

fluorescent dimming systems technical guide

Lutron



# FLUORESCENT DIMMING SYSTEMS TECHNICAL GUIDE

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## LUTRON — THE LEADER IN LIGHTING CONTROL

Since its founding over 40 years ago, Lutron has emerged as the recognized leader in residential and commercial lighting control, and is the brand most preferred by lighting designers and specifiers worldwide. Lutron invented the solid state dimmer (1961), the electronic fluorescent dimming ballast (1969) and qualified for ISO 9001 registration (1991). With over 100 U.S. patents, Lutron has continuously led the industry with high quality innovative products and solutions for lighting control.



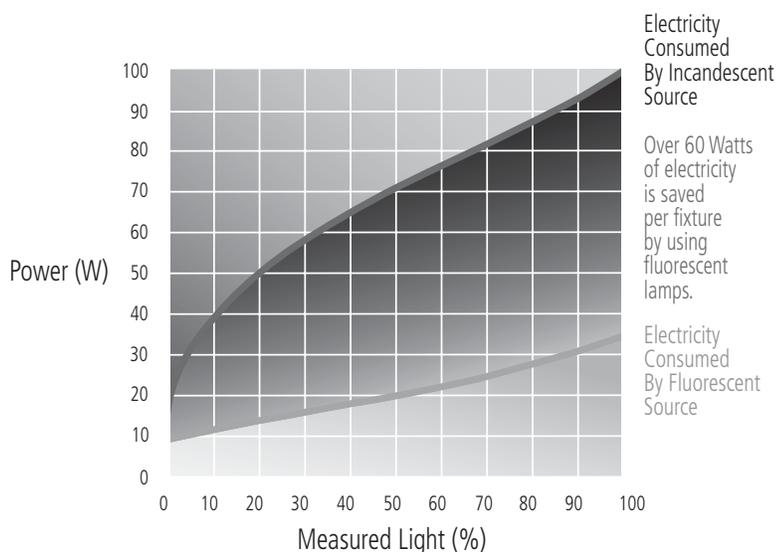
*For ballast model numbers and control selections, please see the Fluorescent Dimming System Selection Guide, P/N 366-002.*

## WHY FLUORESCENT?

### *Fluorescent Lighting Saves Energy*

Fluorescent lighting uses much less power than incandescent lighting. In a typical installation, a 32 Watt compact fluorescent lamp provides approximately the same light output as a 100 Watt incandescent lamp. As both sources are dimmed, fluorescent lamps continue to be a more energy efficient light source.

Some states are mandating certain energy usage limitations for workspace lighting. Fluorescent lighting may now be required in some areas in order to meet both the lighting requirements and energy regulations.



### *Fluorescent Lighting Reduces Operating Costs*

#### **Reduces HVAC Operating Cost**

Fluorescent lighting generates 75% less heat than incandescent lighting and therefore can reduce HVAC ongoing operating cost.

#### **Reduces HVAC Initial Equipment Cost**

For new construction, air conditioning systems must be sized with regard to the maximum lighting load (all lights on at full brightness). A fluorescent solution reduces the lighting load by as much as 66%. This reduction significantly decreases the initial size and cost of AC equipment. Every 3,300 Watts of electricity saved eliminates 1 ton of AC equipment.

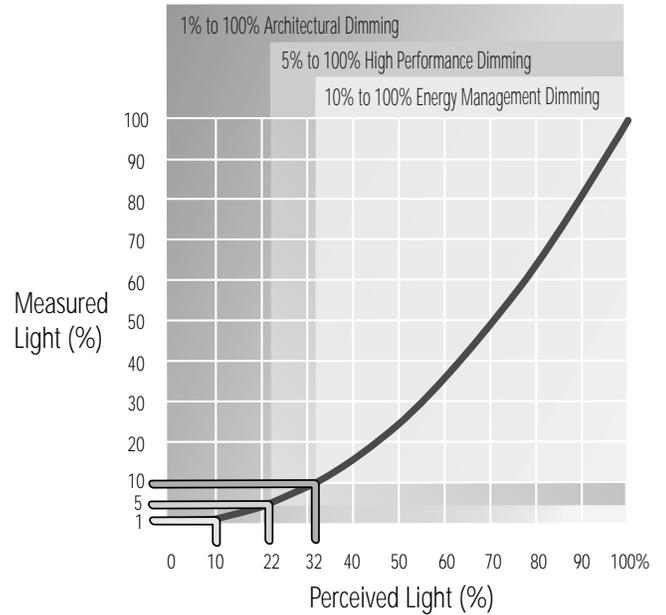
#### **Reduces Maintenance Cost**

Fluorescent lamps last longer than incandescent lamps and require fewer lamp changes, reducing maintenance costs.

# WHY DIFFERENT DIMMING RANGES?

## *The Difference Between Measured and Perceived Light*

The human eye responds to dim light by automatically enlarging the pupil to allow more light into the eye, making the light appear brighter. Measured light (%) is always less than the perceived light (%). Lights dimmed down to 1% measured light are perceived as 10% by the human eye. One percent (1%) is essential for architectural applications.



Source: [IESNA Lighting Handbook](#), 9th Edition, (New York: IESNA, 2000), 27-4.

## *Application Examples*

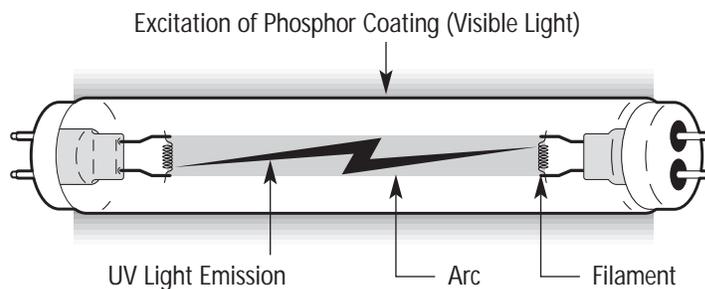
<b>1%</b> Architectural Dimming	<b>5%</b> High Performance Dimming	<b>10%</b> Energy Management Dimming
<ul style="list-style-type: none"> <li>- Conference Room/ Boardroom</li> <li>- Classroom/Lecture Hall</li> <li>- Patient Room/ Examination &amp; Treatment Room</li> <li>- House of Worship</li> <li>- Theater</li> <li>- Convention Area</li> <li>- Elegant Dining Space</li> <li>- Air Traffic Control Center</li> <li>- Industrial Control Room</li> <li>- Partitioned Meeting Room</li> <li>- Graphic Art Workstation</li> <li>- CAD/CAM Workstation</li> <li>- Private Office</li> </ul>	<ul style="list-style-type: none"> <li>- Large Open Office</li> <li>- Small Meeting Room</li> <li>- Customer Service Area/ Call Center</li> <li>- Lobby</li> <li>- Hotel Guest Room</li> </ul>	<ul style="list-style-type: none"> <li>- Corridor/Stairwell</li> <li>- Utility Room</li> <li>- Restroom</li> <li>- Load Shedding</li> <li>- Occupant Detection</li> <li>- Daylight Harvesting</li> </ul>

# HOW DO FLUORESCENT LAMPS AND DIMMING BALLASTS WORK?

## *How Do Fluorescent Lamps Work?*

A linear fluorescent lamp consists of a glass tube containing low pressure mercury vapor with a tungsten filament at each end. Light is produced by striking an arc across the lamp from one filament to the other, causing the gas to glow. The amount of current passing through the lamp determines the light output.

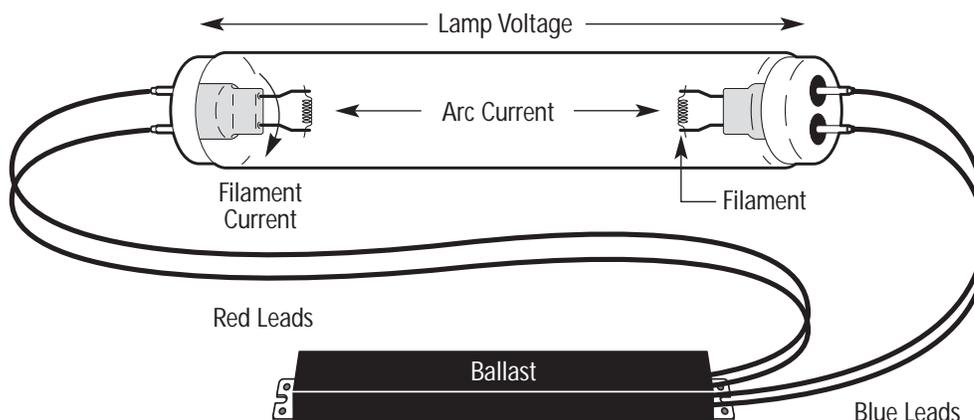
U-bent, twin tube and compact fluorescent lamps are simply linear lamps with a varying number of bends.



## *How Does Lutron Dim Fluorescent Lamps?*

Lutron ballasts control the current passing through the lamp to offer the user light level control. As part of the dimming process, it is important to keep the filaments warm by passing a current through them. Instant-start ballasts do not provide heat to these filaments and use sockets that connect the two filament pins together. A Lutron ballast uses these filaments

and it is important that these two pins are not shorted together in the socket. Hence the need for rapid-start sockets which keep these pin connections separate. Using instant-start sockets with a Lutron ballast will cause excess current to flow in the lamp wires which may permanently damage the ballast.



# CHOOSING THE RIGHT LUTRON DIMMING BALLAST

## *Factors for Choosing Dimming Ballasts*

Ballasts are specified according to the lamp type, low-end light level, supply voltage, and control method.

### **Lamp Type**

Each type of fluorescent lamp has specific electrical requirements in order to operate at variable light levels and achieve the expected lamp lifetime. Lutron designs each fluorescent dimming ballast to achieve the best performance for each lamp type. The result is superior dimming, continuous flicker-free illumination, and expected lamp lifetime.

For information on the various lamp types, please see pg. 13.

### **Low-End Light Level**

Lutron offers 10%, 5%, and 1% dimming ballasts.

This percentage refers to the measured low-end light level.

<b>Ballast Family</b>	<b>Dimming Range</b>	<b>Control Method</b>
Hi-lume®	100%-1%	3-wire
Tu-Wire®	100%-5%	2-wire
Compact SE™	100%-5%	3-wire
Eco-10™	100%-10%	3-wire
TVE	100%-10%	0-10V, 4-wire

### **Supply Voltage**

Lutron offers ballasts for 120V, 277V, and 347V, all at 60Hz.

Ballasts for international voltages and frequencies are also available. Consult Lutron for availability.

*For selection information on our entire line of ballasts and controls for different lamp types, please see the Fluorescent Dimming Systems Selection Guide (P/N 366-002), visit [www.lutron.com/ballasts](http://www.lutron.com/ballasts), or contact the toll-free Lutron Technical Support Center at 1.800.523.9466.*

### **Control Method**

Lutron offers several different ways to install and control our dimming ballasts. See the wiring diagrams in the Appendix for more information.

- **3-wire control**

Ballasts controlled by this method require three control wires: Switched Hot, Dimmed Hot, and Neutral. The Switched Hot and Neutral provide power to the ballast. The Dimmed Hot provides a line-voltage dimming signal from the control to the ballast.

- **2-wire control**

Ballasts controlled by this method require only two control wires. Dimmed Hot and Neutral provide both power and the dimming signal to the ballasts. This control method is ideal for retrofit installations.

- **0-10VDC (4-wire control):**

Ballasts controlled by this method require four control wires: Switched Hot, Neutral, 0-10VDC Positive, and 0-10VDC Negative. The Switched Hot and Neutral provide power to the ballast. The 0-10VDC wires provide the dimming signal from the control to ballasts.

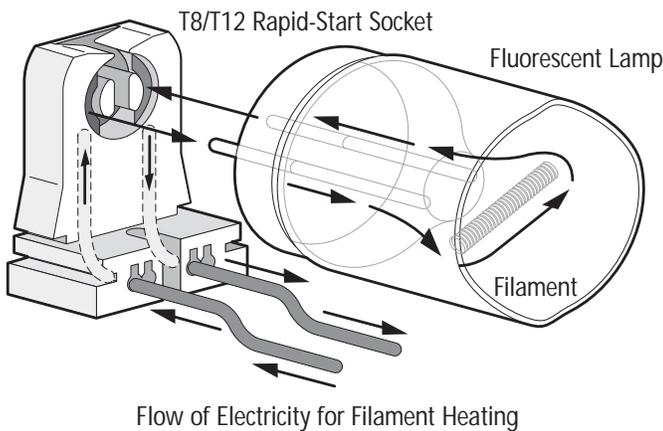
# SOCKETS

## Lamp Sockets

When installing Lutron ballasts, socket type and wiring are important. Good pin-to-socket contact and correct wiring are required to produce flicker-free dimming and ensure long lamp life. For longest lamp life and best filament contact, use only approved or recommended sockets:

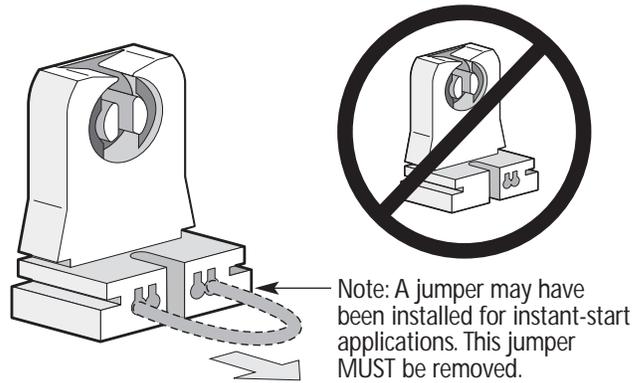
Lamp Type	Recommended Sockets
T8 and T12	Rapid-start knife edge/rotary locking
T5 Linear	Rotary locking
T4 Compact	4-pin
T5 Twin Tube	Sockets that "lock" lamp in place

### Why Are Sockets Important?



Dimming ballasts must access both lamp pins to heat the lamp filaments — without heating, the lamp ends will become black and fail prematurely (may take a day or several months).

### Rapid-Start Linear Lamp Sockets

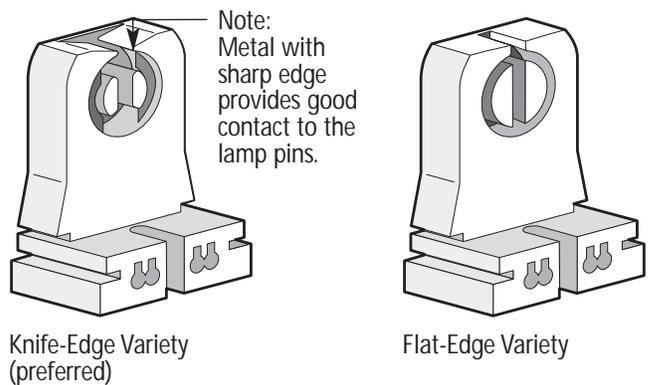


Rapid-start sockets can accept 4 wires (2 for wires from the ballast and 2 for wires to another socket).

Note: Instant-start sockets, which can only accept two wires, MUST be replaced with 4-pin rapid-start sockets.

**⚠ WARNING:** Using Lutron ballasts with instant-start sockets may damage the ballasts.

### Why Use a Knife-Edge Socket?

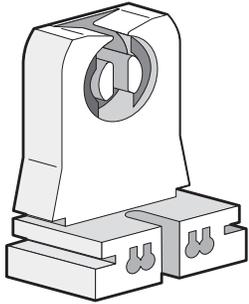


A knife-edge socket makes a superior contact with the lamp pin by contacting with a sharp edge — rather than a flat surface. Dimming ballasts require good pin contact.

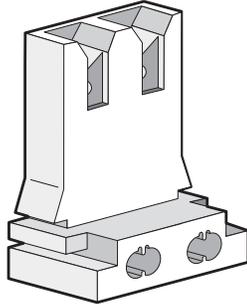
# SOCKETS

## Socket Configurations

### T8 and T12 Linear



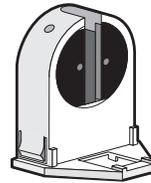
### T8 and T12 U-Bent



#### For T8 and T12 Lamps

The sockets should have knife-edge connections that make good, firm contact with the lamp pins. The sockets may also be of the rotary locking type. The fixture must have a grounded metal surface  $1/2" \pm 1/4"$  ( $12.7\text{mm} \pm 6.4\text{mm}$ ) away from the lamp. The sockets **MUST** be rapid-start type.

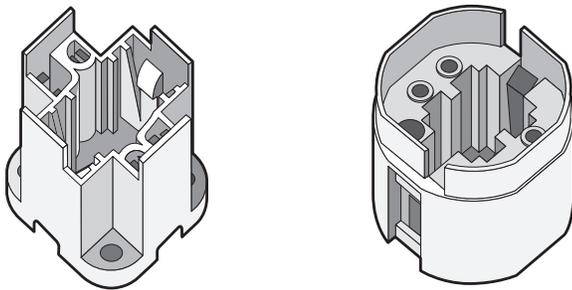
### T5 Linear



#### For T5 Lamps

The sockets should be of the rotary locking type. The fixture must have a grounded metal surface  $3/8" \pm 1/8"$  ( $9.5\text{mm} \pm 3.2\text{mm}$ ) away from the lamp. The sockets **MUST** be rapid-start type.

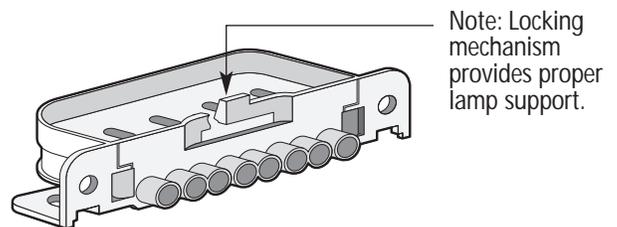
### T4 Compact 4-Pin



#### For T4 Compact Lamps

T4 compact sockets **MUST** be the 4-pin type and must be used with 4-pin compact lamps. Instant-start sockets, which can accept only two wires, **MUST** be replaced with 4-pin rapid-start sockets.

### T5 Twin Tube



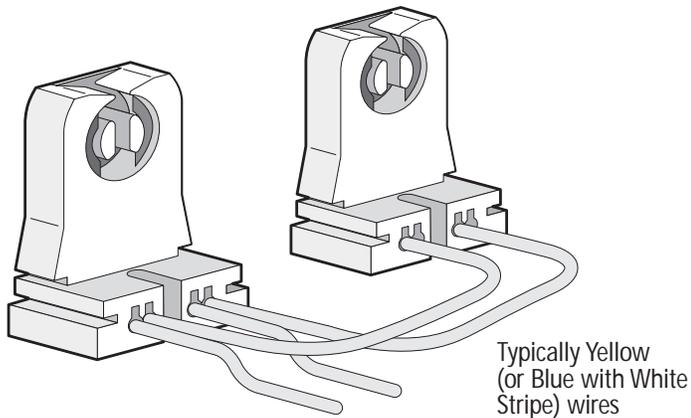
#### For T5 Twin Tube Lamps

T5 twin tube lamps require proper lamp support to hold lamp pins in full contact with socket. Use **ONLY** 4-pin "locking" sockets that hold the lamp in place. The fixture must have a grounded metal surface  $1/2" \pm 1/4"$  ( $12.7\text{mm} \pm 6.4\text{mm}$ ) away from the lamp.

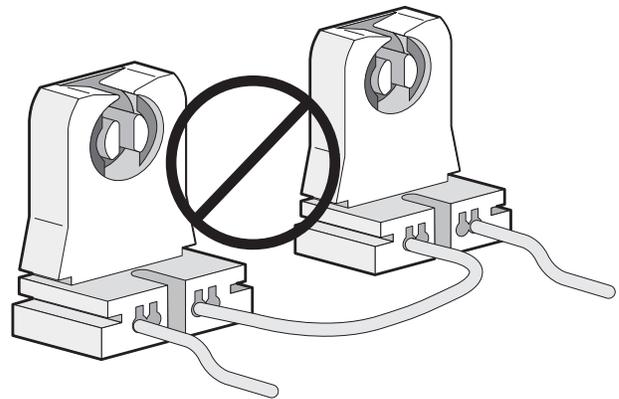
# SOCKET WIRING

## Socket Wiring for T8 and T12 Linear

For ballasts that control more than one lamp, sockets wired to the yellow or blue-with-white stripe leads of the ballast must be wired in parallel, not in series.



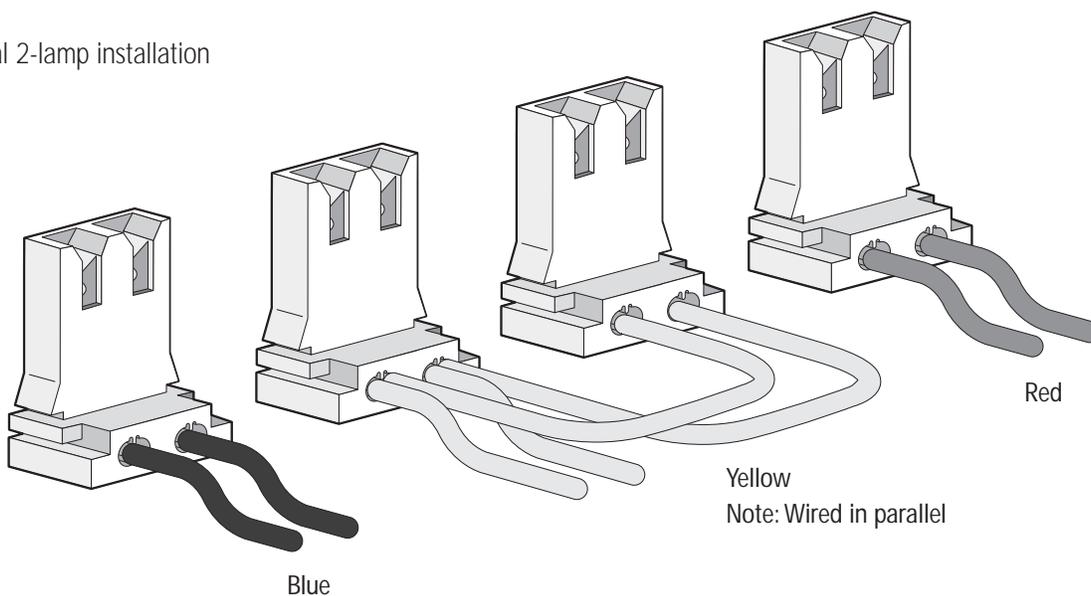
*Correct - sockets wired in parallel*



*Incorrect - sockets wired in series*

## Socket Wiring for T8 and T12 U-Bent

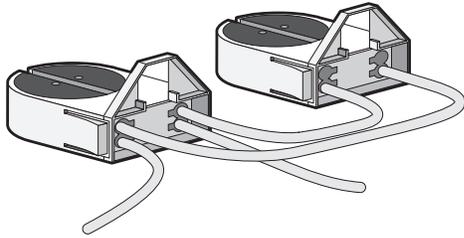
Typical 2-lamp installation



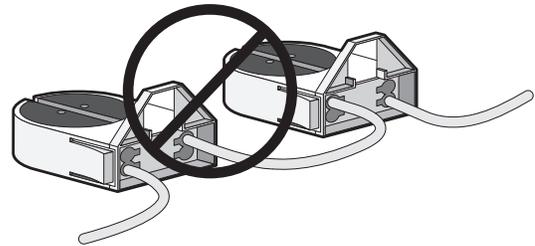
# SOCKET WIRING

## Socket Wiring for T5 Linear

For ballasts that control more than one lamp, sockets wired to the yellow or blue-with-white stripe leads of the ballast must be wired in parallel, not in series.



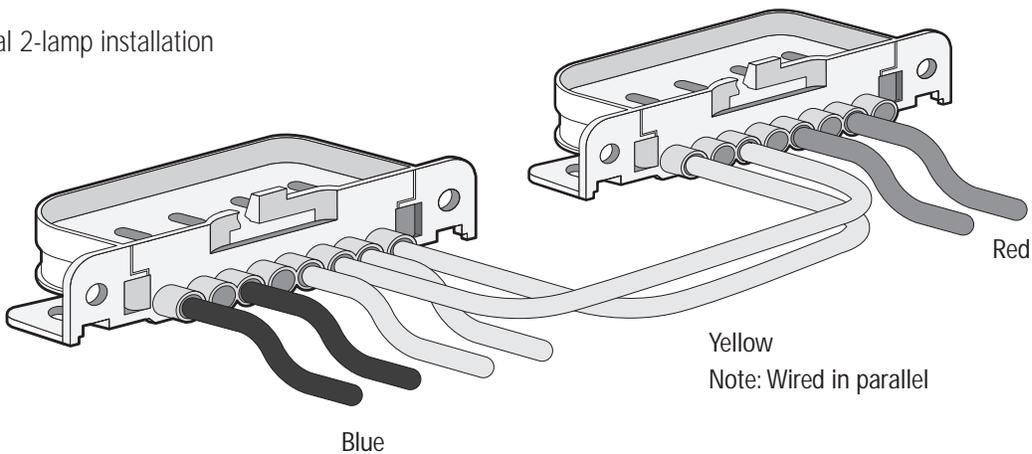
*Correct - sockets wired in parallel*



*Incorrect - sockets wired in series*

## Socket Wiring for T5 Twin Tube

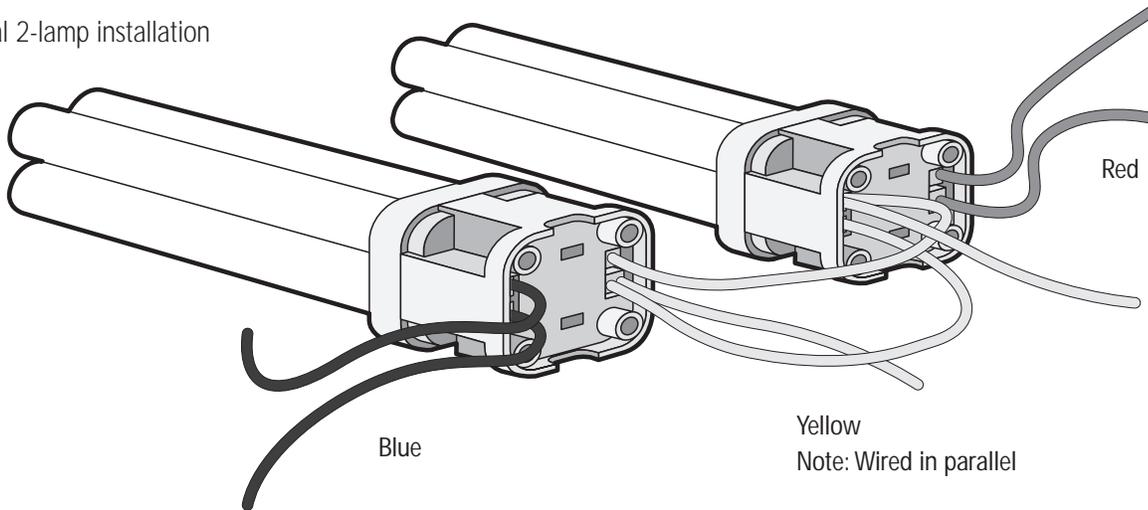
Typical 2-lamp installation



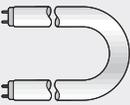
# SOCKET WIRING

## Socket Wiring for T4 Compact 4-Pin

Typical 2-lamp installation



## Wire Lead Length

Lamp Type		Maximum Lead Length (Ballasts to sockets)
T4 Compact		3 feet (0.9 meter)
T5 Twin Tube		
T5 HO Linear High Output		7 feet (2.1 meters)
T8 Linear		
T8 U-Bent		
T12 Linear		
T12 U-Bent		

*Exceeding maximum lead lengths may cause lamp flicker, improper lamp starting, or reduced lamp life.*

# BALLAST TEMPERATURE

## *Ambient Operating Temperature*

Lutron's electronic fluorescent dimming ballasts are designed to operate with an ambient temperature that does not allow any part of the ballast case to exceed 75°C. Lutron ballast specifications and performance expectations are based on this maximum case temperature.

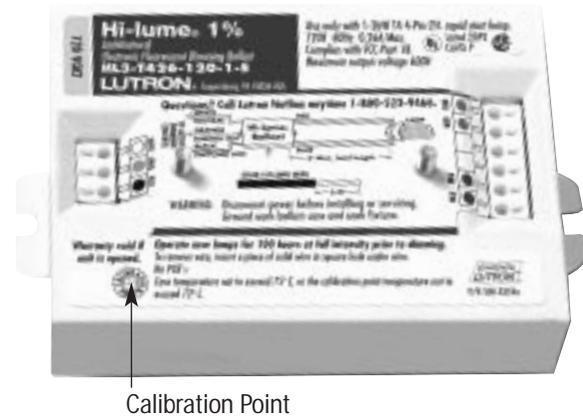
Each ballast has an indicated calibration point. This point, located on the label of the ballast, is a convenient location for measuring ballast temperature. See the example at right for how to verify that the ballast is operating within specifications.

If the calibration point reaches its marked temperature, the maximum case temperature of the ballast is at 75°C (the rated maximum).

The ballast calibration point maximum temperature specification must not be exceeded.

## *OEM Fixture Design*

It is extremely important, when designing a fixture, to ensure that the calibration point does not exceed the marked temperature. This temperature should be measured under the worst-case expected conditions (i.e., ballast operating at high end, temperature stabilized, fixture in most extreme ambient temperature).



## *Calibration Point Measurement Example:*

- (1) Ballast label reads: "When calibration point equals 70°C, maximum case temperature equals 75°C."
- (2) Calibration point is measured and found to be at 65°C.
- (3) Conclusion: 65°C is less than 70°C rating; therefore, case temp is less than 75°C.

## *DOs and DON'Ts*

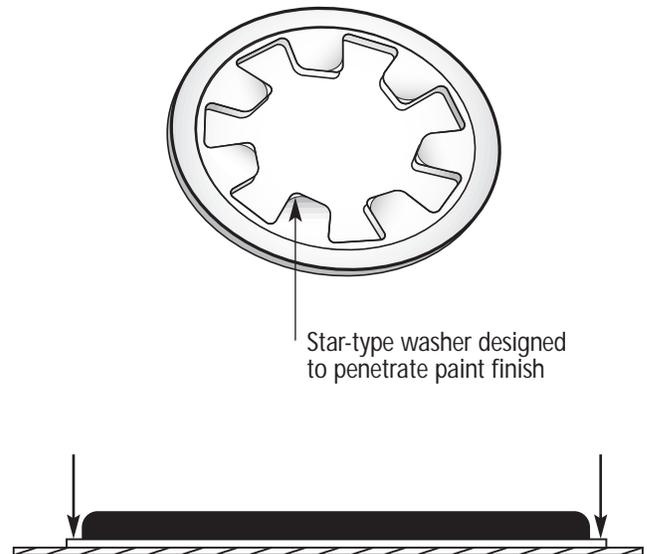
- DON'T mount the ballast on a poor thermal conductor, such as wood, plastic, etc.
- DON'T mount the ballast in a space with poor ventilation.
- DO attach the ballast to a grounded metal fixture.
- DO limit the quantity of the ballasts to be installed in an enclosed space (for instance, a cove installation or a strip fixture) so that the ballasts do not operate above the rated temperature.

# RECOMMENDED INSTALLATION PRACTICES

## Grounding

Both the ballast and the fixture must be connected to earth ground. Grounding the ballast to the fixture requires “star-type” screws, washers or nuts in order to penetrate the paint finish on the ballast. To ensure safety and performance proper grounding is essential.

Both ends of the ballast must be attached to the fixture to ensure proper grounding.

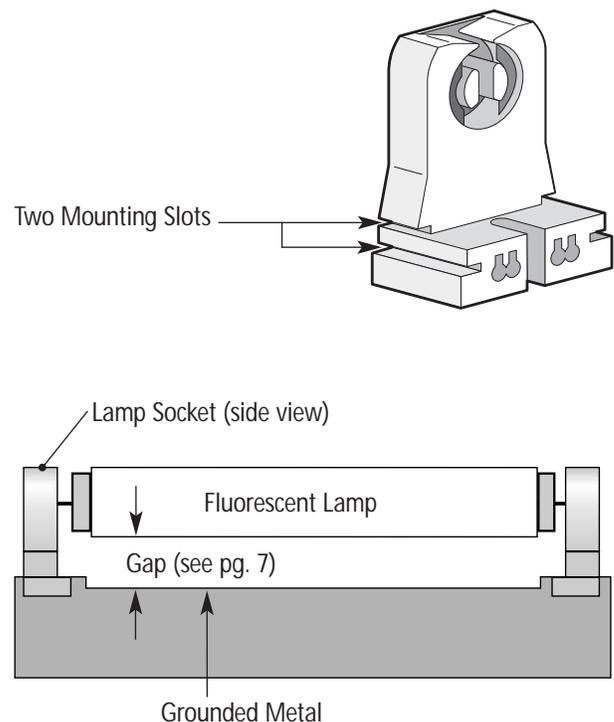


## Lamp Mounting Height

Many fluorescent lamp sockets are available with mounting slots to vary the height of the lamp from the grounded metal surface. Use these slots to get the outside edge of the lamp to be the appropriate distance away from the grounded metal surface (refer to pg. 7).

Mounting a fluorescent lamp too close to the grounded metal will make the minimum intensity too low and may reduce lamp life.

Mounting a fluorescent lamp too far away from the grounded metal may make the lamp flicker or not turn on at all.

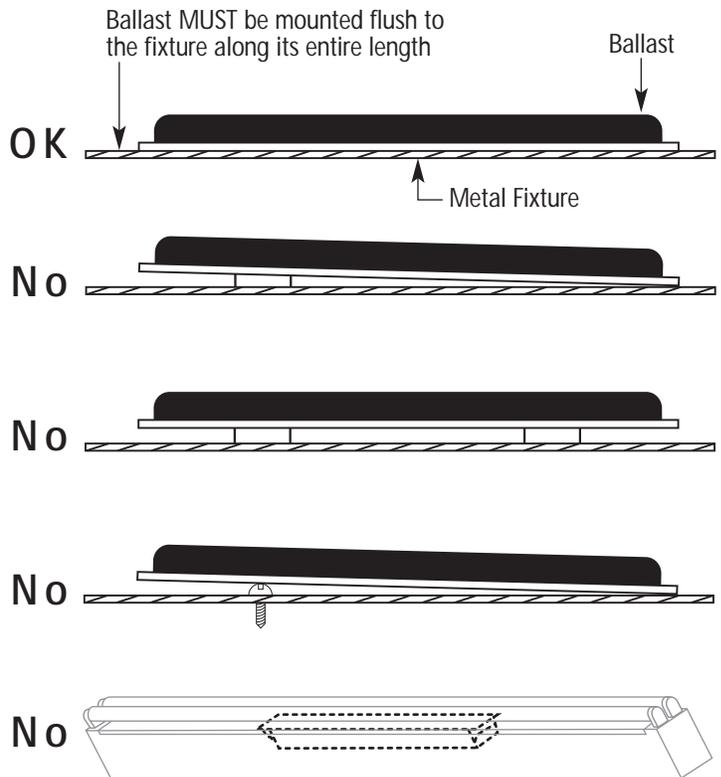


# RECOMMENDED INSTALLATION PRACTICES

## *Ballast Mounting Recommendations*

### **Notes:**

- (1) Ballasts generate heat and must have a means to dissipate it.
- (2) Ballasts MUST be mounted flush to the fixture in order to provide the best heat transfer.
- (3) Screws, knockouts, dimples, or features that raise the ballast off the fixture (even slightly) are not acceptable as these will impair the ballast's ability to dissipate heat.
- (4) Avoid mounting the ballast on the fixture cover plate that holds the lamps. This mounting location is often the hottest point on the fixture.



# LAMP INFORMATION

## Lamp Type

Lutron offers dimming ballasts for every popular lamp type:

### Linear

Linear lamps are straight lamps with pins at both ends. Lutron dimming ballasts work with rapid-start lamps, which will have two pins at either end.

### U-Bent

U-bent lamps have many of the same properties as linear lamps and are usually offered in the same sizes, except they are bent in a “U” shape. Lutron dimming ballasts for linear lamps will often control a U-bent of the same size and wattage.

### Compact

Lutron dimming ballasts for compact lamps are offered in quad tube and triple tube. Quad tube lamps appear to have two or four tubes, while triple tube lamps appear to have three. They are T4 (1/2” (12.7mm)) diameter and mount in 4-pin rapid-start sockets.

### T5 Twin Tube

Lutron also offers ballasts for the T5 twin tube lamps. T5 twin tube lamps use a locking-type 4-pin rapid-start twin tube socket.

*For selection information on our entire line of ballasts and controls for different lamp types, please see the [Fluorescent Dimming Systems Selection Guide \(P/N 366-002\)](#), visit [www.lutron.com/ballasts](http://www.lutron.com/ballasts), or contact the toll-free **Lutron Technical Support Center** at 1.800.523.9466.*

## New Lamps Must be “Seasoned”

### Why keep the lamps at full intensity for 100 hours before dimming?

New fluorescent lamps can have impurities in them that lamp manufacturers cannot eliminate completely. Lutron recommends that lamps be operated at full intensity for 100 hours before dimming to neutralize the harmful effects of these impurities.

Dimming fluorescent lamps without seasoning can reduce performance and lifetime.

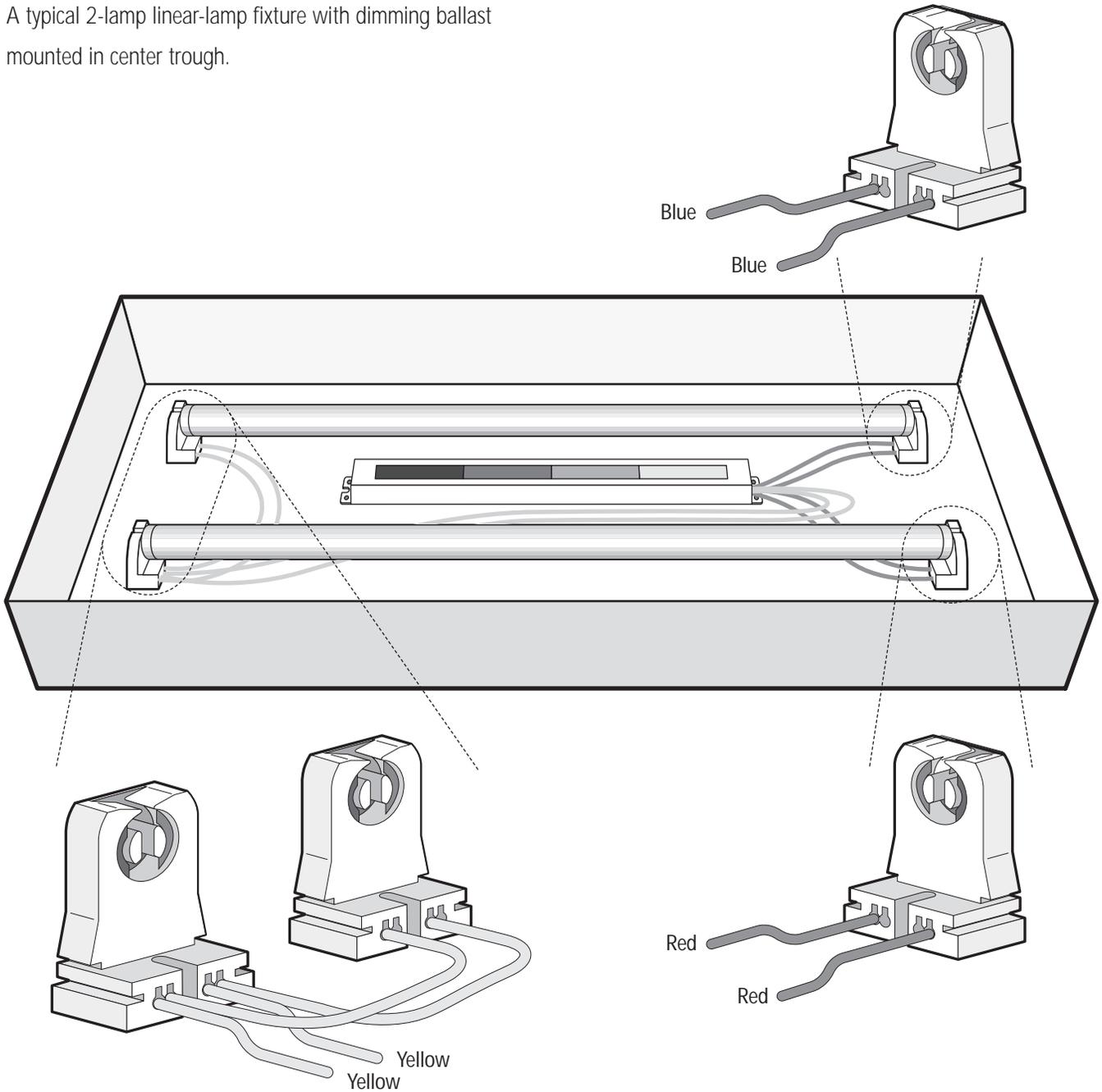
### Ways to Obtain Seasoned Lamps

- Operate new lamps continuously for 100 hours (approximately four days). Time period might include a weekend or holiday.
- Remove lamps with over 100 hours use from another (non-dimmed) area; re-install in dimming area.
- Use a lamp burn-in station to build an inventory of properly seasoned lamps.

# BALLAST WIRING

## *Ballast Wiring Diagram*

A typical 2-lamp linear-lamp fixture with dimming ballast mounted in center trough.



# FUNCTION TESTING BALLASTS AND CONTROLS

## ***3-Wire Control***

### ***Control Test***

DISCONNECT POWER by turning off the breaker. With the 3-wire control inputs connected to the line, connect a DMM (Digital Multimeter) from Dimmed Hot (orange or yellow) to Neutral (white) and set the meter to measure AC voltage. When power is re-applied, the voltage should change as the control is adjusted from high-end to low-end. If the voltage does not change, the control may be damaged or defective.

---

### ***Ballast Test***

DISCONNECT POWER by turning off the breaker. With the ballast properly wired to a fixture, connect the Dimmed Hot (orange) and input Hot (black) input to the Hot feed from the breaker. When power is re-applied, the lamps should go to full brightness. If the lamps do not come on at all, there may be a miswire condition on the lamp sockets or the ballast may be damaged or defective.

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## ***2-Wire Control***

### ***Control Test***

DISCONNECT POWER by turning off the breaker. With the 2-wire control inputs connected to the line but disconnected from the ballasts, connect a 40 Watt incandescent light bulb to the output leads of the dimmer. When the power is re-applied, the light bulb should dim with dimmer position.

### ***Ballast Test***

DISCONNECT POWER by turning off the breaker. With the ballast properly wired to a fixture but disconnected from the control, connect the inputs on the ballast to Hot and Neutral. When power is re-applied, the lamps should go to full brightness.

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## ***0-10 Volt Control***

### ***Control Test***

DISCONNECT POWER by turning off the breaker. With the control **completely disconnected** from the power circuit and the ballasts, measure (with a DMM) the resistance from the purple to grey leads. As the dimmer is adjusted the resistance should change.

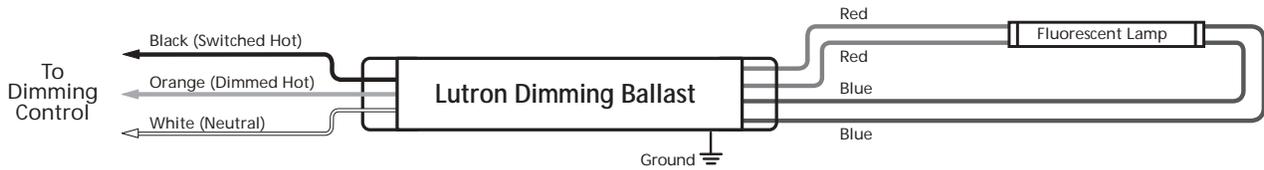
### ***Ballast Test***

DISCONNECT POWER by turning off the breaker. With the ballast connected to power and lamp fixture, disconnect the purple and gray wires from the control. When the power is re-applied, the lamps should go to full brightness.

# APPENDIX: WIRING DIAGRAMS

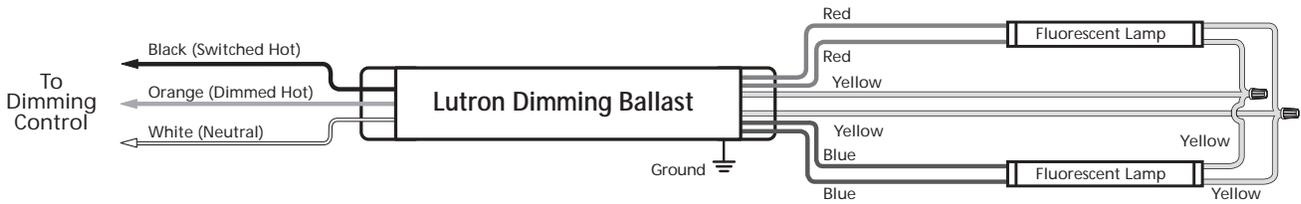
## Linear 1-Lamp 3-Wire Control Method

One Lamp



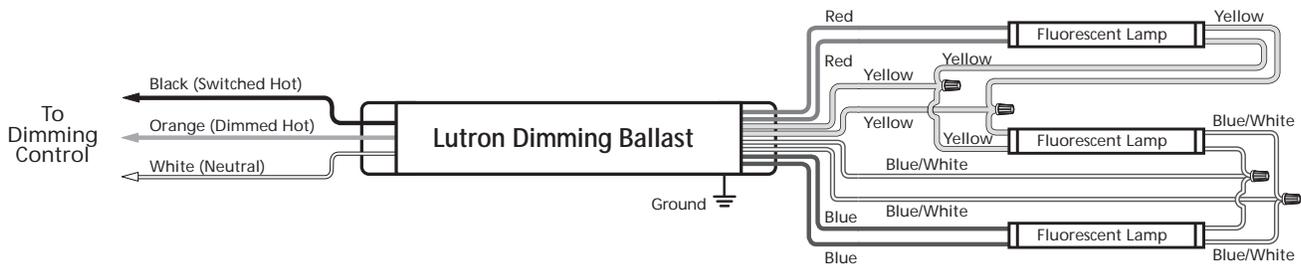
## Linear 2-Lamp 3-Wire Control Method

Two Lamps



## Linear 3-Lamp 3-Wire Control Method

Three Lamps

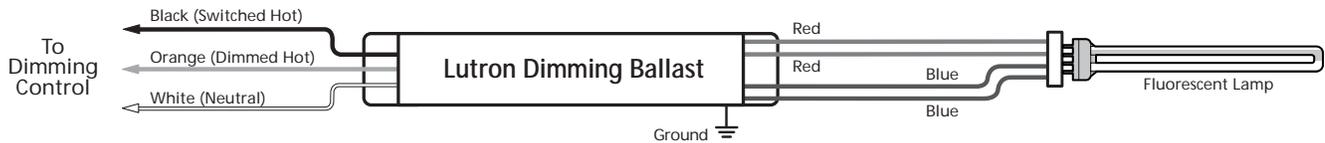


Note: Ballast-to-lamp wire lead lengths must not exceed 7.00' (2.13m) for all wiring scenarios shown above.

# APPENDIX: WIRING DIAGRAMS

## T5 Twin Tube 1-Lamp 3-Wire Control Method

One Lamp



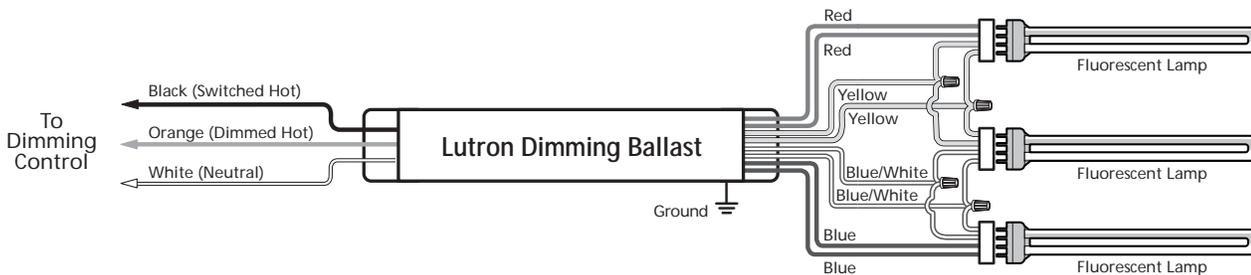
## T5 Twin Tube 2-Lamp 3-Wire Control Method

Two Lamps



## T5 Twin Tube 3-Lamp 3-Wire Control Method

Three Lamps

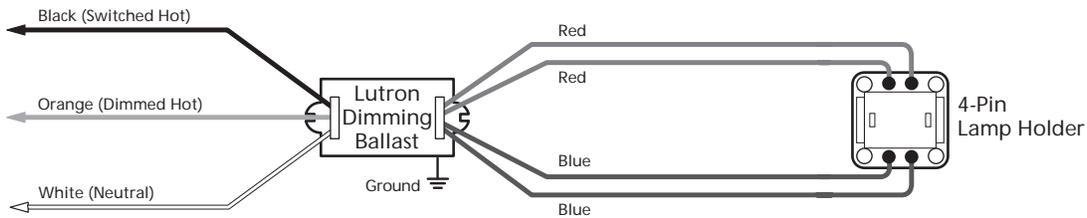


Note: Ballast-to-lamp wire lead lengths must not exceed 3.00' (0.91m) for all wiring scenarios shown above.

# APPENDIX: WIRING DIAGRAMS

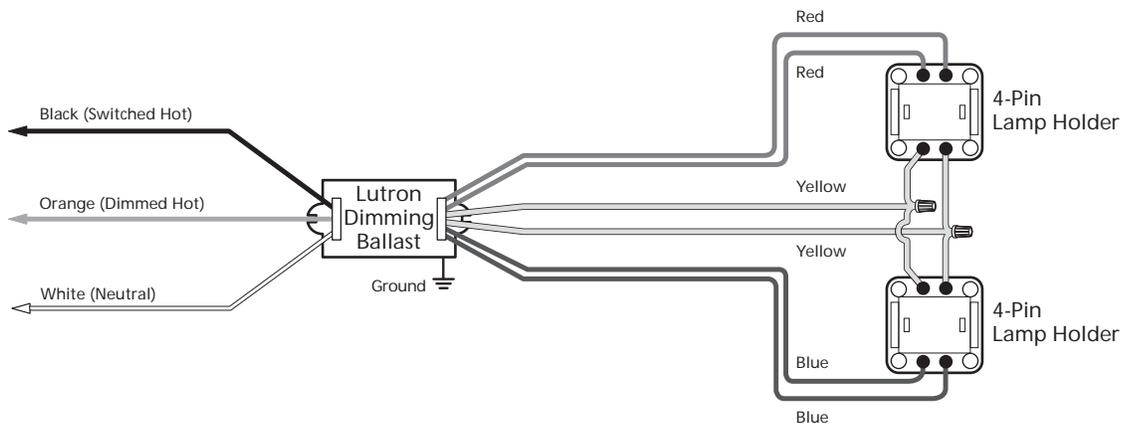
## T4 1-Lamp 3-Wire Control Method

### One Lamp



## T4 2-Lamp 3-Wire Control Method

### Two Lamps

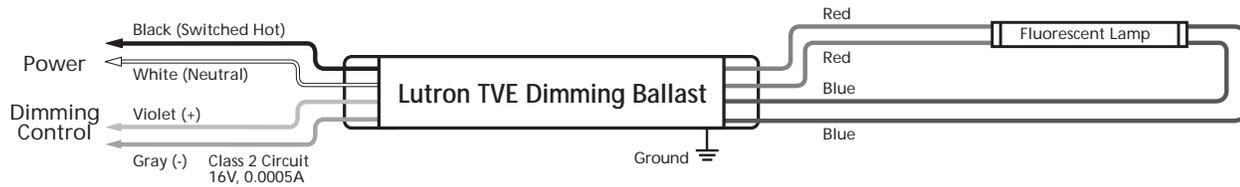


Note: Ballast-to-lamp wire lead lengths must not exceed 3.00' (0.91m) for all wiring scenarios shown above.

# APPENDIX: WIRING DIAGRAMS

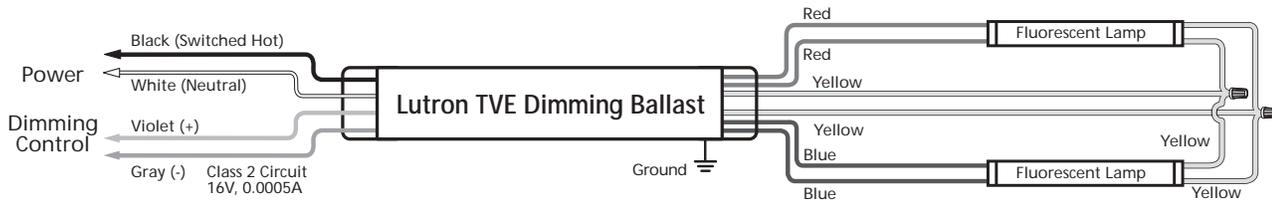
## Linear 1-Lamp 4-Wire (0-10V) Control Method

### One Lamp



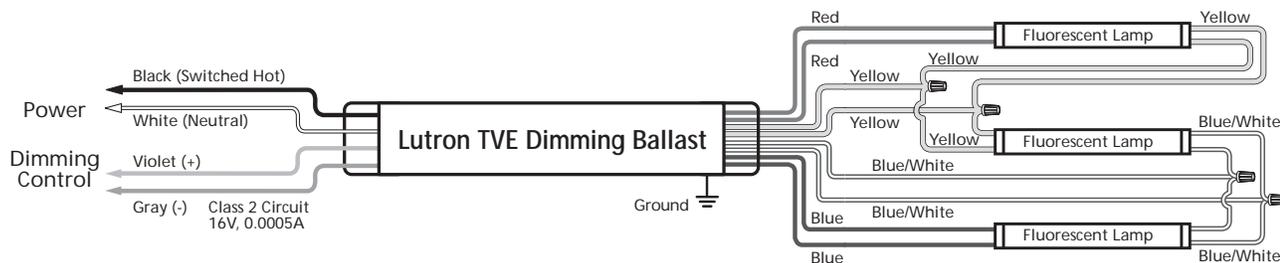
## Linear 2-Lamp 4-Wire (0-10V) Control Method

### Two Lamps



## Linear 3-Lamp 4-Wire (0-10V) Control Method

### Three Lamps

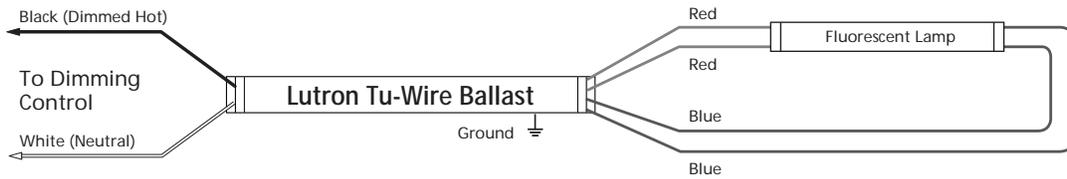


Note: Ballast-to-lamp wire lead lengths must not exceed 7.00' (2.13m) for all wiring scenarios shown above.

# APPENDIX: WIRING DIAGRAMS

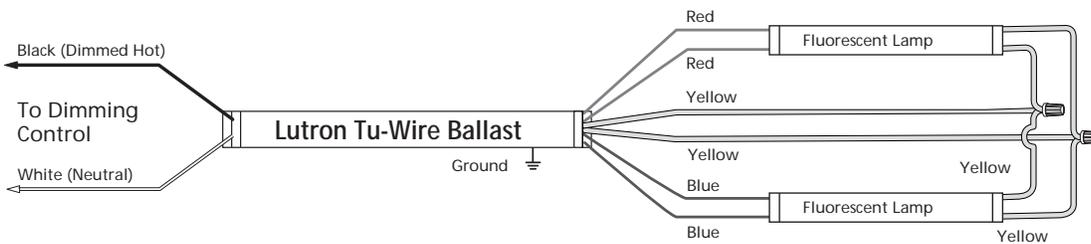
## Linear 1-Lamp 2-Wire Control Method

### One Lamp Linear Fluorescent



## Linear 2-Lamp 2-Wire Control Method

### Two Lamps Linear Fluorescent

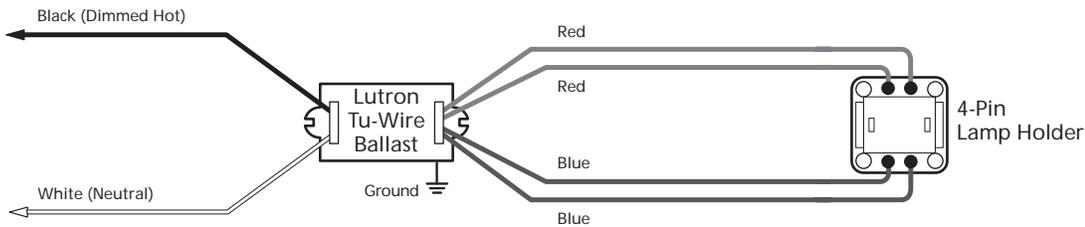


Note: Ballast-to-lamp wire lead lengths must not exceed 7.00' (2.13m) for all wiring scenarios shown above.

# APPENDIX: WIRING DIAGRAMS

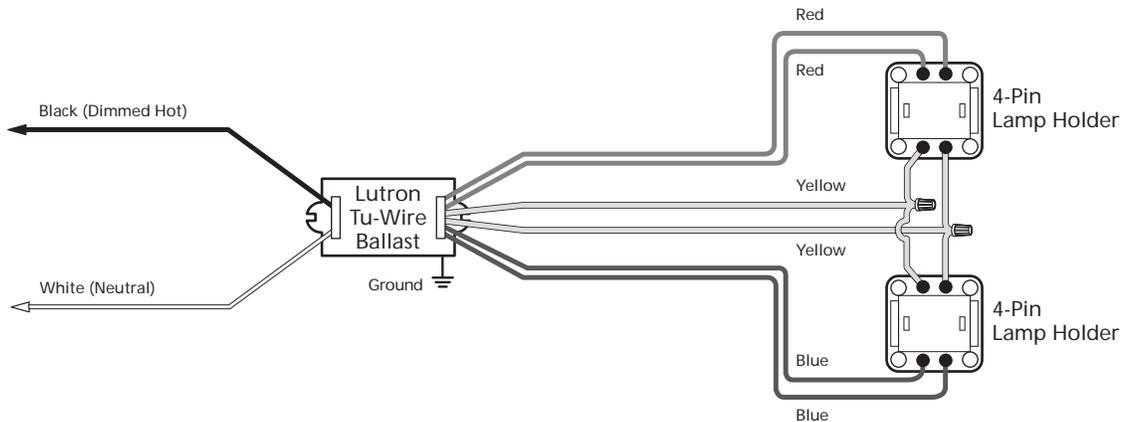
## T4 1-Lamp 2-Wire Control Method

One Lamp Compact Fluorescent



## T4 2-Lamp 2-Wire Control Method

Two Lamps Compact Fluorescent



Note: Ballast-to-lamp wire lead lengths must not exceed 3.00' (0.91m) for all wiring scenarios shown above.

## GLOSSARY

**Ballast** An electrical device used in fluorescent and HID fixtures. It furnishes the necessary circuit conditions (voltage, current, and waveform) for starting and operating a lamp.

**Ballast Factor** A ballast's light output with respect to a reference ballast's light output. The reference ballast is a ballast which produces full light output as defined by the American National Standards Institute (ANSI). Ballast factor is expressed in percentage form (e.g., 0.95 or 95%).

**CSA Certified** Indicates that the product has been evaluated and undergoes continual assessment by CSA International to comply with safety standards established by the Canadian Standards Association.

**Compact SE™** A Lutron high-frequency, solid-state electronic fluorescent dimming ballast for compact fluorescent lamps with a dimming range of 100% to 5%.

**Current Crest Factor** The ratio of the peak value of lamp current to the root-mean-square (RMS) value of lamp current.

**Dentori T-Mark** A registration mark indicating compliance with the Japanese Dentori technical requirements. Similar to UL.

**Eco-10™** A Lutron high-frequency, solid-state electronic fluorescent dimming ballast with a dimming range of 100% to 10%.

**Filament** In fluorescent lamps, the filaments are designed to emit electrons to sustain the arc.

**Filter** An electrical circuit (capacitor and inductor) intended to reduce radio frequency interference (RFI) and lamp buzz. Most Lutron ballasts and dimmers incorporate a filter circuit.

**Fluorescent Lamp** A low-pressure gas-filled electric discharge lamp in which a fluorescent coating (phosphor) transforms ultraviolet radiation into visible light.

**Footcandle** Defines the quantity of illumination on a surface or object, 1 footcandle = 1 lumen per square foot.

**Hi-lume®** A Lutron high-frequency, solid-state electronic fluorescent dimming ballast with a dimming range of 100 to 1% (100 to 5% for T5 twin tube lamps).

**“Hot” Wire** The black wire which is connected to the line voltage (with respect to neutral).

**Incandescent Lamp** An electric lamp in which a filament gives off light when heated by an electric current.

**Inrush Current** The current flow occurring at the instant of turn-on. (The level of inrush current depends on the load type and can be substantially higher than the normal operating current.) All Lutron ballasts incorporate inrush current limiting circuitry.

**Instant-Start Lamp** A class of fluorescent lamps which do not require filament preheating and can start instantly. Lutron dimming ballasts cannot be used with instant-start lamps.

**Intensity** The brightness of a lamp as a percentage of maximum brightness (e.g., 66% intensity describes a lamp dimmed to 2/3 of its maximum brightness).

**KWH (Kilowatt hour)** A unit of energy equal to one kilowatt of power expended for one hour.

**Lamp** A device for producing light (such as a bulb or tube).

**Line Voltage** The voltage between the lines of a supplying power system.

**Load** The device which a dimmer is controlling (i.e., incandescent lamp, ceiling fan, fluorescent lamp).

# GLOSSARY

**Low-end Trim** Adjustable setting on a dimmer that establishes its minimum output, therefore, establishing minimum light level.

**Lumen** The quantity of light that is emitted by a lamp, used in reference to efficacy (lumens per watt).

**Luminance** Describes the light emitted or reflected from a source or object in a particular direction. Luminance produces the sensation of brightness and is measured in candelas per square foot (or square meter) of a source or object surface area in the direction of viewing.

**Lux** 1 lux = 1 lumen per square meter.

**Phase Control** A common method of dimming that removes part of the line cycle, therefore reducing the RMS voltage.

**Power Factor** Ratio of the average power delivered to the lamp ballast system to the product of voltage and current (the ratio of the average power to the VA). This shows how effectively available power is being used.

**Radio Frequency Interference (RFI)** Electrical noise that may be picked up by sensitive audio and radio equipment. Lutron builds filters into every control and ballast to reduce this noise. Also called electromagnetic interference (EMI). See filter.

**Rapid-Start Lamp** A class of fluorescent lamps having filaments which must be constantly heated by an external circuit.

**Source** Refers to the type of lamp, (e.g., fluorescent, incandescent, low voltage, HID, etc.).

**Square Law Dimming** Dimming with a direct correlation between the position of the slider and the perceived light level (e.g., if the slider is halfway down the travel, the perceived light level is 50%). With Square Law Dimming, gradual movement of the linear slider results in a proportional change in the perceived light level—allowing for easy, precise adjustment of the light level setting.

**T4** A fluorescent lamp which has a diameter of 1/2" (12.7mm).

**T5** A fluorescent lamp which has a diameter of 5/8" (15.9mm).

**T8** A fluorescent lamp which has a diameter of 1" (25.4mm).

**T12** A fluorescent lamp which has a diameter of 1 1/2" (38.1mm).

**Tu-wire®** A Lutron high-frequency solid-state electronic fluorescent dimming ballast requiring only two wires (neutral and dimmed-hot) for operation.

**TVE** A Lutron high frequency solid-state electronic fluorescent dimming ballast compatible with 0-10 VDC dimmers and dimming systems.

**3-Way Dimming** 3-Way dimming control (as opposed to single-pole, multi-location, or **Omnislide™** control) allows dimming from one location only (using a 3-way dimmer) and on/off switching from a second location (using a 3-way switch).

**Total Harmonic Distortion (THD)** The total amount of current at frequencies other than 60 Hz (the main frequency), expressed as a percent of the 60 Hz current. No power is delivered to the load by current at these other frequencies.

**UL Listed** Indicates that the product has been evaluated and undergoes continual assessment by Underwriters Laboratories Inc. to comply with safety standards established by Underwriters Laboratories Inc.

# BALLAST WARRANTY

Lutron warrants each new ballast for a period of three years from the date of shipment, to be free from defects in materials or workmanship under conditions of normal use when installed and operated under Lutron product specifications and in accordance with the applicable National Electrical Code and Safety Standards of Underwriters Laboratories. Lutron shall, at its option, repair or replace any defective unit that, in its opinion, has been properly installed, wired, insulated, used and maintained, provided that Lutron shall not be required to remove, install or re-install any defective unit and provided that Lutron is promptly notified of said defect within the aforementioned warranty period. The foregoing warranty and optional remedies are exclusive and, except for the foregoing warranties, THERE ARE NO EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY OR OF ANY OTHER TYPE. In no event shall Lutron or any other seller be liable for consequential or special damages, nor for any repair work undertaken without its prior consent, nor shall Lutron's liability on any claim for damages arising out of or connected with the manufacture, sale installation, delivery or use of said unit ever exceed the price paid therefor. Lutron will not be responsible for any ancillary equipment not furnished by Lutron which is attached to or used in connection with the ballast, or for operation of the ballast with any ancillary equipment and all such equipment is expressly excluded from this warranty. Furthermore, Lutron will not be responsible for any damage to the ballast resulting from the use of ancillary equipment not furnished by Lutron for use with the ballast.

Lutron Electronics Company, Inc., reserves the right to make improvements or changes in its products without prior notice. Although every attempt is made to ensure that this information is accurate and up-to-date, please check with Lutron to confirm product availability, latest specifications, and suitability for your application.

Lutron ballasts may be covered by one or more of the following U.S. patents: 4,663,570; 4,728,866; 4,894,587; B1 5,001,386; B1 5,041,763; 5,055,742; 5,144,205; 5,173,643; 5,224,029; 5,555,150; 5,841,239; 5,864,212; 5,962,979; 6,111,368; 6,452,344; and corresponding foreign patents. Other U.S. and foreign patents may be pending.

Lutron, Hi-lume, the sunburst design, and Tu-Wire are registered trademarks, and Eco-10, Compact SE and Omnislide are trademarks of Lutron Electronics Co., Inc.

Optional field commissioning service available — extends warranty to 8 years (limited).

## **Lutron – Lighting the Way Since 1961**

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