

# Guide to Dimming Low-Voltage Lighting

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## Overview

This guide answers typical questions encountered by Lutron Technical Assistance and Applications personnel concerning low-voltage dimming applications. Lutron manufactures low-voltage dimmers for low-voltage fixtures that use magnetic transformers.

To control electronic (solid-state) transformer-supplied low-voltage lighting, Lutron developed special dimming circuitry after an extensive engineering research and development program. This technology has been built into a series of dimmers specifically for electronic low-voltage (ELV) transformer loads.

Lutron offers dimmers for both load types in a variety of product families.

## Facts About Low-Voltage Lighting

### Why Use Low-Voltage Lighting?

- Low-voltage lighting provides an excellent source of illumination when a precise, concentrated beam of light is required.
- Low-voltages contribute to extended lamp life and increased safety.
- Small fixture sizes permit lamps to be easily aimed and reconfigured.
- Common applications include residences, display lighting, task lighting, and product highlighting.

### What is Low-Voltage Lighting?

Low-voltage lighting uses a transformer to reduce a 120 V $\sim$  line voltage to 12 V $\sim$  or 24 V $\sim$ . This lower voltage is then used to power an incandescent low-voltage lamp. Examples of low-voltage lamps are AR111, MR16, MR11, PAR36, T3-1/4, T5, striplites, etc. Many, but not all, low-voltage lamps are tungsten halogen.

### Where is the Transformer Located?

A low-voltage transformer may be mounted remotely or as an integral part of the fixture.

### Does Dimming Affect Lamp Life?

Dimming will increase the life expectancy of low-voltage lamps. Occasionally, darkening of a low-voltage halogen lamp may occur. If this happens, simply turn on the lamp at 100% illumination for 10 minutes and the black residue (the result of tungsten evaporation) will be nearly eliminated.

## Dimming Low-Voltage Lighting

When dimming a low-voltage fixture, the dimmer controls the line voltage (120 V $\sim$ ) input to the transformer powering the low-voltage lamps. There are two types of transformers manufactured for low-voltage lighting:

- Magnetic (core and coil) low-voltage (MLV)
- Electronic (solid-state) low-voltage (ELV)

**Important:** Before selecting a dimmer, determine what type of transformer is in the lighting fixture. Different characteristics of the two transformer types require special dimming considerations. If you have a question concerning what type of transformer a fixture uses, refer to the fixture manufacturer's literature.

**Note:** Line voltage incandescent and low-voltage fixtures can be mixed on the same circuit, but the correct low-voltage dimmer (for the given low-voltage load) must be used. The total load must not exceed the dimmers capacity. Do not mix magnetic and electronic transformers on the same dimming circuit.

**Note:** Some low-voltage fixtures cannot be dimmed. Read the literature from the fixture manufacturer for details.

## Differences Between Magnetic and Electronic Transformers

### Magnetic

Magnetic transformers step down 120 V $\sim$  line voltage to 12 V $\sim$  or 24 V $\sim$ . Magnetic transformers use copper wound around a steel core which is inductive by nature (inductance is the ability of a device to store energy in the form of a magnetic field). Magnetic transformers are relatively large and heavy. Magnetic transformers are primarily available in two types of construction: toroidal and laminated EI core. For these types of transformers, use a Lutron® MLV dimmer.

These products are rated in volt-ampere (VA), which is explained in **Dimming Magnetic Transformers** on the next page.

All MLV transformers should be equipped with a primary fuse to protect against overheating.

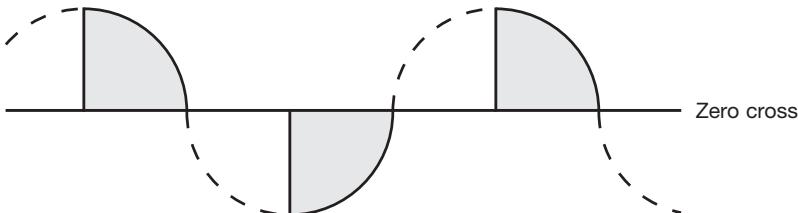
### Electronic

Electronic transformers also step down 120 V $\sim$  line voltage to 12 V $\sim$  or 24 V $\sim$ . This is done with electronic circuitry which is capacitive by nature (capacitance is the ability of a device to store energy in the form of an electric field). Electronic transformers are compact and lightweight. Due to the higher efficiency of ELV transformers, Lutron® ELV dimmers are rated in watts (W), which is the lamp load connected to the transformer.

## Differences Between MLV and ELV Dimmers

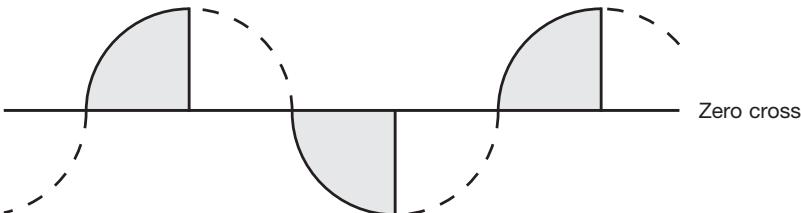
Dimmers for magnetic low-voltage transformers use a technology known as standard phase control or “leading edge,” whereas dimmers for electronic low-voltage transformers use reverse phase control or “trailing edge.” Standard phase control is for use with either inductive (MLV transformers, fans) or resistive (incandescent) loads. Reverse phase control is for use with either capacitive (ELV transformers) or resistive (incandescent) load types.

**Standard phase control or “leading edge”**



With standard phase control, the dimmer does not provide power until sometime later into the line cycle. Once the dimmer starts to provide power, it will do so until the zero cross. Dimming is achieved by delaying the time at which the dimmer starts conducting.

**Reverse phase control or “trailing edge”**



With reverse phase control, the dimmer starts to provide power immediately after the zero cross. Dimming is achieved by delaying the time at which the dimmer stops conducting.

## Dimming Magnetic Transformers

### Why Use Lutron® MLV Dimmers?

Magnetic transformers are inductive loads and are sensitive to DC voltages. A magnetic transformer subjected to DC voltage can overheat.

**Do not use regular incandescent dimmers for MLV lighting.** Regular incandescent dimmers often contain a small amount of DC voltage, which is harmless to a regular incandescent load but may damage magnetic transformers. Lutron® MLV dimmers are specifically designed to prevent DC voltage from being applied to the transformer.

Certain MLV transformers may not be compatible with all Lutron® dimmers. MLV transformers with built-in input chokes or “debuzzing coils” may not be compatible with certain microprocessor-based dimmers. In order to address this compatibility, Lutron offers microprocessor dimmers with a neutral connection. Check with Lutron Customer Service or your local Lutron representative for availability. These transformers should be compatible with standard (non-microprocessor) Diva®, Nova T★®, and Skylark® two-wire controls.

Some MLV transformers have secondary side protection such as PTC, fuses, circuit breakers, or in some cases, an electronic overload/fault detection circuit. In almost all cases PTCs, fuses, and circuit breakers are compatible with Lutron® dimmers. Check with Lutron Technical Support Center for compatibility, especially with MLV transformers equipped with electronic overload/fault detection circuits.

A dimmer controlling an inductive load such as a magnetic transformer is also subjected to large voltage spikes and current surges. Lutron® MLV dimmers are designed to withstand these spikes and surges.

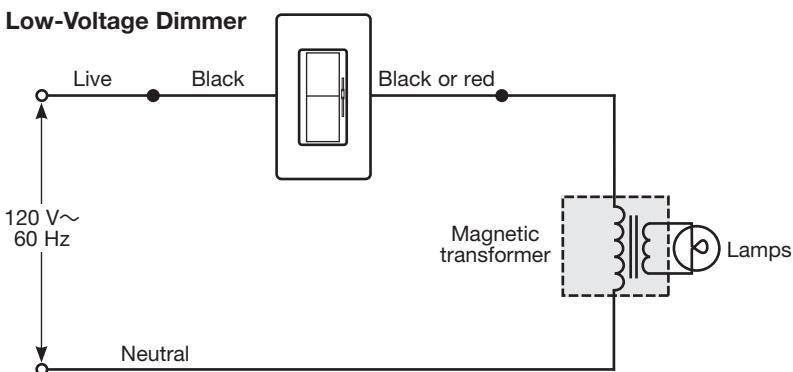
The stated VA rating is the rated capacity of the MLV dimmer. The wattage rating is provided only as a reference and indicates the lamp wattage that can be placed on a UL® approved (80% efficient) MLV without exceeding the VA rating of the dimmer.

Power to transformer (Primary)	Transformer efficiency	Lamp load (Secondary)
1000 VA X	80%	= 800 W

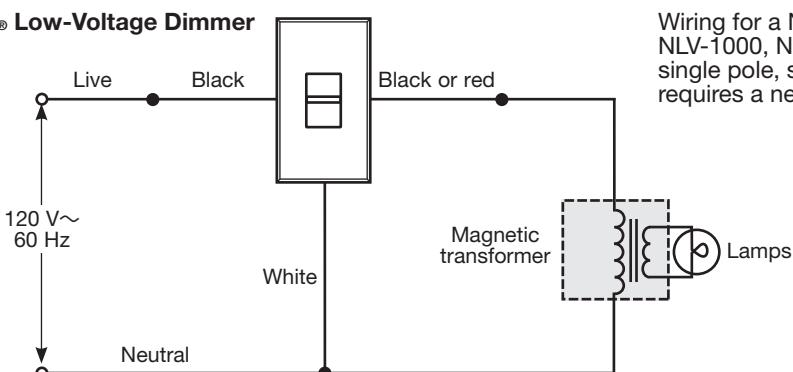
### Wiring

Typical wiring for MLV dimmers.

#### Diva® Low-Voltage Dimmer



#### Nova® Low-Voltage Dimmer



Wiring for a Nova® MLV dimmer (NLV-600, NLV-1000, NLV-1500). Note: only the Nova® single pole, slide-to-off series dimmer requires a neutral wire.

## Dimming Electronic Transformers

### Why Use Lutron® ELV Dimmers?

Lutron® ELV dimmers are designed specifically for the special electrical requirements of electronic transformers. The electrical characteristics of an electronic transformer are capacitive (as opposed to an inductive magnetic transformer) and require special dimming considerations.

**Do not use regular incandescent dimmers for ELV lighting.** When a MLV or incandescent dimmer is used on electronic transformers, there is interaction between the fixture and the dimmer. This interaction will cause any combination of the following: dimmer buzz, fixture buzz, lamp flickering, interaction between circuits, Radio Frequency Interference (RFI), and may damage the dimmer or transformer. To eliminate these problems, use Lutron® ELV dimmers. Lutron® reverse phase control dimmers for ELV transformers do not expose the transformers to the sharp rise of voltage present in standard phase control (high dV/dT). High dV/dT of voltage can shorten the life of the components in the ELV transformer or create acoustic noise. Lutron® ELV dimmers are UL® listed for both ELV transformers and incandescent loads.

One advantage of using ELV dimmers on an incandescent load is that they can completely eliminate AM radio interference, but they do not provide any advantage at controlling lamp buzz. If you experience lamp buzz refer to Application Note #3.

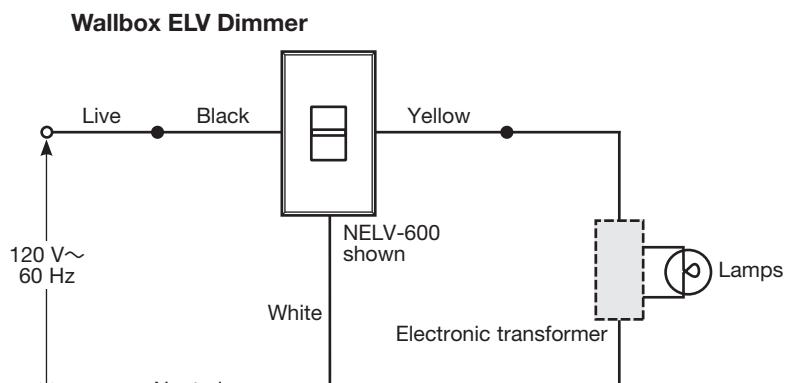
While some ELV transformers are labeled as "dimmable with standard incandescent dimmers" Lutron does not recommend this because the best dimming performance is achieved with Lutron® ELV dimmers or GRAFIK Eye® system controls. While some GRAFIK Eye® systems use standard phase control for controlling ELV loads, a large inductor is used to limit the rise time to the load and the system has a neutral connection for accurate zero cross information.

Lutron® ELV dimmers have overload protection. This protection reduces power to the lighting circuit when dimmer capacity is exceeded, thus preventing problems that could occur if the circuit is overloaded.

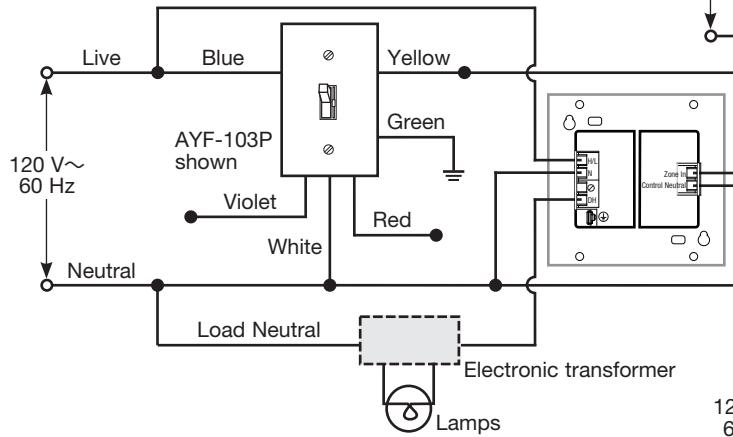
### Wiring

Typical wiring for ELV dimmers.

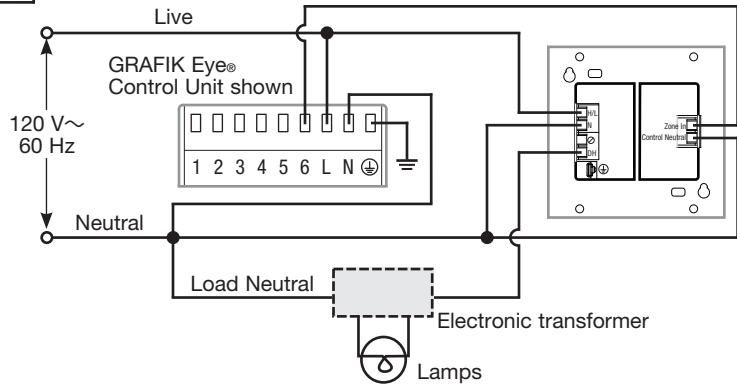
**Note:** All ELV dimmers require a neutral wire.



Fluorescent Dimmer with a PHPM-WBX-DV-WH



GRAFIK Eye® with a PHPM-WBX-DV-WH



## Control Options for Low-Voltage Lighting

Product Family	MLV				ELV									
	600 VA	1000 VA	1500 VA	2000 VA	300 W	450/500 W	600 W	1000 W to 2000 W						
<b>Ariadni®</b>														
Single Pole	AYLV-600P*	HP-2/4/6 <sup>1</sup> or PHPM-WBX-DV <sup>2</sup>				PHPM-WBX-DV-WH <sup>2</sup>								
3-Way	AYLV-603P*													
<b>Diva® and Diva® Satin Colors®</b>														
Single Pole	DVLV600P*	DVLV-10P*	HP-2/4/6 <sup>1</sup> or PHPM-WBX-DV <sup>2</sup>	DVELV-300P	PHPM-WBX-DV-WH <sup>2</sup>									
3-Way	DVLV603P*	DVLV-103P*												
<b>Fadera®</b>														
Single Pole	—	HP-2/4/6 <sup>1</sup>	FAELV-500	FAELV-500M	—									
Multi-location	—													
<b>Glyder®</b>														
Single Pole	GLV-600*	HP-2/4/6 <sup>1</sup>				HP-2/4/6 <sup>1</sup>								
<b>GRAFIK Eye®</b>														
3000 Series	Direct	PHPM-PA-DV-WH				PHPM-PA-DV-WH								
<b>HomeWorks Interactive™ Vareo®</b>														
Single Pole/Multi-location	HWV-600D	HWV-1000D	HP-2/4/6 or PHPM-PA		PHPM-PA-DV-WH <sup>2</sup>									
<b>Lumea2®</b>														
Single Pole/3-Way	LTLV-603P*	HP-2/4/6 <sup>1</sup>				LTELV-303PH	—							
<b>Maestro®</b>														
Single Pole/Multi-location	MALV-600	MALV-1000	HP-2/4/6 <sup>1</sup> or PHPM-WBX <sup>2</sup>		MAELV-600		PHPM-WBX-DV-WH <sup>2</sup>							
<b>Nova®</b>														
Single Pole	NLV-600*	NLV-1000*	NLV-1500*	NLV-2003P*	—		PHPM-WBX-DV-WH <sup>2</sup>							
3-Way	NLV-603P*	NLV-1003P*	NLV-1503P*											
<b>Nova T★®</b>														
Single Pole	NTLV-600*	NTLV-1000*	NTLV-1500*	HP-2/4/6 <sup>1</sup> or PHPM-WBX <sup>2</sup>	NTELV-300	NTELV-600	PHPM-WBX-DV-WH <sup>2</sup>							
3-Way	NTLV-603P*	NTLV-1003P*	NTLV-1503P*											
<b>RadioRA®</b>														
Single Pole	RA-6D	RA-10D	HP-2/4/6 <sup>1</sup> or PHPM-PA <sup>2</sup>		RA-5NE		PHPM-PA-DV-WH <sup>2</sup>							
Multi-location	—	—												
<b>Skylark®</b>														
Single Pole	SLV-600P*	HP-2/4/6 <sup>1</sup> or PHPM-WBX <sup>2</sup>				SELV-300P	PHPM-WBX-DV-WH <sup>2</sup>							
3-Way	SLV-603P*				SELV-303P									
<b>Spacer®</b>														
Single Pole	—				HP-2/4/6 <sup>1</sup>				HP-2/4/6 <sup>1</sup>					
Multi-location	—													
<b>Spacer System®</b>														
Single Pole	SPSLV-600	SPSLV-1000	HP-2/4/6 <sup>1</sup> or PHPM-WBX <sup>2</sup>	SPSELV-600	PHPM-WBX-DV-WH <sup>2</sup>									
Multi-location	SPSLV-600M	SPSLV-1000M												
<b>Vareo®</b>														
Single Pole	V-600*	V-1000*	HP-2/4/6 <sup>1</sup> or PHPM-WBX <sup>2</sup>		PHPM-WBX-DV-WH <sup>2</sup>									
Multi-location	—	—												

## NOTES:

1. Use a Hi-Power 2•4•6™ Dimming Module with a 600 W incandescent dimmer in this product family; when dimming ELV with a Hi-Power 2•4•6™ Dimming Module, transformer **must** be approved for use with standard incandescent dimmers.
2. To dim ELV lighting with this control type, use of an ELV interface (PHPM-WBX-DV-WH) is required in addition to a fluorescent dimmer in this product family. Up to 3 PHPM-WBX-DV-WH may be connected to a single dimmer; this will provide dimming for up to 6000 W of an ELV load.

For loads other than those listed, please contact the toll-free Lutron Technical Support Center.

\* To reduce acoustic noise, a Lamp Debuzzing Coil (LDC) may be used with these products.