

## Circadian Lighting with Lutron

### Converging Systems LED Lighting Controller Systems

#### Min. Requirements

- e-Node/4000
- ILC-400/450
- Lutron QSX/RadioRA3/Athena (LEAP protocols)
- Lutron QS/RadioRA2/Quantum (Telnet/non-LEAP protocol)

#### Driver Backgrounder

Converging Systems has a Lutron development partner has developed an embedded compatibility platform for a wide range of Lutron lighting control platforms that enables control of Converging Systems ILC-xx0 LED lighting controllers (as well as IMC-xxx/CVM motor controllers). Converging Systems' IP-based communication device (e-Node) fully supports CSDDP™ (Converging Systems Device Discovery Protocol) for the individual discovery of connected lighting controller. Converging Systems continually updates its lighting controller offerings as well as the number of supported Lutron controllers to enable Lutron installers to enjoy these new features. One such feature is **Circadian lighting** (see below).

Note: With a respect to Lutron lighting platforms, no special driver downloads are necessary as all interface technology is factory integrated within all e-Node communication gateways. Depending upon the specific Lutron platform to be supported, specific models of the e-Node may be required (Circadian requires the e-Node 4000).

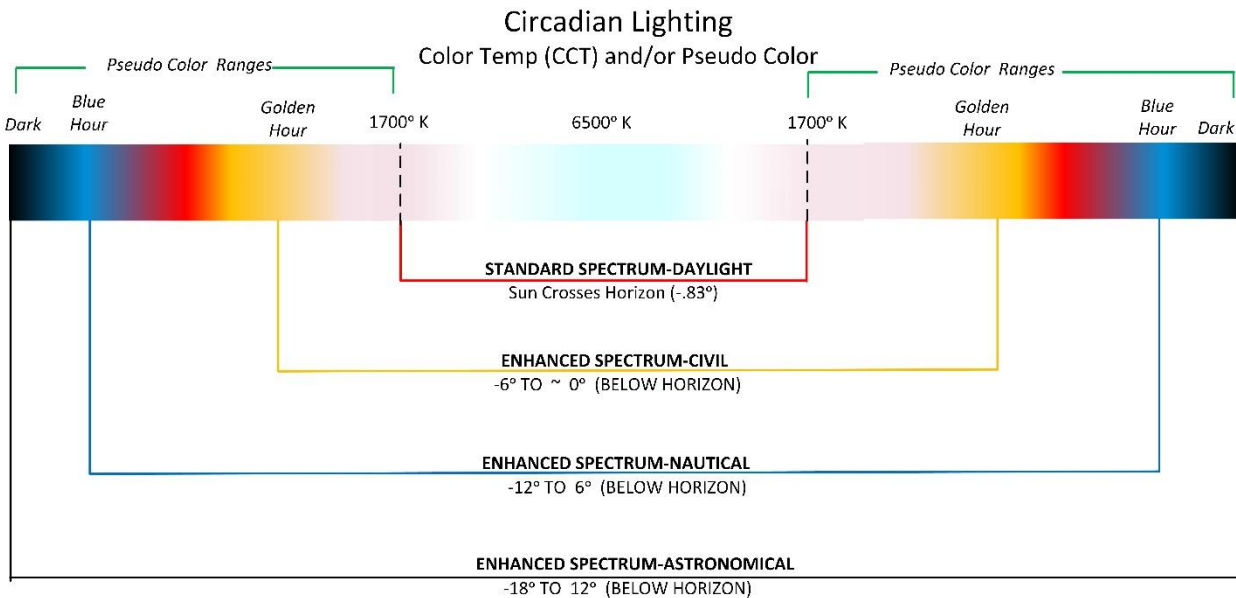
#### Circadian Lighting

Circadian Lighting is a corollary to human circadian rhythm. Circadian rhythm is a 24-hour clock controlled by the hypothalamus, an area of the brain, that controls each person's circadian rhythm by receiving stimuli from the eyes and signaling when it is daytime and nighttime. Cooler temperatures are used in spaces when it is appropriate to promote alertness and attention. Warmer temperatures (seen when the sun is rising or setting) are used when people are waking up or falling asleep. The concept of using light to influence human circadian rhythm is a relatively new idea in the lighting industry and research continues to provide new findings. Converging Systems has mapped the chromaticity values of the sun on the Big Island of Hawaii (where the atmospheric interference is often less intense and/or impacted by pollution/cloud cover) over a course of a week from total darkness to mid-day sun and then all the wall back to darkness over a number of successive days. (This is one of the reasons the Mauna Kea observatory was built at that location). Converging Systems then mapped those values along with proprietary algorithms into a number of our own Circadian-compatible ILC-4xx controllers leveraging off of the e-Node 4000 family's most powerful front-end processor which enables the feature set documented within this Tech Note.

In order to understand the significance of these advancements, the following short section (not mandatory reading) has been created to explain the range of Circadian Lighting output choices available. The built-in intelligence and the user-entered geographical location is all that is required to trigger accurate Circadian lighting capability within this environment. Please note that for simplicity the following description relates to pre-dawn to mid-day sun events (but the concepts are equally applicable-yet reversed for pre-sunset through dusk to total darkness).

## Understanding Night to Mid-day Sun Events (or Mid-day Sun to Night Events)

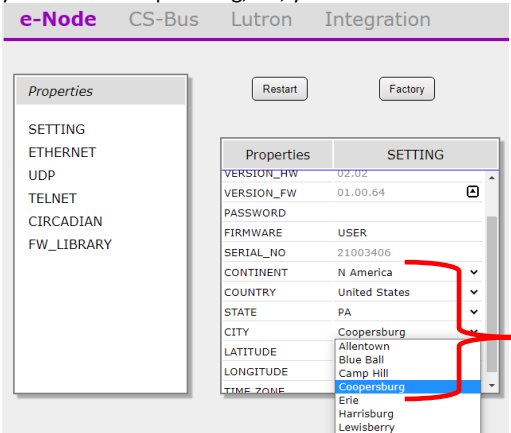
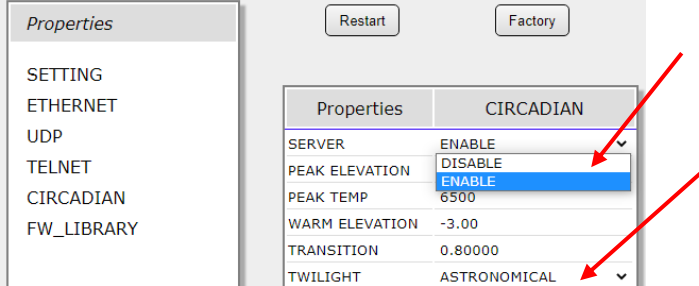
Note there are three major Periods (i.e., Astronomical Twilight (AT), Nautical Twilight (NT) and Civil Twilight (CT)) leading up to traditional DayLight (DL) sun. During each of these periods there are mid-to-wide variations in the chromaticity (Hue and Saturation) as well as Brightness levels perceived by an optical receiver (electronic equipment or the human eye). With proper replication of these variations within each Period, a lighting system can be used to provide a good approximation in many regards (but not all) to the target Sun's output. These periods and their associated light output are quite relevant to replicating Circadian cycles for health, comfort, marketing, or particular product differentiation needs. These Periods are represented by the following figure.

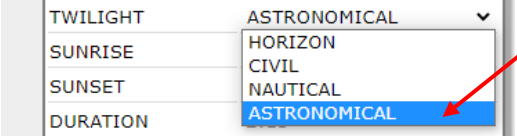


The selection and proper representation of these four types of Circadian cycles is implemented with the e-Node/4000 gateway. For more information, see a separate Tech Note [here](#).

## Quick Steps

We have created this Tech Note for installers interested in experimenting and implementing Circadian Lighting from various supported Lutron platforms. You are free to modify the assumptions given above for the particulars of your installation.

Step #	Overview	Steps
1	<p>Set-up your location within the e-Node/Settings page.</p> <p><b>Note:</b> This feature requires that you are initially connected to the internet to access the pre-programmed database of cities and time zones. After the initial setup, it is often not necessary to be internet-connected for proper operation.</p>	<p>Within the e-Node 4000 <b>Settings</b> tab, enter your city or city close to your location or alternatively your Latitude/Longitude (negative sign for West or South entries).</p> <p><b>Example:</b> If you lived in Coopersburg, PA, you would enter this:</p>  <p><b>Note:</b> Since there is a vast set of cities throughout the world accessible and selectable through the scroll down menu within this setup feature, if your city is not listed, it is generally sufficient only to select the closest city to your location (provided it is within the same time zone as your location).</p>
2	<p>Invoke the Circadian Server's functionality (within the e-Node)</p>	<p><b>Step 2a.</b> Invoke the Circadian Server.</p> <p>Within the e-Node 4000 <b>Circadian</b> tab, set Server to <b>Enabled</b> (see image below). This sets up the e-Node internally to track all the metrics for the solar cycle for the specific programmed location. However, not until a linkage between a specific <b>Zone/Group/Node (Z.G.N)</b> Device address and the Circadian server (enabled in this Step 2) is set up, will any particular lighting element be considered "Circadian Active." Now proceed to <a href="#">Step 3</a> to make that linkage.</p> <p><b>Note:</b> there are additional settings below the <b>Server</b> entry. These are more advanced in concept and can simply be left as is for now.</p>  <p><b>Step 2b.</b> Select the type of <b>Twilight</b> desired. Invoke the Circadian Server. See link <a href="#">here</a> for more information on the various selections possible.</p>

		 <p>Note: for the most vibrant (and most complete) twilight, select <b>Astronomical</b>.</p>
3	<p>Make any target <b>Zone/Group/Address</b> (address for any ILC-xxx controller) <b>Circadian Active</b>.</p>	<p>In order to make a specific Device (with a <b>Z.G.N</b> address) <b>Circadian Active</b>, the <b>SOLAR</b> command needs to be invoked for each Device. A Device here shall be considered one with a unique <b>Zone/Group/Node</b> address (<b>Z.G.N</b>). Wildcards can be used to trigger an entire range of devices where a "0" within a specific octet, controls all devices with numbers between 1 and 254 (in that octet).</p> <p><b>EXAMPLE 1.</b> This is an example of a command that is required to invoke the Circadian Server for a lighting controller with a <b>Z.G.N</b> of 2.1.1 and a peak brightness of 100% (referring to the maximum brightness of the Circadian cycle when the sun is at its highest apogee).  <b>Note:</b> The range for the Circadian Cycle maximum brightness level can range from &gt;0 to 240 which equates to &gt;0 to 100%--therefore, a value of "240" means 100% brightness at the cycle's midpoint.</p> <p>String: <b>#2.1.1.LED=SOLAR,240;&lt;cr&gt;</b></p> <p>Detail: This above string will trigger a LED controller with a <b>Zone/Group/Node</b> address of 2.1.1. that includes (i) the trigger command (<b>SOLAR</b>) to invoke the Circadian Server and (ii) the peak brightness value of 240 (i.e., 100% at mid-day peak) for the circadian cycle.</p> <p><b>EXAMPLE 2:</b>  If you wanted to adjust the maximum brightness intensity (for mid-day sun to 75% of the available brightness) for your luminaries you would enter:</p> <p>String: <b>#2.1.1.LED=SOLAR,180;&lt;cr&gt;</b> (since "180" is 75% of 240)</p> <p>Note: Different fixtures can have their own level of brightness.</p> <p><b>EXAMPLE 3:</b> This is an example of a command that is required to invoke the Circadian Server for a bank of lighting controllers with the same <b>Zone</b> and <b>Group</b> address but with differing <b>Node</b> addresses (i.e., three devices with addresses 2.1.1 for the first device, 2.1.2 for the second device, and 2.1.3 device for the third device). Here a wildcard address of <b>Z.G.N</b> of 2.1.0 can be used. Again, a peak brightness of 100% or "240" (referring to the maximum brightness of the Circadian cycle's when the sun is at its highest apogee) will be used.</p> <p>String: <b>#2.1.0.LED=SOLAR,240;&lt;cr&gt;</b></p> <p>Detail: This above string will trigger LED Devices (controllers) with a <b>Zone/Group/Node</b> address of 2.1.0. that includes (i) the trigger command name (<b>SOLAR</b>) which triggers the targeted device(s) to be <b>Circadian Active</b> with (ii) its peak brightness value of 240 (i.e., 100% at mid-day peak) for the circadian cycle.</p> <p>Now proceed to <a href="#">Step 4</a> to implement this <b>Circadian Active</b> function.</p>

4	<p>“SOLAR” command programming within the e-Node/Lutron Table page (within the e-Node web page).</p>	<p>-Discover all Lutron Device IDs (DID) using the procedure specified with the separate <a href="#">Quick Start Guide</a> for the applicable supported Lutron platform. Select the <b>Lutron</b> tab within the e-Node’s web server, and under the <b>Table</b> Tab select the SOLAR command from the pull-down menu and enter the maximum brightness desired to be reached (for mid-day sun) under the VALUE column for the first device for which Circadian tracking is desired (i.e., CS-bus device (supported now) or DMX device TBD).</p> <p>-Proceed and perform this same step for each additional device to be programmed to track the Circadian server’s output.</p> <p><b>EXAMPLE 1.</b> This is an example of a command that is required to invoke the Circadian Server for a lighting controller with a <b>Z.G.N</b> of 2.1.1 and a peak brightness of 100% (referring to the maximum brightness of the Circadian cycle’s when the sun is at its highest apogee).  <b>Note:</b> The range for the Circadian Cycle maximum brightness level can range from &gt;0 to 240 which equates to &gt;0 to 100%--therefore, a value of “240” means 100% brightness at the cycle’s midpoint.</p> <table border="1" data-bbox="695 842 1416 940"> <thead> <tr> <th>↻</th> <th>Lutron ID</th> <th>Address</th> <th>Device</th> <th>Command</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>🗑️</td> <td>1470,4</td> <td>2.1.1</td> <td>LED</td> <td>SOLAR</td> <td>240</td> </tr> </tbody> </table> <p>Detail: This string will trigger a LED controller with a <b>Zone/Group/Node</b> address of 2.1.1. that includes (i) the trigger command (<b>SOLAR</b>) to invoke the Circadian Server and (ii) the peak brightness value of 240 (i.e., 100% at mid-day peak) for the circadian cycle.</p> <p><b>EXAMPLE 2:</b>  If you wanted to adjust the maximum brightness intensity (for mid-day sun to 75% of the available brightness) for your luminaries you would enter:</p> <table border="1" data-bbox="695 1289 1416 1367"> <thead> <tr> <th>↻</th> <th>Lutron ID</th> <th>Address</th> <th>Device</th> <th>Command</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>🗑️</td> <td>1470,4</td> <td>2.1.1</td> <td>LED</td> <td>SOLAR</td> <td>180</td> </tr> </tbody> </table> <p><b>(since “180” is 75% of 240)</b></p> <p>Now proceed to <a href="#">step 5</a>.</p>	↻	Lutron ID	Address	Device	Command	Value	🗑️	1470,4	2.1.1	LED	SOLAR	240	↻	Lutron ID	Address	Device	Command	Value	🗑️	1470,4	2.1.1	LED	SOLAR	180
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5	<p>-Retriggering the Circadian Functionality after an “Interruption”</p>	<p><b>Background on Operation.</b> Once a <b>Z.G.N</b> address (Device) has been made <b>Circadian Active</b> (through initially turning on the Circadian server-ENABLE within e-Node, and a subsequent triggering of the <b>SOLAR</b> command for the particular <b>Z.G.N</b> address has been issued, the targeted <b>Z.G.N</b> Device will continue to operate outputting a Circadian cycle daily until interrupted. Interrupted means that the Z.G.N Device receives any command (i.e., OFF, ON or any other CCT or Color setting or brightness-SET command). At the point of interruption, the Circadian tracking is temporarily suspended until one of the following events occurs:</p> <p>-The next calendar day occurs when the e-Node Circadian Server will automatically retrigger a Circadian active state as if nothing ever stopped or interrupted it, or</p>																								

		<p>-The SOLAR,n command is once again transmitted to the targeted device.</p> <p>Simply program a button press event on any Lutron supported device to invoke the same command specified in <a href="#">step 2b</a> above.</p> <p><b>EXAMPLE:</b> The top button on a 15-button desktop keypad could be programmed to <b>Trigger or Resume Circadian</b>.</p> <table border="1" data-bbox="695 464 1416 562"> <thead> <tr> <th data-bbox="695 464 764 520">↻</th> <th data-bbox="764 464 857 520">Lutron ID</th> <th data-bbox="857 464 1057 520">Address</th> <th data-bbox="1057 464 1146 520">Device</th> <th data-bbox="1146 464 1252 520">Command</th> <th data-bbox="1252 464 1416 520">Value</th> </tr> </thead> <tbody> <tr> <td data-bbox="695 520 764 562">🗑️</td> <td data-bbox="764 520 857 562">1470,4</td> <td data-bbox="857 520 1057 562">2.1.1</td> <td data-bbox="1057 520 1146 562">LED</td> <td data-bbox="1146 520 1252 562">SOLAR</td> <td data-bbox="1252 520 1416 562">240</td> </tr> </tbody> </table> <p>Now, whenever you re-start (at the current time) the Circadian Service for a targeted <b>Z.G.N</b> device, all you need to do is press the Circadian Resume button.</p>	↻	Lutron ID	Address	Device	Command	Value	🗑️	1470,4	2.1.1	LED	SOLAR	240
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## Appendix 1

How to sync up with Lutron Natural Show (see [Case 1](#) above)

Lutron's new Homeworks™ QSX platform provides direct support for Lutron's innovative Ketra™ fixtures which are programmed using a single Lutron programming platform--Lutron's Designer™ software. An innovative feature available from Lutron's offering is its ability to provide Circadian output from Ketra fixtures based on a combination of CCT (color temperature) and INT (intensity) values from sunrise to sunset -- Lutron's tradename for this feature is the "Natural Show."

Although Lutron dealers can modify the standard Natural Show for demonstration or alternative purposes (with alternative start times, starting CCT & INT levels and ending CCT & INT levels), the Natural Show if set to track the default astronomical events of sunrise through sunset, can be tracked by Converging Systems' Circadian Server during the course of the day to complement the Ketra-fixture offerings with those luminaries supported by Converging Systems (such as our FLLA™ family of linear luminaries) in order to expand the range of luminaries able to be controlled from the QSX platform.

Using the e-Node 4000/4100 Lutron/Table SLIM programming platform (available through e-Node web server feature), several options are available:

- A Lutron Ketra load (actual load) could be tracked by the e-Node 4000/4100—in effect the CSI supported luminaire would "track" the Lutron Ketra fixture, and/or
- A Lutron button press could trigger a phantom Ketra Load which would in effect appear to the e-Node 4000/4100 as another "Ketra" load that it could "track"

Although the e-Node 4000/4100 can provide 3 enhanced versions of standard Circadian lighting ([Case 2](#), [Case 3](#) and [Case 4](#)), the feature set described within [Case 1](#) (spectrum pictured below) best matches the Lutron Natural Show and should therefore be selected when attempting to extend the Lutron system.

