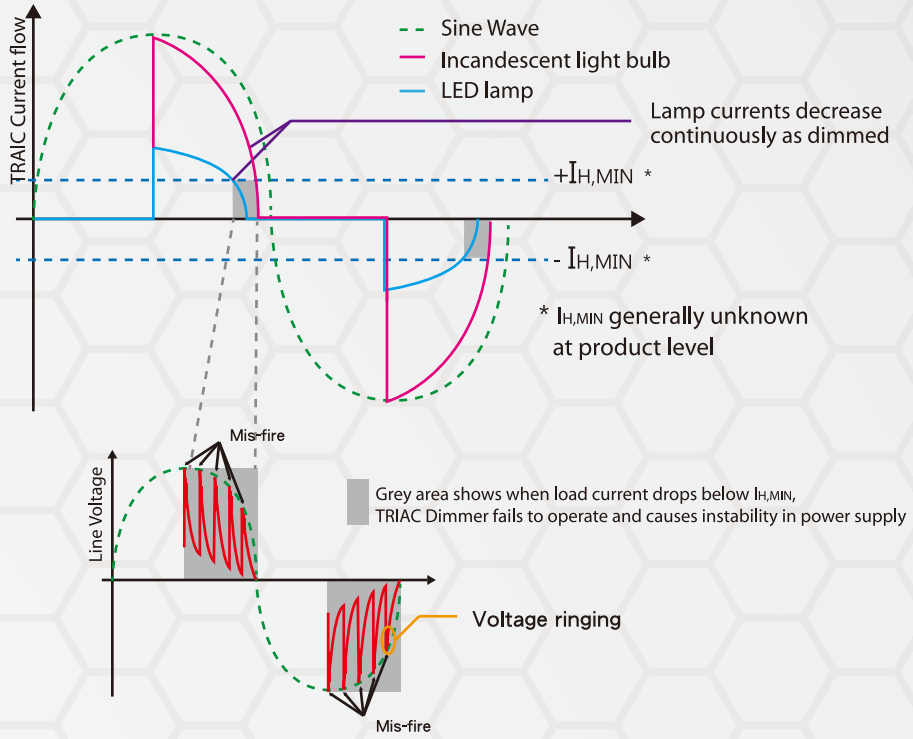
Digital LED Dimmer vs. TRIAC Dimmer

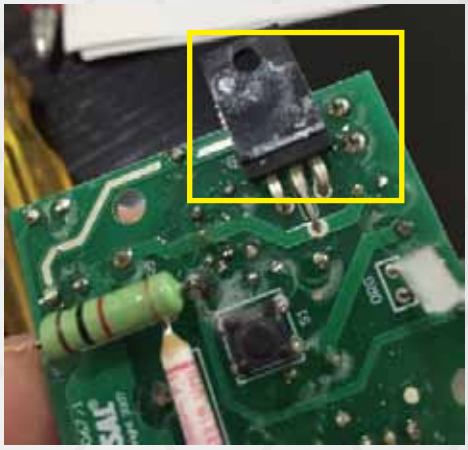
Phase-Cut dimmer blocks the input line for a portion of the line cycle, which inhibits the average energy transferred to the lamp load and hence, the output brightness. Both TRIAC dimmer and DIMEZE™ LED dimmers operate by phase-cut dimming principle. However, they are very different in design; TRIAC dimmers operate on leading (forward) phase-cutting methodology, while DIMEZE™ dimmers are known as "Universal Dimmers" because it has the option to support both leading and trailing (reverse) phase-cutting methodology. Designed for Incandescent and Halogen bulbs, when used with LED Lighting TRIAC dimmers are usually associated with the following problems:

#1 Performance Inconsistency

"For many times, installers found some TRIAC dimmers tend to work better with some LED lamps, but the same model may not always work for the next installation. I wonder if there is a "Compatibility List"."

TRIAC dimmer relies on a TRIAC IC for phase-cut operation. Once fired, a minimum holding current (IH,MIN) must be sustained during the whole conduction cycle. Since Incandescent and halogen lamps consume much higher current than LEDs, even when the current flowing through the TRIAC is reduced by the dimming operation, it is still very high compared to the IH,MIN ; in case, it drops below the benchmark for a very short period of time, it has virtually no effect on the average input power. But same is not true for LEDs; already operating on marginal level, once the current drops below the IH,MIN , the TRIAC IC will be off immediately; the dimmer misfires and causes instability to LED driver(s) and triggers a series of visible flickers. Since line voltage is shared across the system, if any equipment shows flickering or popping, other devices also probe for issues as well and the situation becomes chaotic!
The problem of using TRIAC dimmer for LED dimming is that it relies solely on the specific value of the intrinsic parameter (IH,MIN) of the TRIAC component and its dimming performance is highly related to how much current is drawn from LED driver(s) at low level, which are all **unknowns** at finished product level. By using inadequate equipment and hoping it would work, the market effort on the "LED dimming compatibility problem" is fundamentally wrong and only leads to frustration. Our Marketing goal is to bring up awareness to the general public for proper understanding and expectation of the technology.





▲ TRIAC IC

#2 Shorter Product Lifespan

"For those that matched, lifespan of the TRIAC dimmer or the LED driver is noticeably shorter than expected."

Besides the $I_{H,MIN}$ issue, TRIAC dimmer or leading-edge (forward) phase-cut dimming shall generally not be preferred for LED lighting because the sudden rise of forward current from 0 to load-limited current usually generates current spikes and current ringing, which further leads to misfire of the dimmer and visible flickers. The voltage spikes, current spikes and current ringing present stress to other parameters of the TRIAC IC. **Exceeding the MAX allowed tolerance damages the TRIAC and causes the short lifespan.**

Dimmer and Driver Work Hand-in-Hand for Deep Dimming

In conclusion, how should we understand the role of Dimmer and Driver in LED Dimming? First, we must remember dimmer and driver always work hand-in-hand. The first condition for LED dimming is obviously the driver, since if the driver is not dimmable, the LED lamp won't dim; if the dimmable driver design is not good, the dimming performance would be prompt to problems. From LED dimmers point-of-view, a quality dimmer only reflects (not changes, nor improves) the driving capability of the LED driver at low brightness level.

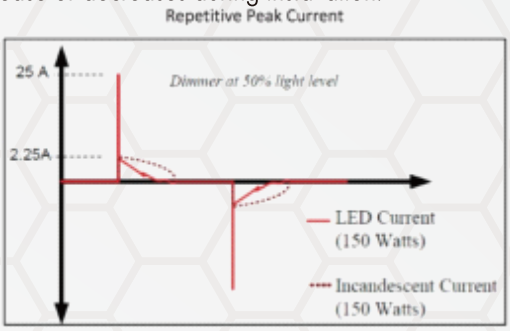
As a system controller, the dimmer determines how low the LED driver dims; there are cases when LED driver sets a certain minimum level below which it doesn't dim further even the line voltage continues to drop "buck-boost design". For deep dimming, a key dimmer performance indicator is the Minimum-Load-Required by the dimmer itself. As LEDs are very sensitive to the changes of the driving current from the driver, which ultimately is powered through the dimmer, very stable system performance by both the dimmer and the driver at low brightness level (when the current is already very small) is the key for project success. "Deep Dimming Compatibility" shall be the real target to look for in practical applications.

When we refer to "**Deep Dimmable Compatibility**", we refer to the following:
"Quality Dimmer" + "Quality Dimmable Driver" = "Deep Dimming Performance"
"Quality Dimmer" + "Poor Quality Dimmable Driver" = "Poor Dimming Performance" ...

MAXIMUM Number of Lamps

To choose the right dimmer device, it's necessary to understand correctly the MAX and MIN loading requirement of the device in order to ensure product safety and to have consistent performance as the number of lamps increase or decreases during installation.

- The MIN Power states the minimum power the dimmer circuit itself requires for normal operation and it also determines how low the lighting system can be dimmed.
- The MAX Power determines how many lamps can be connected to the dimmer without causing electrical stress or potential faults. While DIMEZE™ dimmer series has the MAX rating of 450W, to determine the maximum number of lamps can be connected is not as simple as dividing the overall rated power of the dimmer by that of each lamp. **The simple logic of "450W / 10W per Lamp = 45 Lamps Connected" does NOT apply!**



In reality, in-rush current, repetitive peak current and power factor of LED drivers pose significant electrical stress to dimmers. Thus, in order to determine the maximum number of lamps can be connected, the LED sources behavior must also be considered. To do this properly, the power rating of dimmer devices must be **de-rated** in order to provide product safety and consistent dimming performance as the number of lamps increase.

Given above right finding of repetitive peak current in retrofit lamps, some manufacturers provide a conservative rule to define the maximum number of LED lamps load can be MAX Total LED Lamps Power ≤ 1/10th of Dimmer Maximum Rated Power. In reality, it's not uncommon for LED drivers to draw a start-up current as high as 4 - 5x of the normal driving current; this factor is really what needs to be considered for de-rating of the dimmer. As each lighting fixture behaves differently, there is no simple answer to that question.

"1-Wire" Dimmer

Sometimes even with a great lighting design, designers should realize that in local market, most of the retrofitting scenario only has the Live wire for the dimmer switch to connect and the Neutral wire is shared or connected to the lamps next rooms. Thus, if the designer selects a dimmer that requires individual Neutral wire connection would be problematic in field installation or the design just can't be implemented. The schematics of our EVK shows only Live-wire is connected to dimmer, "Live-in, Live-out", also known as "Hot, Dimmed Hot"in the U.S.

Given all factors mentioned above, mock-up to connect the actual devices together is the only sure-fire way for LED dimming projects and should be suggested to serious customers. Serious customers are recommended to contact our field representatives for our evaluation kit or samples for trial.