

INTRODUCTION

This application note will address the different types of line voltage dimmers which are compatible with the TROPO series of LED drivers.

Dimmers are available in several basic types from many manufacturers around the world. TROPO drivers have been designed to operate with most standard dimmer switches designed for incandescent lighting as well as other types of lighting. This application note does not discuss methods of dimming, such as 0-10V, which do not apply to TROPO drivers.



Be certain the application and installation complies with the dimmer manufacturer's installation guidelines as well as all local, state and federal laws, requirements and codes. Wire the dimmer to the TROPO driver in accordance with the dimmer manufacturer installation requirements, connecting the driver in place of the lighting fixture with the LED connected to the output of the driver.

NOTE: TROPO LED drivers incorporate linear dimming technology (not PWM technology). As a result, each application must be carefully evaluated to ensure it meets the specifications of the end product and the specific LED.

BASIC DIMMER APPLICATION

A line voltage dimmer is a device that connects between the AC power source and the lighting fixture. For LED lighting with a TROPO driver, the dimmer is connected to the input source of the driver and the LED is connected to the output of the driver. The dimmer chops the AC voltage and the driver reacts to this by adjusting the output current supplied to the LED.

Figure 1 depicts a simple application of the TROPO LED driver.

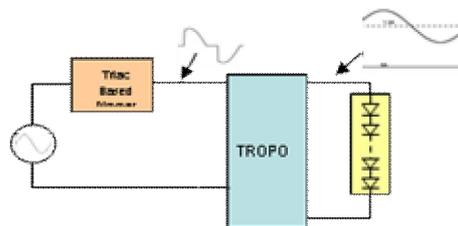


Figure 1

The period of the AC cycle during which power is applied to the driver is referred to as the conduction time. This is measured in degrees of a half AC cycle or time (typically ms). A full period would be 180 degrees or 8.3ms for 60Hz and 10ms for 50Hz. This application note uses the conduction time in reference to this period.

TRIAC BASED DIMMERS

The most common type of dimmer in use for residential applications is better known as a triac based dimmer. These are also the simplest types of dimmers, and in general, the least expensive. A triac based dimmer may also be referred to as a Forward Phase-Control or Leading Edge dimmer. A triac is used as the power switching element in the dimmer. Due to the nature of the triac, the dimmer does not apply power to the controlled device (driver) until sometime after the zero crossing of the AC cycle. Once the dimmer starts conducting, it will do so until the zero crossing of the AC cycle. Dimming is achieved by delaying the time at which the dimmer starts to conduct. As the dimmer is moved through its range, the amount of time that the AC voltage is applied varies.

Figure 2 shows the relationship of the AC input voltage versus the output of a triac based dimmer.

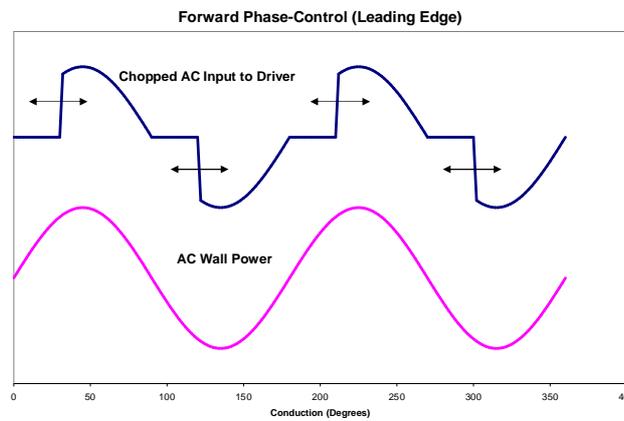


Figure 2

A triac based dimmer is typically a simple 2 wire device that is connected as a switch. This means the second line of the AC power is not required to be connected to the dimmer.

ELECTRONIC LOW VOLTAGE (ELV) DIMMERS

ELV dimmers are typically more expensive than triac based dimmers. These dimmers use more elaborate circuitry to control the output voltage. ELV dimmers are available in both Forward Phase-Control (Leading Edge) and Reverse Phase-Control or Trailing Edge types. A Reverse Phase-Control dimmer will start to provide power to the load at the zero crossing of the AC cycle and terminate somewhere during the cycle. Dimming is achieved by delaying the time at which the dimmer stops conducting.

Figure 3 shows the relationship of the AC input voltage versus the output of a Reverse Phase-Control dimmer.

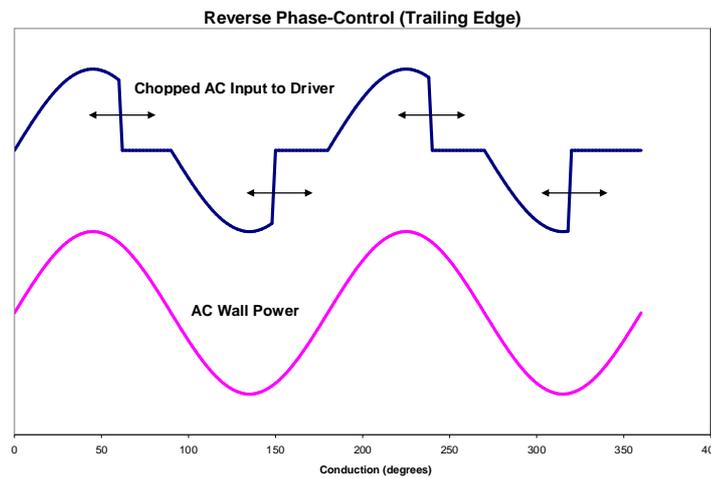


Figure 3

ELV dimmers require power to operate. This means that the dimmer must be wired to both sides of the AC input voltage.

DIMMER CONSIDERATIONS

There are a few considerations for line voltage dimmers. All triac based dimmers have a minimum operating power level, typically around 40W. With incandescent bulbs, meeting this minimum power requirement was never a concern. However, with LED lighting, multiple drivers/fixtures may have to be connected to a single triac based dimmer in order to meet this requirement. In most applications, a single TROPO will operate properly when connected to a single dimmer, but this cannot be guaranteed due to the variability and characteristics of the dimmer.

Each application should be carefully reviewed to ensure that the minimum power level of the dimmer is achieved. If the application consumes less power than the minimum dimmer rating, a different dimmer should be chosen or perhaps an ELV dimmer which does not suffer from this limitation.

Another consideration that applies to all dimmers is the dimming range. The dimming range varies greatly from manufacturer to manufacturer and sometimes from lot to lot of dimmers. Some dimmers will operate over a very wide range while others are very small. In some case, the minimum amount of conduction time will not permit the driver to reduce the output to 10% of nominal current. Similarly, the maximum amount of conduction time of some dimmers may result in the output of the driver to be less than the full rated current. However, TROPO has been designed to operate with most dimmers and operation should be very similar to what would be expected with an incandescent bulb.

TROPO has been designed to operate with most standard line voltage dimmers of all types. Operational characteristics are greatly affected by the dimmer chosen.

Due to the nature of the triac dimmer being a very uncontrolled (specifications vary significantly), the end product that uses the TROPO driver must be carefully evaluated to ensure it is compliant with the end products requirements and customer expectations.

DIMMER SPECIFICATIONS

TROPO is designed to dim down to 10% of the nominal output current. In order to achieve this, the dimmer must be capable of reducing the conduction angle down to approximately 30 degrees. To achieve full output current from the driver, the dimmer must be capable of achieving a conduction angle of at least 150 degrees.

Figure 4 shows the output characteristics of a typical TROPO model comparing the output current versus the conduction angle at various input voltages.

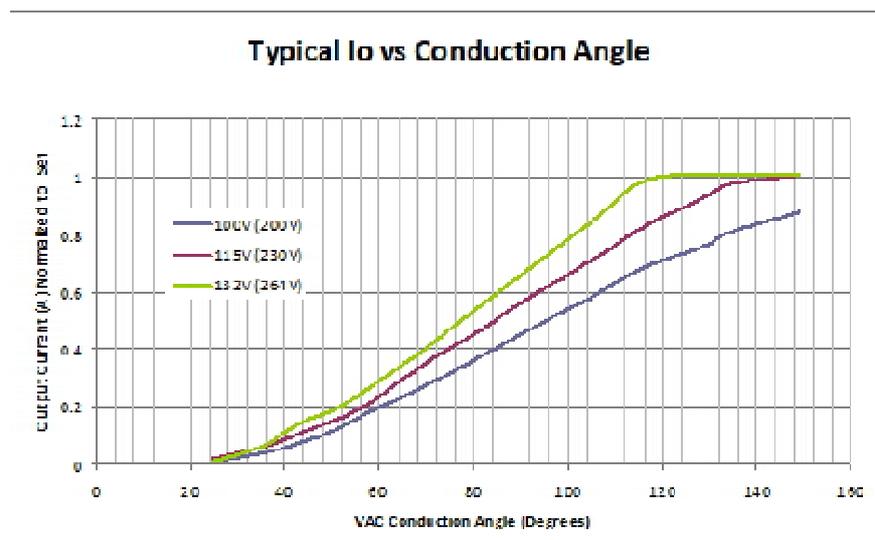


Figure 4

In order to obtain the optimum dimming performance from the TROPO driver, ensure the dimmer and application are compatible, refer to dimmer considerations for details. Failure to meet the minimum load requirements may result in poor dimming performance or flicker, especially at low dimming levels.

SUGGESTED DIMMERS

TROPO drivers are designed to operate with most standard dimmers. However, ENEDO has performed extensive testing with the dimmers listed below. This list of dimmers does not imply any guarantee or warranty of compatibility with a particular application. The lack of dimmers on this list does not imply it is not compatible with TROPO drivers.

Cooper, Aspire Series (Part numbers 9530XXX)
Leviton, Illumitech Series (Part numbers IPI06-XXX)
Leviton, Trimatron Series (Part numbers 6602-X, 6681-X, 6683-X, 6684-X, 700-X and 705-X)
Leviton, SureSlide Series (Part Numbers 6631)
Leviton, True Touch Series (Part Number 6606-1LM)
Lutron Skylark Series (Part Number S-600, S2-LH)

In addition, the following Electronic Low Voltage (ELV) dimmers that employ reverse phase control have been tested with TROPO:

Lutron NOVA T Series (Part number NTELV-600)
Lutron FAEDRA (Part Number FAELV-500-XX)
Leviton ACENTI (Part Number ACE06-XXX)
Leviton VIZIA (Part Number VZE04)

While the above dimmers have been tested by ENEDO, the performance varies greatly. Some dimmers are not capable of meeting the wide conduction angles that TROPO can support. As a result, reduced range of dimming may occur.

Digital dimmers, such as the Lutron Maestro are not supported by TROPO. Damage will not occur to the dimmer or the TROPO driver, but proper performance is not possible with these dimmers.

ENEDO has tested the dimmers with TROPO over a wide variety of system configurations. However, due to the high degree of variability when dimming, all applications of TROPO should be evaluated prior to product release to ensure the end product meets expectations. When the installation exceeds 10 fixtures on a single dimmer or distribution lengths exceed 100 feet, extra care must be taken to ensure the end product performs properly. This is a result of the high degree of variability in the triac dimmers.

Although ENEDO has performed extensive testing on TROPO, the number of system variables is significant. Therefore, operations in every conceivable system application cannot be guaranteed.

TROUBLESHOOTING OF DIMMING PROBLEMS

Problem	Possible Cause	Solution
LED does not achieve full light output at high end of dimming range	<ul style="list-style-type: none"> • Dimmer maximum conduction angle <150 degrees • Low AC Input voltage • Incorrect TROPO driver for LED in use • Faulty dimmer • Faulty driver / LED 	<ul style="list-style-type: none"> • Change dimmer to a device that dims to >150 degrees • Correct low AC voltage • Call ENEDO to discuss the application • Replace dimmer • Replace driver / LED
LED is always at full brightness, does not dim	<ul style="list-style-type: none"> • Dimmer wired incorrectly • Faulty dimmer 	<ul style="list-style-type: none"> • Check and correct wiring • Replace dimmer
When the dimmer is turned to minimum and the power applied, the LED doesn't turn on until the dimmer level is raised.	<ul style="list-style-type: none"> • This is typical operation for dimmers that reduce to a conduction angle of less than approximately 20 degrees. The TROPO driver will operate at this very low conduction angle, but may have difficulty starting up in this condition. 	<ul style="list-style-type: none"> • If the dimmer includes a low-end adjustment, raise the dimming level. • Suggest operation should include turning up, and then down to set the desired setting. • Replace with a dimmer with low end adjustment and set accordingly.
When the dimmer level is raised very fast, the light output appears to reach a level and then reduce slightly.	<ul style="list-style-type: none"> • Under some conditions (load, line, LED voltage etc), the output circuit of TROPO may overshoot slightly when rapidly adjusting the dimming. Typically, this occurs when the output power is less than the rating of the driver and only when the dimmer is changed rapidly. 	<ul style="list-style-type: none"> • If the condition is severe, contact ENEDO to discuss the application.
LED dims, but does not low enough	<ul style="list-style-type: none"> • Dimmer minimum conduction angle is >30 degrees 	<ul style="list-style-type: none"> • If the dimmer is equipped with a low-end adjustment, lower the minimum angle • Change dimmer to a device that dims to <30 degrees
LED flickers (not when dimming)	<ul style="list-style-type: none"> • Driver / LED is less than the minimum rating of the dimmer • Poor electrical connections 	<ul style="list-style-type: none"> • Change the dimmer to an ELV type • Connect additional fixtures to the dimmer circuit to satisfy the dimmer minimum load rating • Check and correct any poor connections

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