

RTISS-TE™ Operation

Real-Time Illumination Stability Systems for trailing-edge (reverse phase control) dimmers

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I. Overview

The RTISS™ technology has been proven to successfully provide stable light output for phase control dimmers in the presence of poor power quality. Through its research, Lutron has identified six different types of power line anomalies:

- High frequency noise
- Impulse noise
- Low-frequency non-harmonics and signaling systems
- Notches and low-frequency distortion
- RMS (Root Mean Square) voltage changes
- Variable fundamental frequency

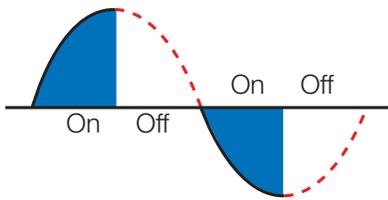
These noise sources may occur independently or in combination. Some of the worst power quality problems usually involve more than one of these noise types. Due to the increasing severity of poor power quality, Lutron has continued research into the performance of its commercial lighting systems. As a result of this research, Lutron has found it necessary to develop an additional type of RTISS design.

II. Dimmer operation

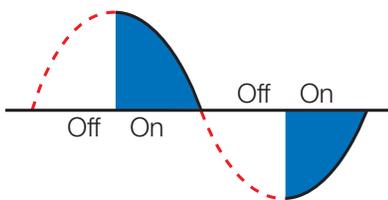
Lutron's RTISS-TE™ (Real-Time Illumination Stability Systems) technology has been designed around "Trailing-Edge (TE)" or "Reverse Phase Control (RPC)" dimmers. This type of dimmer uses transistors such as FETs or IGBTs as the power device instead of the typical triac or SCR devices used in Leading-Edge (LE) or Forward Phase Control (FPC) dimmers. The transistors allow the circuit to apply or interrupt current anywhere in the line cycle. A triac or SCR device can only be controlled to turn on at a predefined point. The turnoff of these devices is only controlled when the load current goes through a zero crossing.

As the name implies, a trailing-edge dimmer applies line-voltage to the load beginning at the zero crossing. Then the power device switches off at some point in the half cycle creating a trailing-edge waveform. The need for the two dimming waveforms is a result of the drive requirements of different loadtypes. Incandescent loads can be driven by either dimming waveform. Electronic low-voltage loads have a capacitive input and require a trailing-edge waveform for dimming. Magnetic low-voltage loads can only be dimmed using a leading-edge waveform.

The two waveforms are shown graphically in the pictures to the left.



**Trailing-edge Dimmer Output
or
Reverse Phase Control
Waveform**

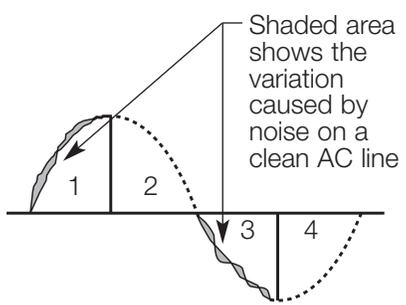


**Leading-edge Dimmer Output
or
Forward Phase
Control Waveform**

Lutron’s research of the poor AC power quality and dimming performance revealed that the rising edge of the AC waveform sometimes contains more interference from loads that draw large currents in the first and third quarter of each line cycle. This was especially noticeable on systems that used generator power or “softer” AC utility lines (examples of this are shipboard systems or emergency backup generators). This noise results in RMS voltage fluctuations that occur only in the beginning portion of each half cycle. It was also noted that these fluctuations could be different from half cycle to half cycle. A standard triac-based dimmer uses Leading-Edge (LE) or Forward Phase Control (FPC). In this mode of operation, the triac is off during this portion of the AC line. As a result, the noisiest part of the waveform does not

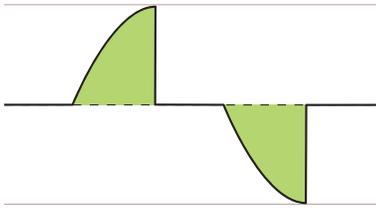
appear across the load. On loads that require the trailing-edge or reverse phase control dimmers, the noisy portion of the AC line is all that gets delivered to the load. As a result, the load sees a large variation in RMS voltage, which may result in visible flicker.

Lutron engineers developed a new method of control specifically for trailing-edge dimmers to maintain a stable output even in the presence of the power quality issues described earlier. This method uses sophisticated signal processing to precisely measure the amount of power delivered to the load within each half cycle. When the appropriate energy is delivered, the voltage is removed from the load by opening the power device. By using this method, it is possible to maintain the output within a 2% variation even with a 10% variation in the RMS line voltage from half cycle to half cycle.

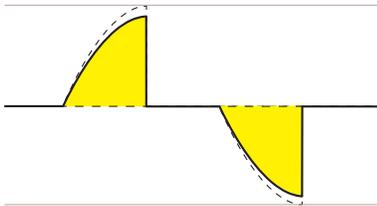


Example of noise on the rising edge of the AC line

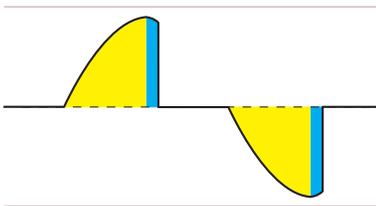
How does it work? Example – Line Sag



Expected power provided to the dimmer



Poor quality power caused by line sag



RTISS-TE™ compensates for the line sag by conducting longer (blue section)



The actual RTISS-TE power output when the line sags is the same as the expected power

Note: RTISS-TE provides a similar response due to a line surge by conducting for a shorter period of time.

III. How does it work?

The dimmer first needs to receive the value of the desired power level for the load. Once this is obtained, the power device turns on as close to the zero crossing as possible. The standard RTISS™ filter is used to ensure the dimmer can find a clean zero crossing point in the AC waveform. Next, the voltage delivered to the load is measured and used to calculate the power delivered to the load. When the desired power level is reached, the power device is given a signal to turn off. The process is then repeated in the next half cycle. Each half cycle is controlled independently so that the power is constant throughout either frequency or voltage variations.

The diagram to the left shows a simple variation in the AC line to illustrate how the RTISS-TE™ applies a correction. The RTISS-TE technology ensures that the conduction time of the power device is sufficient to deliver the consistent power to the load regardless of the waveshape. This can be seen graphically by the areas under each waveform.

IV. Better than a switch

RTISS-TE™ will provide better performance than a standard light switch. As long as the high-end level is set lower than 90% of full, the output power (light level) can be maintained even with a 10% drop in input voltage (dimmers can't generate voltage). A switch cannot provide any correction to incoming voltages. On a switch, a 10% drop in input voltage will result in a 10% drop in output voltage. Power is proportional to the square of the voltage. This means the power (light level) drop on a switch will be approximately 20%.

V. Conclusion

The RTISS-TE technology shows Lutron's commitment to advancing the performance of dimming systems. It ensures that Lutron customers will continue to experience the superior performance they are accustomed to even with trailing-edge dimming technology. When compared with a standard toggle switch, the RTISS-TE technology provides an advantage in performance. A lamp controlled by a switch is subjected to all the RMS variation that may exist on the power line. The Lutron RTISS-TE equipped dimmer continuously modifies the conduction time so that the lamp power remains constant at all times.

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For more information about Lutron RTISS™
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