

Maintaining Optimal Performance when Upgrading Fluorescent Fixtures with Lutron Dimming Ballasts to TLEDs

Many customers are upgrading their legacy fluorescent dimming ballasts and lamps to LEDs for improved lamp life, lowered energy usage, and improved light quality. These fluorescent-to-LED upgrades, commonly called TLEDs, must be carefully planned in order to:

- a. Minimize installation costs
- b. Minimize any negative impact on the space
- c. Minimize any impact on any existing dimmers or control systems

Without installing new fixtures, these upgrades fall into three options:

1. Using new TLED lamps with existing dimming ballasts (UL® type A retrofits);
Note: Lutron does not endorse any TLED product that re-uses the existing fluorescent ballast
2. Using new TLED lamps with new LED drivers without changing the control system (UL® type C retrofits);
3. Using the new TLED lamps with new drivers AND updating the control system (see Wireless Control Upgrades – page 7)

This application note focuses on option 2 – correctly identifying and upgrading existing installations of Lutron dimming ballasts and fluorescent lamps in order to upgrade them with Lutron LED drivers with TLEDs. This is commonly called a “UL Type C” retrofit: both the fluorescent ballast and lamp are being replaced by an LED driver and a TLED lamp.

The goal of this document is to explain the various TLED upgrades available, based on the existing ballast and control system being used, in order to maximize the dimming performance of the new TLEDs and minimize the impact on an existing Lutron control system. In some cases, the upgrade options may even allow a customer to enhance the performance of their legacy control systems.

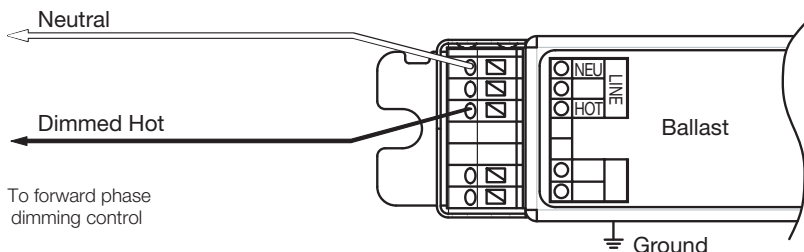
As background, it is useful to review the whitepaper “[TLED Lighting Scenarios for Retrofit Applications](#)” (PN 367-2689), which discusses the various types of TLED upgrades.

Dimmer Control Technologies¹

Most Lutron fluorescent dimming ballasts are controlled by three control types:

2-wire Analog Phase control (Lutron name “Tu-Wire”)

Two-wire controlled ballasts were frequently used in simple 120 V~ control applications where existing wire was already present as they utilize the same wiring as non-dimmable ballasts. Two-wire controlled ballasts have two wires between the dimmer control and the ballast: Dimmed Hot and Neutral. This control method was also used by other ballast manufacturers, such as the Philips® Advance Mark 10® series of ballasts.

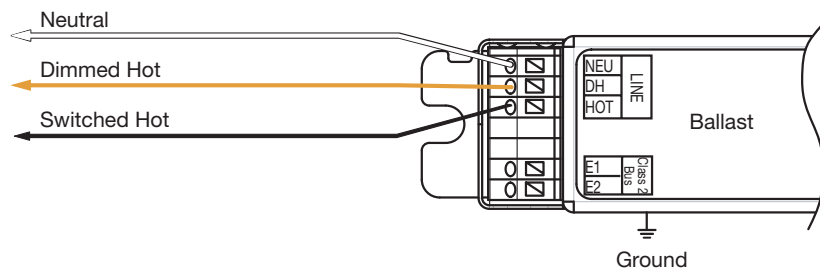


3-wire Analog Phase Control

Since 1974, Lutron promoted our 3-wire controlled ballasts widely in commercial installations, as they allow for large numbers of dimming ballasts to be used without adverse effects on power line quality. They are also capable of dimming to low light levels, as low as 1%.

In this 3-wire scenario, there are three wires that run from the dimmer control to the ballast:

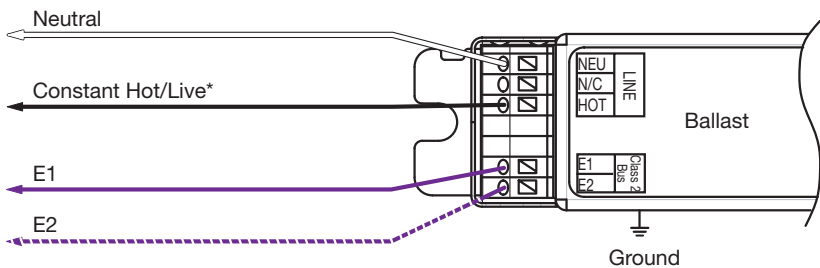
1. Switched Hot (provides on/off power to the load), usually red or black colored wire
2. Dimmed Hot (provides a line voltage phase-cut signal, but does not deliver power), usually orange colored wire
3. Neutral



EcoSystem Digital

EcoSystem controlled ballasts utilize four wires for power and control: a two-wire digital communications bus (E1/E2, usually purple-colored wire) connected to up to 64 ballasts over a single pair of wires, and power on a separate pair of line-voltage wires (Hot/Neutral) directly from a circuit breaker panel. The power and bus link can be run separately or in the same conduit; the wiring is topology free and polarity insensitive.

EcoSystem ballasts are used to create a flexible, digitally-controlled lighting system that is capable of being re-zoned without any wiring changes.



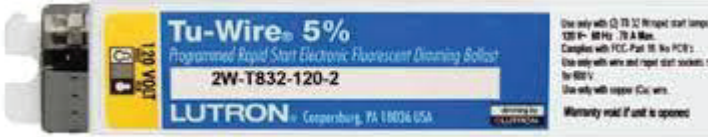
¹ All descriptions presume a ground wire is also connected to each ballast; it is not included in the wire descriptions.

Lutron Ballast Families¹


Lutron has a variety of ballast families that have been sold in the past. Just by looking at a ballast label and model number, you can determine which control type(s) the ballast supports and the dimming performance (for example, low end light level of 10%, 5%, or 1%). After confirming the wiring to the fixture, as explained in the previous section, you can identify the control type being used.

Note: Images are for illustrative purposes only, and may vary based on the age or specific model of the ballast.

“Tu-Wire” Ballasts

| | |
|-------------------------------|--|
| Model number prefix: | 2W- |
| Example Image: |  |
| Voltages supported: | 120 V~ |
| Control input supported: | 2-wire (Dimmed Hot/Neutral) |
| Low end dimming level: | 5% |
| Compatible LED Driver family: | Hi-lume 1% 2-wire LED driver (LTE prefix) |
| Notes: | <ol style="list-style-type: none"> 1. Tu-Wire ballasts are capable of dimming only to 5% low end light level. LTE 2-wire drivers are capable of dimming down to a 1% light level. Depending on the control system being used, a low-end trim setting may be adjusted higher to match the 5% light level of a Tu-Wire ballast, if desired. 2. It may not be possible to put as many LTE drivers on a control as there were Tu-Wire ballasts. Please confirm maximum LTE driver count for the control being used by referencing the Compatible Controls table on the Hi-lume 1% LTE Driver spec sheet (P/N 369543) on www.lutron.com |


“Eco-10” Ballasts

| | |
|-------------------------------|--|
| Model number prefix: | EC3- or ECO- |
| Example Image: |  |
| Voltages supported: | 120–277 V~ |
| Control input supported: | 3-wire (Dimmed Hot/Switched Hot/Neutral) |
| Low end dimming level: | 10% |
| Compatible LED Driver family: | Hi-lume 1% 3-wire LED driver (L3DA prefix) |
| Notes: | L3DA drivers are capable of dimming down to a 1% light level. Depending on the control system being used, a low-end trim setting may be adjusted higher to match the 10% light level of an ECO-10 ballast, if desired. |


¹ All descriptions presume a ground wire is also connected to each ballast; it is not included in the wire descriptions.

Lutron Ballast Families (continued)¹

“Hi-lume” Ballasts

| | |
|-------------------------------|--|
| Model number prefix: | FDB- or HL3- |
| Example Image: |  |
| Voltages supported: | 120–277 V~ |
| Control input supported: | 3-wire (Dimmed Hot/Switched Hot/Neutral) |
| Low end dimming level: | 1% for linear lamps; 5% for compact fluorescent lamps |
| Compatible LED Driver family: | Hi-lume 1% 3-wire LED driver (L3DA prefix) |
| Notes: | <ol style="list-style-type: none"> 1. For linear lamps, the L3DA driver is a drop-in replacement for the Hi-lume ballast; no control system adjustments are necessary. 2. For compact fluorescent lamps, the Hi-lume family of ballasts are capable of dimming only to 5% low-end light level. The L3D drivers dim down to a 1% light level. Depending on the control system being used, a low-end trim setting may be adjusted higher to match the 5% light level of a Hi-lume ballast, if desired. |


“EcoSystem” Ballasts

| | |
|-------------------------------|---|
| Model number prefix: | EC5- or EC3D- |
| Example Image: |  |
| Voltages supported: | 120–277 V~ |
| Control input supported: | Digital EcoSystem (Hot/Neutral/E1/E2) or 3-wire (Dimmed Hot/Switched Hot/Neutral) |
| Low end dimming level: | 10% |
| Compatible LED Driver family: | EcoSystem control: 5-Series LED driver (5% low end; LDE5 prefix) 3-wire control: Hi-lume 1% 3-wire LED driver (1% low end; L3DA prefix) |
| Notes: | <ol style="list-style-type: none"> 1. The EcoSystem family of ballasts can be controlled via an EcoSystem or 3-wire control. If 3-wire control was being used, then only L3DA drivers can act as a replacement. 2. The EcoSystem family of ballasts are capable of dimming only to 10% low-end light level. 5-Series LDE5 drivers with soft-on and fade-to-black dim down to 5% light level, and Hi-lume 1% LDE1 drives have soft-on and fade-to-black and dim down to 1% light level. Depending on the control system being used, a low-end trim setting may be adjusted higher to match the 10% light level of an EcoSystem ballast, if desired. 3. Many models of the EcoSystem family of ballasts were capable of powering sensor controls connected directly to the ballast. Lutron LED drivers do NOT have integral connections for controls; see Appendix A for details. 4. If digital EcoSystem control is used, see Appendix B for notes on addressing EcoSystem drivers/ballasts. |


¹ All descriptions presume a ground wire is also connected to each ballast; it is not included in the wire descriptions.

Lutron Ballast Families (continued)¹

“Hi-lume 3D” Ballasts

| | |
|-------------------------------|--|
| Model number prefix: | H3D- |
| Example Image: |  The image shows a Hi-lume 3D ballast, model H3D T832 C UNV 2 17. It is a rectangular device with a blue and white label. The label includes the text 'Hi-lume 3D H3D T832 C UNV 2 17', 'Programmed Rapid Start 1% Electronic Fluorescent Dimming Ballast', and 'Multiple Control Input'. It also features a warning: 'Use only with two 32 W T8 rapid start lamps. 120/277 V~ 60 Hz 0.667/0.278 A Max. Complies with FCC Part 15 - for PCBs. Use only with wire and rapid start sockets rated for 600 V. Use only within an electrical enclosure. Ballast and fixture must be grounded. To remove wire, pinch bottom on top of connector and pull wire. Warranty void if unit is opened.' There are also UL and SF logos. |
| Voltages supported: | 120–277 V~ |
| Control input supported: | Digital EcoSystem (Hot/Neutral/E1/E2) or 3-wire (Dimmed Hot/Switched Hot/Neutral) |
| Low end dimming level: | 1% |
| Compatible LED Driver family: | EcoSystem control: Hi-lume 1% driver with Soft-On/Fade-to-Black (LDE1 prefix) 3-wire control: Hi-lume 1% 3-wire LED driver (L3DA prefix) |
| Notes: | <ol style="list-style-type: none"> Hi-lume 3D ballasts can be controlled via EcoSystem or 3-wire control. If 3-wire control is installed, then L3DA drivers should be used as a replacement; if an EcoSystem control is installed, then the LDE1 driver should be used. If an EcoSystem control is used, see Appendix B for notes on addressing EcoSystem drivers/ballasts. |

“EcoSystem H-Series” Ballasts

| | |
|-------------------------------|---|
| Model number prefix: | EHD- |
| Example Image: |  The image shows an EcoSystem H-Series ballast, model EHD T528MU210. It is a rectangular device with a blue and white label. The label includes the text 'LUTRON. lutron.com', 'EcoSystem H-Series EHD T528MU210', and 'Programmed Rapid Start / Programmed Rapid Start 1% Electronic Fluorescent Dimming Ballast'. It also features a warning: 'Use only with two 32 W T8 rapid start lamps. 120/277 V~ 60 Hz 0.667/0.278 A Max. Complies with FCC Part 15 - for PCBs. Use only with wire and rapid start sockets rated for 600 V. Use only within an electrical enclosure. Ballast and fixture must be grounded. To remove wire, pinch bottom on top of connector and pull wire. Warranty void if unit is opened.' There are also UL, R6HS, and FC logos. |
| Voltages supported: | 120–277 V~ |
| Control input supported: | Digital EcoSystem (Hot/Neutral/E1/E2) |
| Low end dimming level: | 1% |
| Compatible LED Driver family: | Hi-lume 1% driver with Soft-On and Fade-to-Black (LDE1 prefix) |
| Notes: | See Appendix B for notes on addressing EcoSystem ballasts |

¹ All descriptions presume a ground wire is also connected to each ballast; it is not included in the wire descriptions.

Available TLED Solutions

Retrofit LED lamps are designed to match the large variety of shapes and lengths of existing fluorescent lamps. Suitable TLED UL Type C solutions that are available with Lutron drivers are available from several manufacturers. **Note that Lutron offers a warranty on our drivers only and does not make any warranty or performance guarantees for third-party products.** It is up to the installer and manufacturer of any retrofit solution to ensure the ultimate suitability for the application, including any environmental (temperature, humidity, etc.) considerations. Lutron is not responsible for installations that do not meet our driver's specifications.

Light Efficient Designs (LED-LLC)/Remphos

The Remphos brand from Light Efficient Design offers a broad selection of TLED lamps for replacing fluorescents, including T5 HO and T5 HE (2-foot, 3-foot, and 4-foot), T8 (2-foot, 3-foot, and 4-foot), PLL/BIAX, and pin-based CFL with a variety of different Lutron driver options. See the following spec sheet on www.led-llc.com:

- See “Lutron Retrofit Solutions” sheet to show available TLEDs for Lutron systems retrofits at www.led-llc.com/retrolutron

GE

GE's Type C TLED solution is available in T8 and T5 2-foot and 4-foot lengths, multiple color temperatures, and various lumen outputs. Their lamps are compatible with a wide variety of Lutron drivers, including EcoSystem, 2-wire, and 3-wire controls (check with GE for availability details). See the following spec sheets on www.currentbyge.com for details, or see your local GE representative or distributor:

- [T5 TLED lamps](#)
- [T8 TLED lamps](#)

Note that these GE TLED solutions have a 1000 piece minimum buy quantity, and are made-to-order. Contact GE for lead time details.

Other Solutions

Different manufacturers offer other solutions for retrofitting existing fluorescent fixtures with LEDs which do not require TLEDs. These are often called LED retrofit kits, and may involve installing a subplate within the fixture, or employ other methods beyond just TLEDs. In some cases, it may make sense to entirely replace the existing fluorescent fixture and replace it with a new LED fixture. Some LED retrofit kits also offer Lutron Vive wireless control options that allow an upgrade from any fluorescent ballast, whether dimmable or non-dimmable. Examples of all these solutions can be found at www.lutron.com/findafixture, and should follow the same guidelines found in this application note.



Figure 1: Remphos LED replacement offering



Figure 2: GE TLED solution

Wireless Control Upgrades

In many cases, it may make sense to use TLEDs as a lighting upgrade and to also retrofit an existing wired control solution with Vive, a wireless-controlled system, especially if:

- a. The control type of the desired LED driver is not compatible with the available existing electrical wiring, or;
- b. A code compliance requirement for occupancy/vacancy sensors and/or daylight sensors needs to be addressed

All of the methods described allow re-using existing electrical wiring and eliminates the existing (wired) control system. Adding a new Lutron wireless Vive enables communication with wireless fixture controls. Besides an existing constant-hot power feed, no additional wires are required to be run to the fixture.

1. Using a TLED and an EcoSystem driver with a Vive EcoSystem PowPak

This option allows any EcoSystem driver to be controlled with an EcoSystem PowPak, model number FCJS-ECO. The PowPak can be mounted on a knockout on the outside of the fixture, which requires access to the top exterior side of the fixture, or a nearby junction box. See the PowPak Wireless Fixture Control Design application guide (P/N 048620) at www.lutron.com for details. See the PowPak Wireless Fixture Control Design and Application Guide (P/N 048620) at www.lutron.com for details.

2. Using a TLED and a 0-10V driver (by others) with a Vive 0-10V PowPak

This option allows any 0-10V driver to be controlled with a 0-10V PowPak, model FCJS-010. The PowPak can be mounted on a knockout on the outside of the fixture, which requires access to the top exterior side of the fixture, or on a nearby junction box. See the PowPak Wireless Fixture Control Design and Application Guide (P/N 048620) at www.lutron.com for details.

Note that Lutron does not make any 0-10V drivers, so the driver must be provided by others, and Lutron cannot guarantee the compatibility nor the dimming performance of drivers provided by others.

3. Using a TLED and an EcoSystem driver with a Vive Integral “In-Fixture” Controller

Lutron’s Integral “In-Fixture” Controller is available to all Lutron OEMs and allows wireless control of EcoSystem and DALI-compatible drivers. The In-Fixture Controller is not designed for field installation, so this option is most likely to be feasible only if there are plans to use an LED Retrofit Kit that offers the Vive In-Fixture Controller option, or one plans to replace the entire fixture. See www.lutron.com/findafixture for a list of fixtures available with a Lutron wireless in-fixture controller.

Custom Ballast Factors (CBF)

Lutron has historically offered a line of ballasts with a custom ballast factor, indicated by a “-Cxx” suffix (where xx represents an integer) on the model number of the driver. These ballasts had a lower available lumen output at their high-end and were used to tune the maximum available amount of light to a value that was more suitable to the application. Thus, energy could be saved by not providing more light than necessary.

While there is no direct LED driver replacement for ballasts that have been programmed with a custom ballast factor, it is important to consider the effect that use of a custom ballast factor had on the completed fixture and lighting design. In many cases, a mockup installation of one (or more) fixtures is highly recommended to ensure the end result is satisfactory.

- Custom ballast factor ballasts had lower input current than their standard ballast factor equivalent. Therefore, it's important that any replacement LED driver has the same or lower input current as the ballast being replaced (to prevent potential breaker overload). This isn't usually a problem, as LED drivers often take a lower input current for an equivalent amount of delivered light); however, this must be confirmed by the installer during installation..
- The maximum light output of a custom ballast factor ballast is proportional to the ballast factor printed on the ballast. For example, a ballast with a custom ballast factor of 0.75 (listed as -C75 on the ballast) will have a maximum output that is only 75% of a standard ballast.
- TLEDs often have an increased brightness (perceived and/or measured) than the fluorescent lamps they're replacing. This could be due to the more directional nature of the light or increased light quality inherent with LEDs.

There are several potential solutions for replacing custom ballast factor ballasts with LEDs:

1. Use a driver with a lower output current

This allows a driver to mimic the reduced output of a custom ballast factor ballast. For example, if a standard driver being used with a particular TLED solution has a maximum output current of 1000 mA, and it's being used in an application where a ballast has a custom ballast factor of 0.75, then a 750 mA driver could be used instead.

Whether or not a custom driver current could be used is up to the manufacturer of the TLED lamp. Contact them to see if this solution is available for the TLED solution being considered.

2. Reduced high-end trim

In this case, adjustments are made to the programming of the control system to reduce the maximum high end via software. Not all Lutron controls provide the ability to adjust the high-end trim of a load (e.g., most wall-box dimmers do not provide this function).

See the instructions for the Lutron control system being used to determine whether high-end trim is an available option, or contact Lutron Customer Assistance for more information.

3. Other options

Finally, depending on the custom ballast factor currently installed, and the lumen output of the TLED lamps being considered, it may be possible to use a TLED solution which matches the reduced lumen output of the fluorescent lamp.

If multiple lamps in a fixture are being replaced, it may make sense to consider installing fewer TLED lamps than there are existing fluorescent lamps (for example, only installing two TLED lamps in a three-lamp fluorescent fixture).

Appendix A: Options for replacing existing fluorescent dimming ballasts that use integral sensor connections

There are no LED drivers which support integral sensor connections, as Lutron's "EcoSystem" ballast family did. Therefore, if there are applications where sensors are wired directly to "EcoSystem" ballasts, an alternate method will need to be used to get the sensor data into the control system.

Several options are available, but we strongly suggest coordinating with a local Lutron representative and planning on a Lutron Field Service field service visit:

1. For systems that do not utilize a QS Link (for example, our legacy GRX or OMX links to connect keypads back to the control system), a C5-BMJ-2A must be added to the EcoSystem link and used to connect the sensors. The output of the C5-BMJ-2A must then be connected via a 3-wire connection to an L3DA driver (such as those used to replace Hi-lume or Eco-10 ballasts).
2. For systems that utilize a QS link, or systems that can be upgraded to support a QS link, an Energi Savr Node (ESN) or QS Sensor Module (QSM) can be added to connect the existing wired sensors. This will require reprogramming of the control system to support the new sensor connections.
3. If necessary, the wired sensors and controls could be replaced with wireless sensors and Picos. Then, either a QSM could be used to get the sensor data on to the QS link, or the control system could be upgraded to Vive. See the section on Wireless Upgrades for more details.

Appendix B: Commissioning new digital EcoSystem devices

Lutron's digital-controlled EcoSystem drivers and ballasts give contractors a high degree of installation freedom, while giving facility owners and managers the ability to easily reprogram how their space operates as their needs change.

To achieve this functionality, each EcoSystem device is given a software-based address, allowing it to be individually recognized and controlled as part of a Lutron lighting control system.

All EcoSystem devices come unprogrammed from the factory and must be given a new software-based address when added into a system. This is especially true when existing EcoSystem ballasts are replaced with EcoSystem drivers as part of a TLED retrofit. The procedure for addressing EcoSystem devices varies by system. In some cases, new EcoSystem devices can be addressed by the end user or installer as part of the TLED retrofit operation; with larger systems, like Quantum, a Lutron field service technician visit may be necessary to properly commission the system. When considering a product that involves retrofitting EcoSystem controls, please contact your local Lutron representative to discuss the most appropriate commissioning method for your installation.

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