



Residential Systems Control of LED Lighting (120V)

1.0 Overview

Light Emitting Diode (LED) lighting is becoming more prevalent in the marketplace and is often being implemented in residences in place of less efficient lighting load types. Demand will continue to increase for the high efficacy LED lighting and it is as important as ever to understand the various types of LED technology and how Lutron's Residential System product families control these technologies. This application note will discuss which Residential Systems controls can be used with specific LED technologies available in the market.

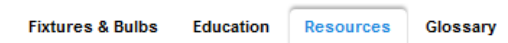
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2.0 LED Tools and Resources

Throughout this application note, various LED and Lighting Control technologies will be referenced such as 0-10V dimming, DMX 512, forward and reverse phase control. For more detailed information on these technologies, please refer to the *Controlling LEDs* White Paper (p/n 367-2035) which is available at www.lutron.com/led, by clicking on the White Papers link under the Resources tab of the LED light sources page.

LED



Resources

Lutron is striving to educate the LED industry about the importance of lighting control and the compatibility issues that exist in the market today. Lutron is providing this education through webinars, conference sessions, magazine editorials, and more.



It is also important to note that Lutron performs its own LED testing with lamps/fixtures from a multitude of 3rd party manufacturers. Lamps/fixtures that pass the full set of testing and meet the technical and performance requirements are deemed “Recommended.” Recommended lamps/fixtures are then placed into the LED Product Selection tool, along with their Report Cards which detail product specific performance. The Product Selection Tool is a drop down menu selection tool which can help one find Recommended lamps/fixtures based on Lamp Manufacturer, Lamp/Fixture type, or even Lutron product family. The Product Selection Tool is located at www.lutron.com/ledtool.

A video on how to use the tool can be found in the LED section of lutron.com. Click [here](#) to view the video.

3.0 LED Technology and Residential Systems Applications

This section focuses on the specific variations of LED technologies which are prevalent in the market today and how the technologies interact with RadioRA 2 and Homeworks QS products. For more information on specific LED technology variations, as well as Product Compatibility, please visit www.lutron.com/led.

3.1 Line Voltage LED Control with Integrated Drivers (LEDi)

LED lamps/fixtures with integrated drivers are common. Many are direct replacements of incandescent lamps with the driver residing in the base of the lamp itself. In these cases, the dimmer is actually sending a signal to the driver which subsequently controls the lighting element. The driver technology varies greatly from lamp to lamp. Some integrated drivers work well with forward phase, triac-based dimmers, while others perform better with reverse phase dimming.

The following chart displays the wall mounted dimmers which are UL Listed to control up to 150W of recommended LED lighting loads. To determine if the dimmer is compatible with specific LEDi lamps, refer to the LED Product Selection Tool at www.lutron.com/ledtool.

RadioRA 2	HomeWorks QS (120V)
RRD-6NA	HQRx-6NA
RRD-6CL	HQRx-6ND
RRD-10ND	HQRx-6CL
	HQRx-10ND
	HWx-6ND
	HWx-10ND

The following chart displays the wall mounted dimmers which are UL Listed to control up to 250W of recommended LED lighting loads. To determine if the dimmer is compatible with specific LEDi lamps, refer to the LED Product Selection Tool at www.lutron.com/ledtool.

RadioRA 2	HomeWorks QS (120V)
RRT-G25LW	HQRT-G25LW
RRT-GHxB	HQRT-GHxB
RRT-G5NEW	HQRT-G5NEW

The following chart displays the dimmers which are UL Listed to control up to 100W of recommended LED lighting loads. To determine if the dimmer is compatible with specific LEDi lamps, refer to the LED Product Selection Tool at www.lutron.com/ledtool.

RadioRA 2	HomeWorks QS (120V)
RRD-3LD	HQR-3LD
RRD-3PD	HQR-3PD
RRD-HNx	HQRx-HNy
RRD-Hx	HQRx-Hy

It is also possible to control these types of LED lamps with centralized dimming modules and interfaces. To determine if the dimming module is compatible with specific LEDi lamps, refer to the LED Product Selection Tool at www.lutron.com/ledtool.

RadioRA 2	HomeWorks QS (120V)
Grafik Eye QS (QSGRJ-xP)	Grafik Eye QS (QSGRx-yP)
LQRJ-WPM-6P-120	LQRJ-WPM-6P-120
	HW-RPM-4U-120 ¹
	HW-RPM-4A-120 ¹
	GP (Harrier) Card ¹

3.2 Line Voltage LED Control with External Drivers

Some LED fixtures on the market have the LED lighting element separate from the driver. The driver fits into the system similarly to that of fluorescent ballasts, mounting within the fixture. As with integrated drivers, the dimmer is actually controlling the driver, which then controls the lighting element appropriately. To determine if the dimming control is compatible with a specific LED lamp with external driver, refer to the LED Product Selection Tool at www.lutron.com/ledtool.

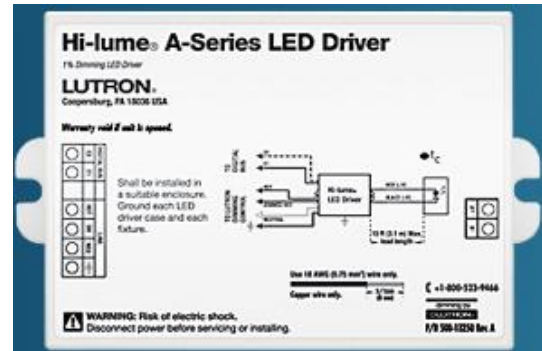
RadioRA 2	HomeWorks QS (120V)
RRD-6NA	HQRx-6NA
RRD-6CL	HQRx-6ND
RRD-10ND	HQRx-6CL
RRT-G25LW	HQRx-10ND
RRT-GHxB	HWx-6ND
RRT-G5NEW	HWx-10ND
RRD-HNx	HQRT-G25LW
	HQRT-GHxB
	HQRT-G5NEW
	HQRx-HNy

RadioRA 2	HomeWorks QS (120V)
RRD-3LD	HQR-3LD
RRD-3PD	HQR-3PD

RadioRA 2	HomeWorks QS (120V)
Grafik Eye QS (QSGRJ-xP)	Grafik Eye QS (QSGRx-yP)
LQRJ-WPM-6P-120	LQRJ-WPM-6P-120
	HW-RPM-4U-120 ¹
	HW-RPM-4A-120 ¹
	GP (Harrier) Card ¹

¹ Requires a system keypad to control the centralized lighting zones of this device

Lutron manufactures its own LED Driver, part of the Hi-lume product family. The Hi-lume A Series LED driver from Lutron offers smooth and continuous LED dimming with a 1% low end for all approved LED fixtures. The A Series driver is compatible with Lutron Ivalo lighting fixtures as well as 3rd party fixtures and is available in both constant current and constant voltage configurations. The A Series driver is available in two formats from an input standpoint: forward phase control and 3 wire control. A list of current approved 3rd party fixtures is available from www.lutron.com (p/n 368-2817). The LED Product Selection Tool, at www.lutron.com/ledtool, can also be used to determine compatibility. Many 3rd party fixtures can be ordered to ship with the Lutron driver built into the fixture.



For control of the 3 wire Lutron Hi-lume A Series LED driver, the 120/277V 3 Wire Fluorescent Dimmer can be used. The brass terminal provides a constant hot for the driver(s) while the orange control wire passes the control signal to the driver(s) in order for the driver(s) to determine the light output necessary to match the desired light level output.

RadioRA 2	HomeWorks QS (120V)
RRD-F6AN-DV	HQRx-F6AN-DV

For control of the forward phase Lutron Hi-lume A Series LED driver, neutral based Residential Systems products can be used for control. These products include both local and more centralized control options. Note that phase selectable or adaptive products must be set to forward phase.

RadioRA 2	HomeWorks QS (120V)
RRD-6NA	HQRx-6NA
RRD-10ND	HQRx-6ND
Grafik Eye QS (QSGRJ-xP)	HQRx-10ND
LQRJ-WPM-6P-120 ²	HWx-6ND
RRT-G25LW	HWx-10ND
RRT-G5NEW	Grafik Eye QS (QSGRJ-xP)
RRT-GHxB	LQRJ-WPM-6P-120 ²
RRD-HNx	HW-RPM-4U-120 ²
	HW-RPM-4A-120 ²
	GP (Harrier) Card ²
	HQRT-G25LW
	HQRT-G5NEW
	HQRT-GHxB
	HQRx-HNy

² Requires a system keypad to control the centralized lighting zones of this device

3.3 0-10V (Current Sink)

With 0-10V dimming, there are two methods for control of the LED light source. The 0-10V dimming method is determined by which device is the 0-10V source for the LED lighting. In current sinking, a driver provides the 0-10V source and a separate device controls the ballast. In our Residential Systems, there are a few ways to control this type of technology. Again, refer to the LED Product Selection Tool for a list of compatible products (www.lutron.com/ledtool).

RadioRA 2	HomeWorks QS (120V)
GRX-TVI ³	GRX-TVI ³
LMJ-5T-DV-B ⁴	GRX-TVM2 Module ⁴
	LMJ-5T-DV-B ⁴

3.4 0-10V (Current Source)

The other type of 0-10V dimming technology is called current source where the control device is providing the source to the LED lighting as opposed to a driver. Refer to the LED Product Selection Tool for a list of compatible products (www.lutron.com/ledtool).

RadioRA 2	HomeWorks QS (120V)
LMJ-5T-DV-B ⁴	GRX-TVM2 Module ⁴
	LMJ-5T-DV-B ⁴

3.5 Pulse Width Modulation (PWM) Control

PWM is a control protocol implementing a square wave signal, utilizing the corresponding on and off time ratio, within a fixed period of time per cycle, to determine the intensity level. Per IEC standards, maximum light level is obtained when providing more off time than on time. Refer to the LED Product Selection Tool for a list of compatible products (www.lutron.com/ledtool).

HomeWorks QS (120V)
GRX-PWM-250
GRX-TVM2 Module ⁴

³ Requires a neutral wire dimmer to control

⁴ Requires a system keypad to control the centralized lighting zones of this device

3.6 Digital Addressable Lighting Interface (DALI) Control

DALI is another form of low voltage lighting control that is used to send digital intensity information to an LED driver or multiple drivers. Refer to the LED Product Selection Tool for a list of compatible products (www.lutron.com/ledtool).

HomeWorks QS (120V)
GRX-TVM2 Module ⁵

3.7 EcoSystem

EcoSystem is Lutron's DALI extension, designed to ensure compatibility between all EcoSystem controls and EcoSystem ballasts and drivers. Digital information is passed from the control to the ballast or driver via a two wire communication bus or loop which can contain up to 64 ballasts or drivers. Any fixture containing an EcoSystem driver or Eco Enabled chip will be able to activate to an EcoSystem control.

HomeWorks QS (120V)
LQSE-2ECO ⁵
Grafik Eye QS (QSGRJ-xE)

3.8 DMX512 Control

DMX512 is yet another low voltage lighting protocol and integration protocol which is often utilized with Cyan-Magenta-Yellow (CMY) or Red-Green-Blue (RGB) lighting technology which utilizes three different LED colors to produce colors throughout the entire visible spectrum. Intensity values and colors used can be defined in the programming of the Lutron system. Refer to the LED Product Selection Tool for a list of compatible products (www.lutron.com/ledtool).

HomeWorks QS (120V)
QSE-CI-DMX ⁵

For more information on how to program DMX technology with a HomeWorks QS system, refer to the application note and supplementary training video located on the HomeWorks QS dealer site at <http://resi.lutron.com>. (Qualified Accounts only)

⁵ Requires a system keypad to control the centralized lighting zones of this device

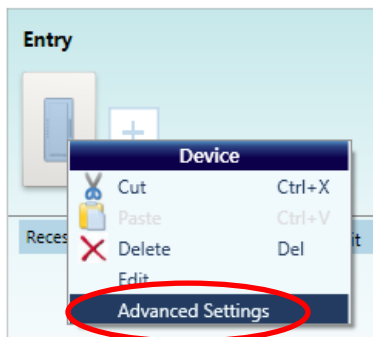
4.0 Setting High and Low End Trim

Some LED loads will require adjustments to be made to the dimming range of the dimmer in order to perform at the highest possible level for the end user. Adjustments of low end and high end trim settings of the dimming control eliminate potential undesirable issues such as flickering, shimmering, pop-on, or dead travel.

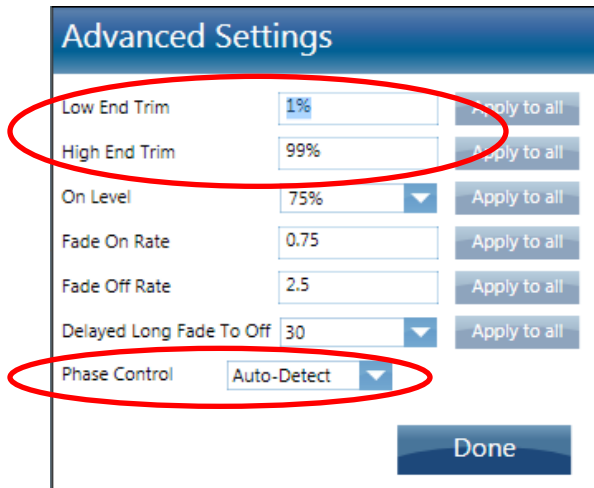
Recommended trim settings can be found, for all approved LED fixtures and loads, using the LED Product Selection Tool at <http://www.lutron.com/ledtool>. Trim settings can also be determined by on-site testing with the aid of the system programming utility. Required trim settings can be entered on a per zone basis using the system programming utility and are changed on a device level during system database transfers.

4.1 Adjusting Trim Settings in the RadioRA 2 Programming Software

Low and High end trim can be adjusted using the RadioRA 2 Programming Software on a control by control basis. To adjust these trim settings, locate the dimming control to be adjusted, within the Design tab of the software, and then right-click on the image of the control.



In the menu that appears, click on Advanced Settings.



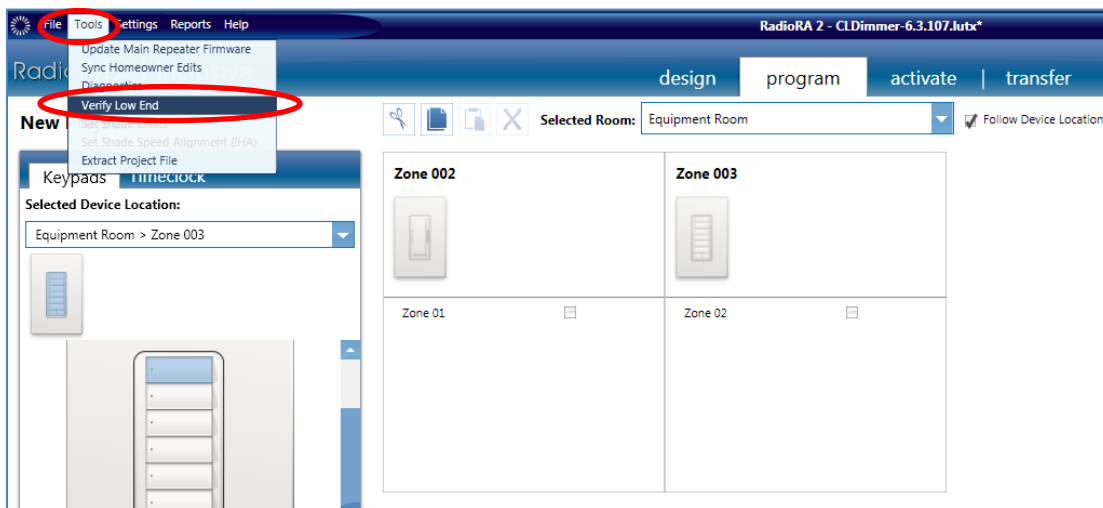
The Advanced Settings window will appear for the dimming control. Low end and high end trim settings can be adjusted here, as needed.

Some LED fixtures or lamps may require the phase control of adaptive phase control devices to be locked in either Reverse or Forward phase, as opposed to Auto-Detect. Phase control can be set in Advanced Settings. Only change this setting if directed to do so by the LED Report Card for the specific LED fixture or lamp that is being controlled.

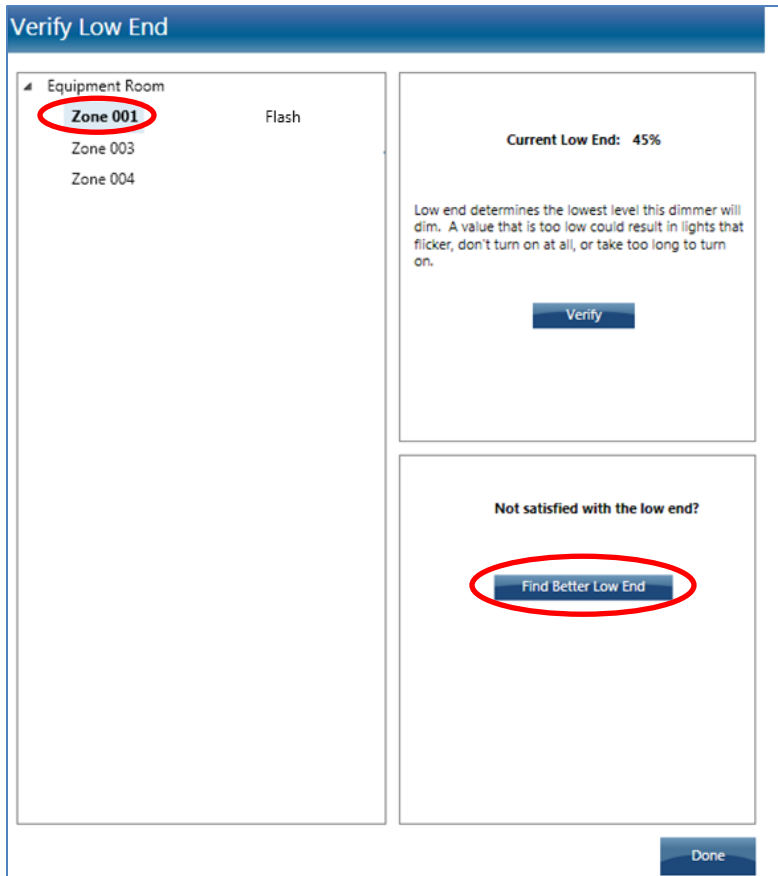
4.2 RadioRA 2 Low End Trim Tool

If a customer is not satisfied with the performance of LED lamps at low end, the RadioRA 2 Programming Software offers a tool to aid in finding an appropriate low end. This tool will allow you to modify the low end in real time to find a satisfying low end.

Locate the Verify Low End feature in the Tools menu of the software.



In the window that appears, select the lighting zone, on the left, that you would like to edit the low end trim setting for. Once the appropriate zone has been selected, click on Find Better Low End to begin the adjustment.



The low end can be tuned using the Auto Increment feature or by Fine Tuning the low end setting manually using the up and down arrow buttons in the software. Once the desired low end is achieved, click on Save Low End.

NOTE: Clicking on Save Low End passes the new Low End Trim setting to the device. A database transfer is not required.

Verify Low End

Equipment Room

- Zone 001** Flash
- Zone 003
- Zone 004

Set Dimmer Low End

1. Find low end: ?

Auto increment:

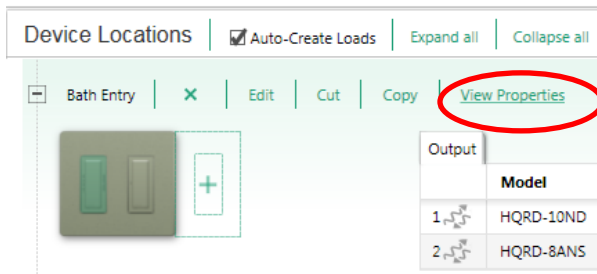
Fine tune: %

2. Verify that the bulbs can be turned on instantly at low end. This will turn your lights off and turn them back on at low end:

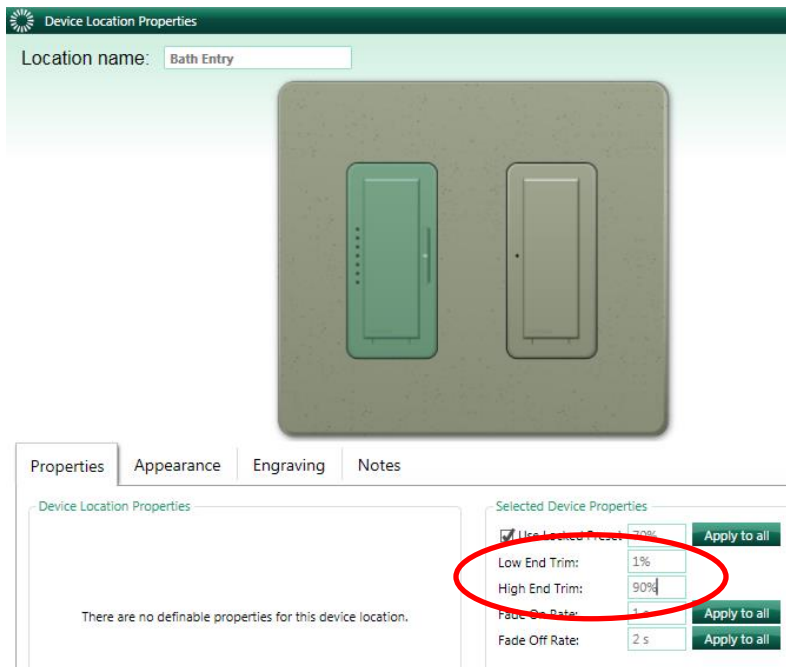
3. If your lights can be turned on instantly at low end, save this level in the database and update device:

4.3 Adjusting Trim Settings in the HomeWorks QS Programming Software

Low and High end trim can be adjusted using the HomeWorks QS Programming Software on a zone by zone basis. To adjust these trim settings, locate the dimming control to be adjusted, within the Design Controls tab of the software, and then click on View Properties for the corresponding Device Location.



The low and high end trim settings for each local dimming control can be found in the Properties tab of the Device Location Properties window.



Low and high end trim settings can also be adjusted at the load, as opposed to the control, by finding the appropriate load in the Design Loads tab of the programming software. Note that it may be necessary to use the Customize Columns menu to make the trim settings visible (check the boxes for Low and High End).

The screenshot shows the 'Design Loads' window with a table of loads. The 'High End' and 'Low End' columns are circled in red. The table has the following data:

Device Name	Assigned To	Fixture	Voltage	Load Type	Fixture Wattage	Fixture Qty	Total Watts	High End	Low End
A	...vice 1	Recessed Cans DIM - 50W MR16	120V	Magnetic Low Voltage	50	1	60	90	1

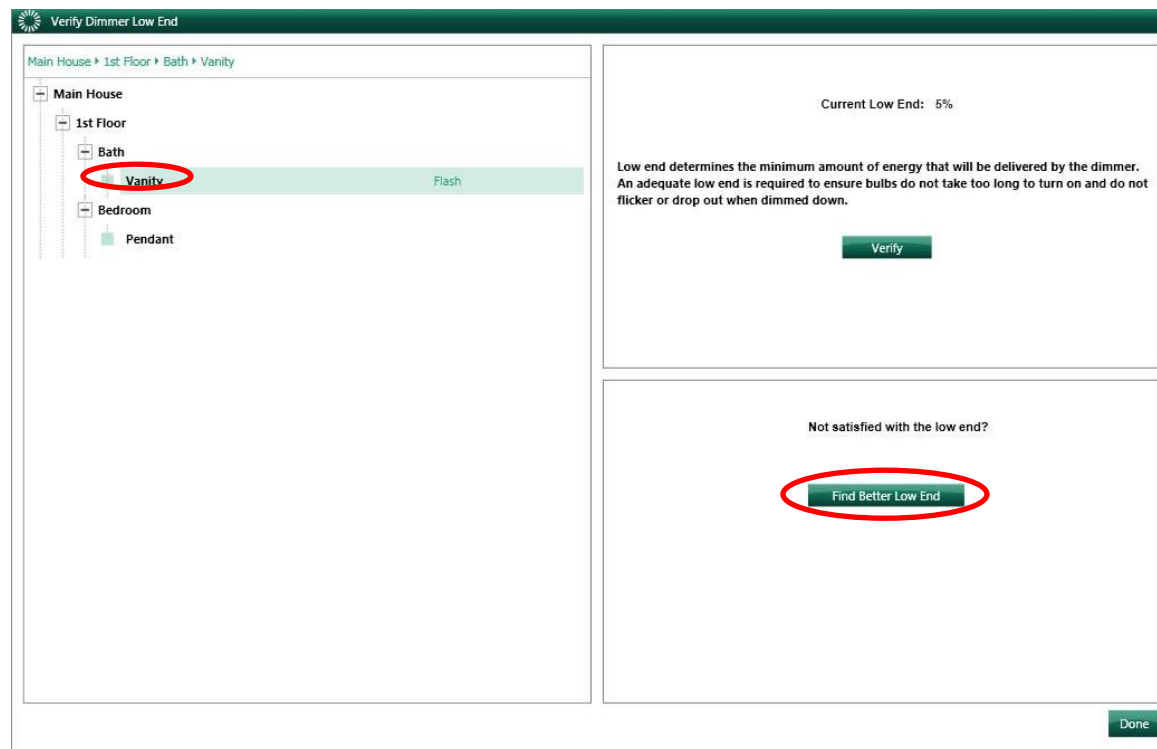
4.4 HomeWorks QS Low End Trim Tool

If a customer is not satisfied with the performance of LED lamps at low end, the HomeWorks QS Programming Software offers a tool to aid in finding an appropriate low end. This tool will allow you to modify the low end in real time to find a satisfying low end.

Locate the Verify Dimmer Low End feature in the Tools menu of the software.

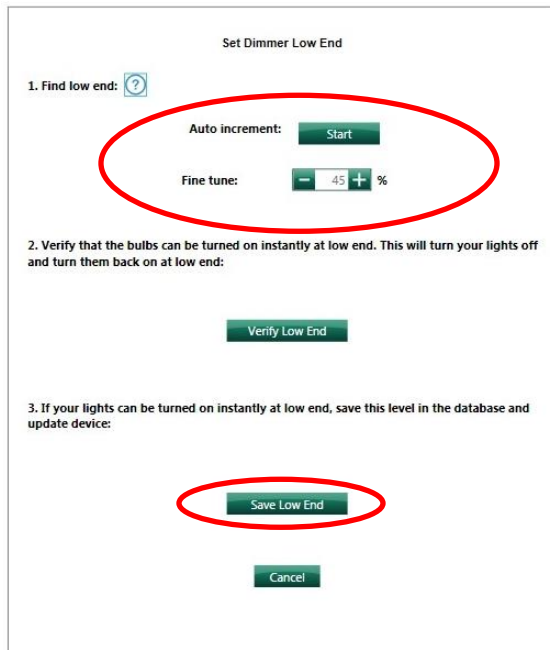


In the window that appears, select the lighting zone, on the left, that you would like to edit the low end trim setting for. Once the appropriate zone has been selected, click on Find Better Low End to begin the adjustment.



The low end can be tuned using the Auto Increment feature or by Fine Tuning the low end setting manually using the up and down arrow buttons in the software. Once the desired low end is achieved, click on Save Low End.

NOTE: Clicking on Save Low End passes the new Low End Trim setting to the device. A database transfer is not required.



5.0 Using an LUT-LBX as an Active Load

Dimming LEDs can prove to be difficult. In some instances, instability such as flickering or issues (particularly at low end) with the LED load can be corrected by adding a simulated resistive load into the dimming control output circuit. Lutron manufactures an active load device, the LUT-LBX. The LUT-LBX is a 10W solid state load which simulates a 50W resistive load on the output of the dimming control.

LED loads will meet the minimum load requirements while in the ON or conducting state but, when attempting to turn the LED load OFF, can pose minimum load issues for the dimming control. This issue often manifests itself when the LED load never fully turns off even when the dimming control is sent into the OFF state. The LUT-LBX provides more than enough simulated resistive load to meet the minimum load requirements of all Lutron dimming controls.

The LUT-LBX must be either surface or recessed mounted. Surface mounting would require a provided junction box (Lutron P/N 241-496). For more information, refer to the specification submittal document: <http://www.lutron.com/TechnicalDocumentLibrary/LUT-LBX-1.pdf>.

6.0 FAQs

If the information contained on the packaging indicates that the LED lamp is dimmable, does that mean that it will be compatible with Lutron Residential Systems dimming products?

The definition of compatible is one that is subjective. If a lamp only dims to a low end of 50%, is that truly dimmable? While the light level technically changes, Lutron strives to provide its customers with a high quality solution driven by high performance. Lamps must have a wide range of dimming without flicker, shimmer, and pop-on in order to meet the criteria of being compatible with our dimming products. Ideally, the dimming range and performance should be very close or essentially equivalent to that of an incandescent lamp.

I cannot find a specific lamp or fixture on the LED Product Selection Tool. Now what do I do?

With the multitude of lamps and fixtures on the market, as well as the time needed to adequately test each lamp and fixture with the multitude of Lutron product, there will always be lamps and fixtures that Lutron has not yet tested. In cases like this, where an end user is adamant about control of a specific lamp or fixture, performing your own testing will be the best option.

Consider each lamp or fixture to be a 100W load (to account for the most extreme repetitive peak inrush currents), and connect a dimmer to the circuit. Depending on the load type and application, the products previously listed can be used as test samples. Test the lamps through the entire dimming range. Flickering, shimmering, or dead travel (no change in intensity while the local Maestro LEDs move up or down) may occur at low or high end. The low end and high end trim of each individual dimmer can be adjusted using the RadioRA 2 and HomeWorks QS programming software to minimize or eliminate this effect.

Be sure that the total number of 100W lamps/fixtures does not exceed the incandescent maximum rating of the dimmer zone. If it is exceeded, you may need to add a power booster. Be sure to test the performance with the booster in place as the booster circuitry may interact with the lamps/fixtures differently than the control would alone.