

Code-Compliant Daylighting with Vive

Many commercial spaces require that lighting controls include daylight harvesting. The Lutron Vive system supports daylight harvesting with a variety of sensors and software configuration options. Many spaces will daylight harvest to occupant expectations with no additional setup, but specialized knowledge is required in order to evaluate the system against energy codes and make adjustments such that the controls comply with those energy codes.

The purpose of this application note is to provide the knowledge required to operate a Lutron Vive system and evaluate the daylight harvesting performance. It also provides guidance for making adjustments necessary for the system to comply with energy codes. It does not provide the necessary background or instruction on how to evaluate the space to any specific energy code, as the expected audience are certified inspectors already equipped with the knowledge necessary for this evaluation. At the time of writing, the most comprehensive and involved compliance testing in use is the California Energy Commission Title 24 Chapter 5 CEC-400-2016-033 S130.1. All terms used throughout this document are harmonized with said standard's functional testing requirements and will not match other energy standards. Please refer to this publicly available document to better understand the terminology employed here if looking to complete compliance testing against a different energy standard. Also reference the CEC-NRCA-LTI-03-A as it is the most recent publicly available compliance testing worksheet for Title 24 Automatic Daylighting Controls.

Vive Daylighting Sensor Options

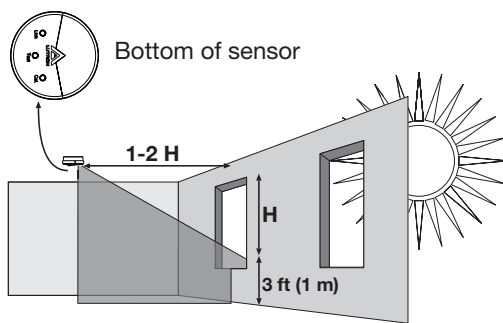
Currently The Lutron Vive System supports two different modes of daylight sensing and control. The wireless daylight sensor, LRF2-DCRB-WH, is the best solution for code-compliant daylight harvesting and provides flexible sensor placement, full daylight parameter adjustments, and allows the system to be setup in a way that matches the intent of performance testing. Lutron fixture controls, like the FC-SENSOR and the DFCSJ-OEM-OCC, offer fixture level control which maximize energy savings from both occupancy and daylight harvesting. They are simple to design and install. However, fixture controls do not allow for sensor movement, and currently do not expose all available daylight adjustments. All fixture controls work with the wireless daylight sensor, which means any system built with fixture controls can be upgraded with wireless sensors to support the fully adjustable daylight harvesting options provided by the LRF2-DCRB-WH.

Wireless Daylight Sensor

Per the specification submittal for the wireless daylight sensor, placement is dependent on space size. Guidance on those two cases is shown below:

1. Location for average size areas

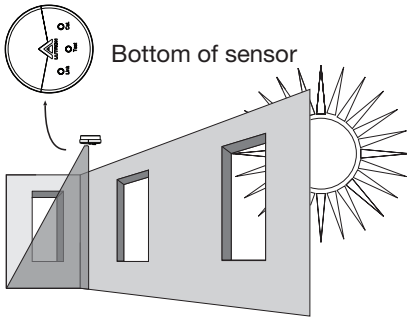
Arrow points towards the area viewed by the sensor (towards windows).



H = Effective Window Height

2. Location for narrow areas (corridors, private offices)

Arrow points towards the area viewed by the sensor (away from window).



Typically the best place to put a wireless daylight sensor is at the boundary of the daylight zones as defined by CEC-400-2015-033-CMF sections 5.4.4.2. In the event that placement in that location does not produce a compliant system please try the following:

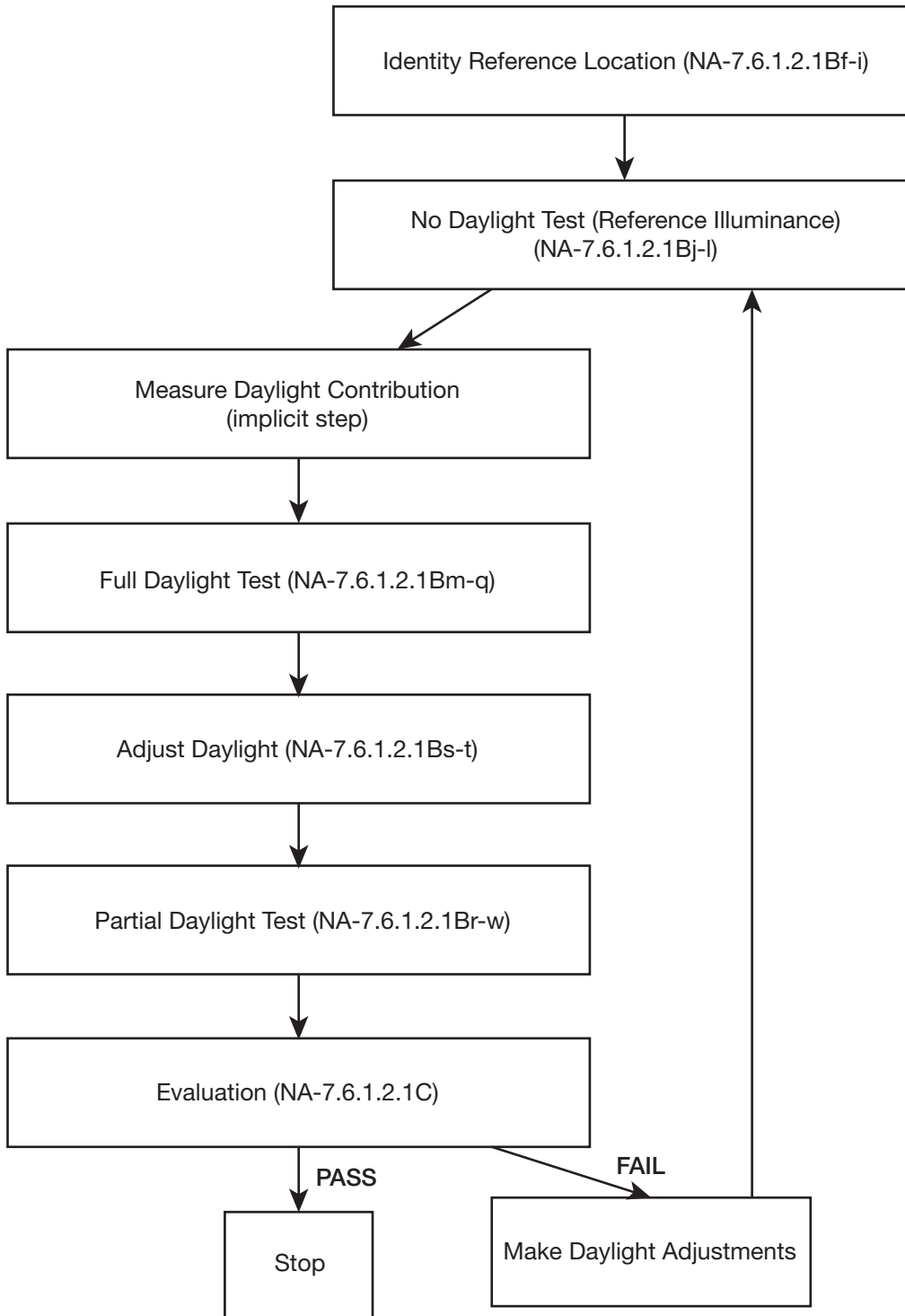
1. Rotate the sensor in its current location so it faces inward.
2. Move the sensor to another location along the boundary of the daylight zone.
3. Move the sensor to the middle of the daylight zone.

Lutron Fixture Controls

Lutron fixture controls offer ease of space design and a high density of sensing in a space under occupancy or daylight harvesting control. They do not, however, offer the flexibility to move the sensor as sensor placement is fixed within a fixture and fixture placement is fixed within an occupant space. Fixture controls can still be evaluated for energy code compliance and still offer some level of adjustments. Their behavior is different than the wireless daylight sensor and they do not offer all the adjustments available for that device.

Title 24 Daylight Harvesting Evaluation Flow

This flowchart and its terms are referenced throughout the remainder of this document. All terms are taken from the State of California Automatic Daylight Control Acceptance Document CEC-NRCA-LTI-03-A. The flowchart below refers to the Functional Performance Testing section of that document for Continuous Dimming Systems, also referred to as NA-7.6.1.2.1.



Identify Reference Location (NA-7.6.1.2.1Bf-i)

Prior to evaluating the performance of a daylight harvesting lighting control system, Title 24 requires that the inspector choose a reference location to place the illuminance meter. The placement options that are outlined in NA-7.6.1.2.1 allow the inspector to place the meter either at the edge of the daylight zone or at the minimum daylight location in the zone. Reference location selection can heavily influence the results obtained by an evaluation and Lutron recommends choosing a location towards the edge of the daylight zone in an area near the daylight sensor or sensors being evaluated.

No Daylight Test (Reference Illuminance) (NA-7.6.1.2.1Bj-l)

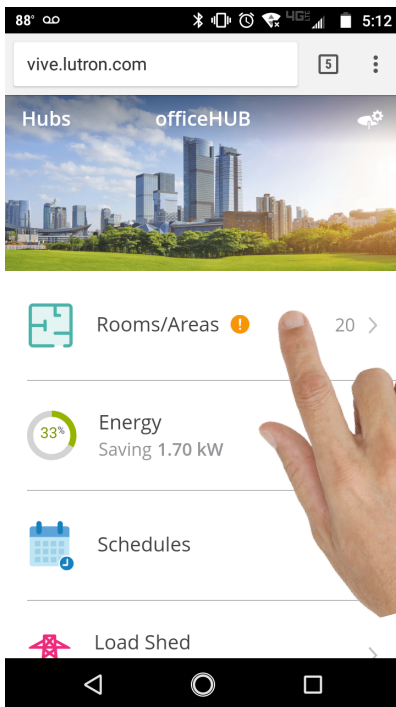
After identification of the reference location NA-7.6.1.2.1 requires an evaluation of the illuminance at the reference location with the following conditions:

1. No daylight is entering the space. This can be accomplished with the following methods:
 - A. Covering of the fenestration, using permanently installed window treatments or temporarily applied coverings.
 - B. A night time manual measurement, when the sun is down.
 - C. Night time illuminance logging.
2. The daylight harvesting function is disabled in the system.
3. The electric lights are at full output.
 - A. User light level is set to maximum.
 - B. High-end trims are in place.

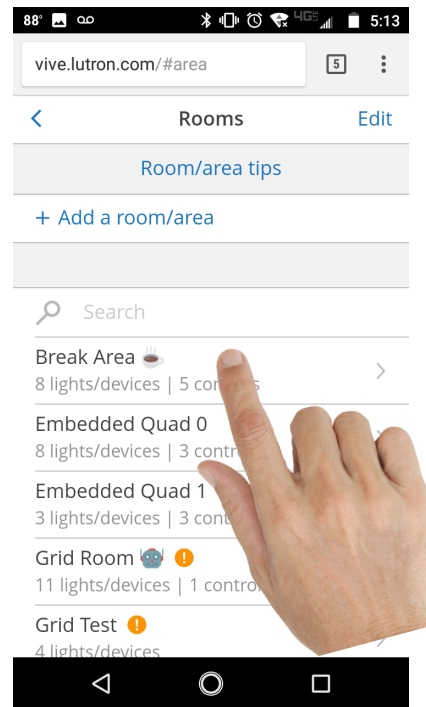
We recommend the use of fenestration covers as the complete evaluation can often be executed in a single visit and changes to the reference location or daylight parameters do not require a long wait to re-evaluate this step. Lutron Shading Solutions are an extremely simple way to manipulate fenestration coverings and expedite the evaluation process.

Conditions 2 and 3 (above) can be obtained via the Vive Hub in the following way:

1. Select Rooms/Areas

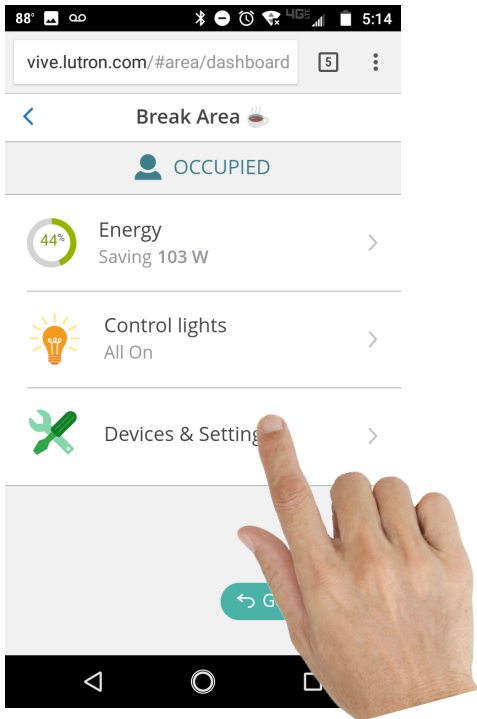


2. Select the area under evaluation

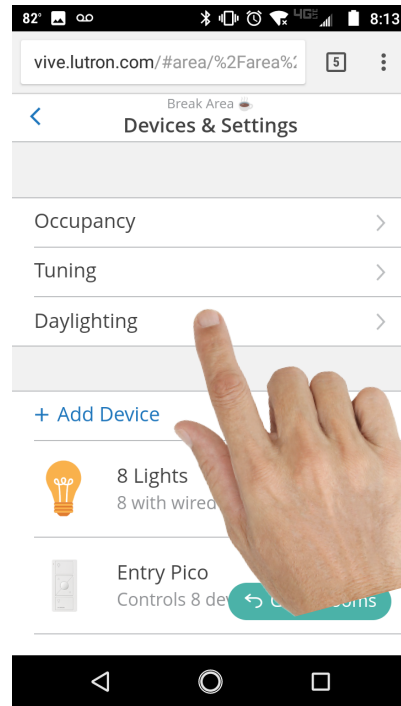


No Daylight Test (Reference Illuminance) (NA-7.6.1.2.1Bj-I) (continued)

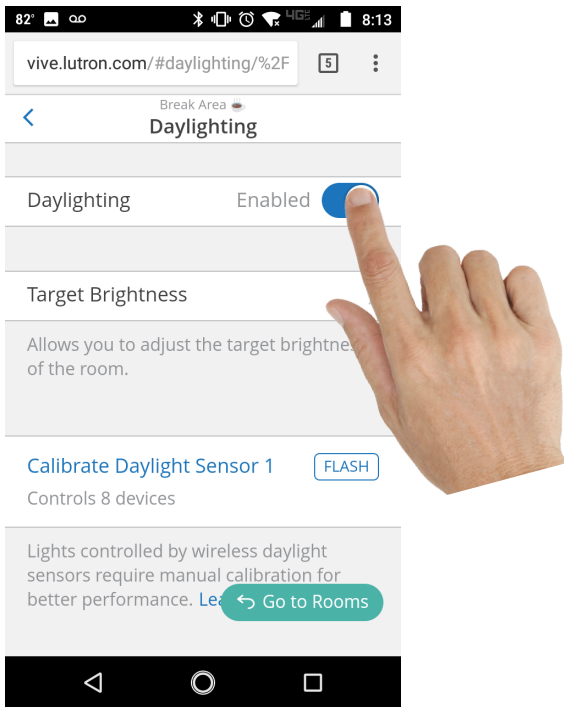
3. Choose Devices & Settings



4. Choose Daylighting



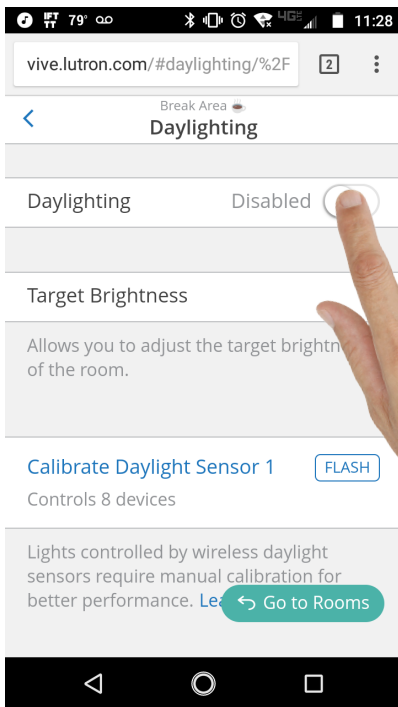
5. Use the slider to disable daylighting on the area under evaluation



6. Take the reference illuminance reading and record as necessary

No Daylight Test (Reference Illuminance) (NA-7.6.1.2.1Bj-l) (continued)

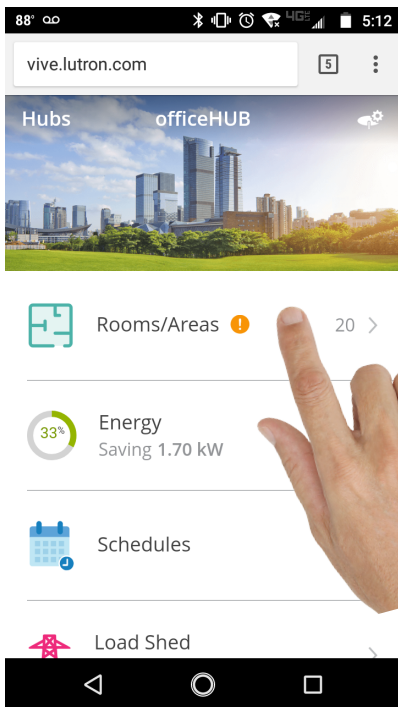
- After the measurement is complete re-enable daylighting via the same method



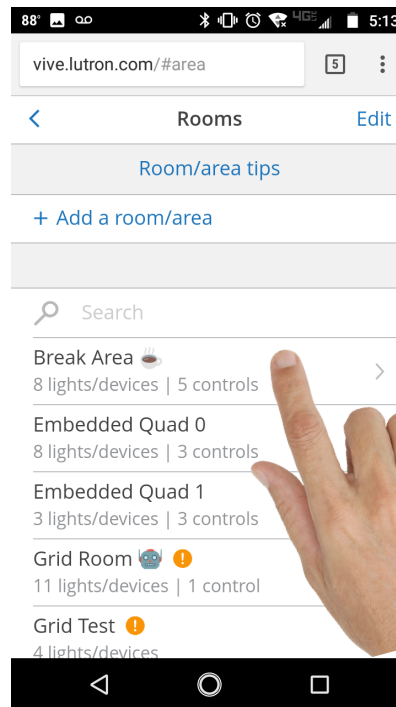
Measure Daylight Contribution (implicit step)

The purpose of this setup is to get a natural light contribution to the illuminance reading. NA-7.6.1.2.1B does not call this out explicitly, but step 3 requires that the daylight in the space is >150% of the reference illuminance and step 2 requires this contribution be in a specific range. Confirming that this is the case requires all loads turned to off, and this can be done via any associated control or the Vive Hub as follows:

- Select Rooms/Areas

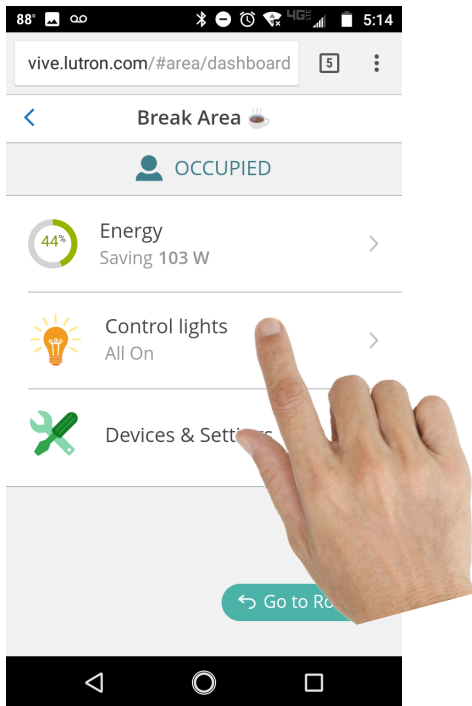


- Select the area under evaluation

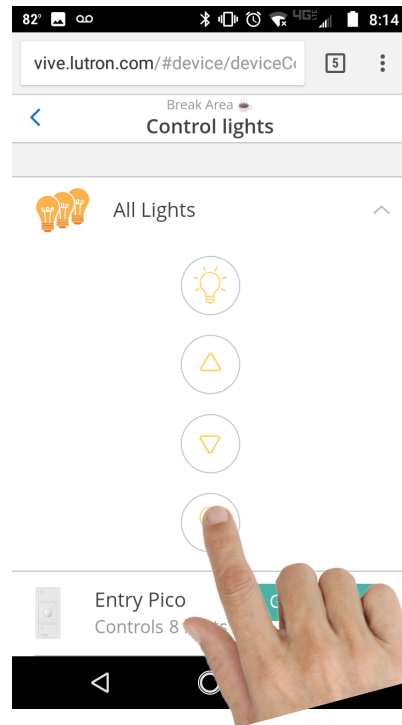


Measure Daylight Contribution (implicit step) (continued)

3. Choose Control Lights



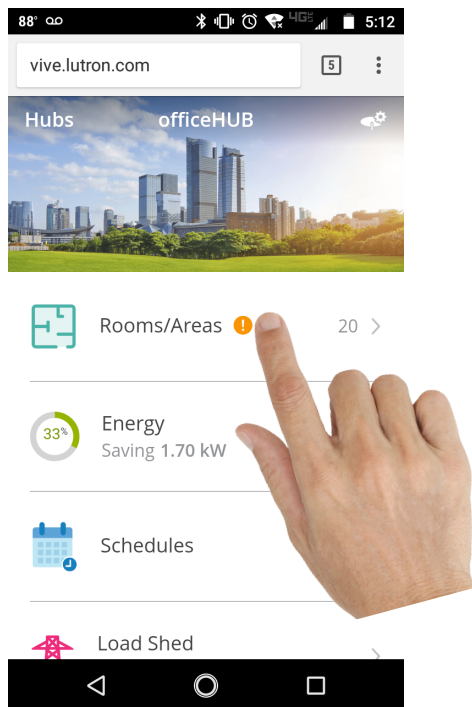
4. Turn the lights off with the off button



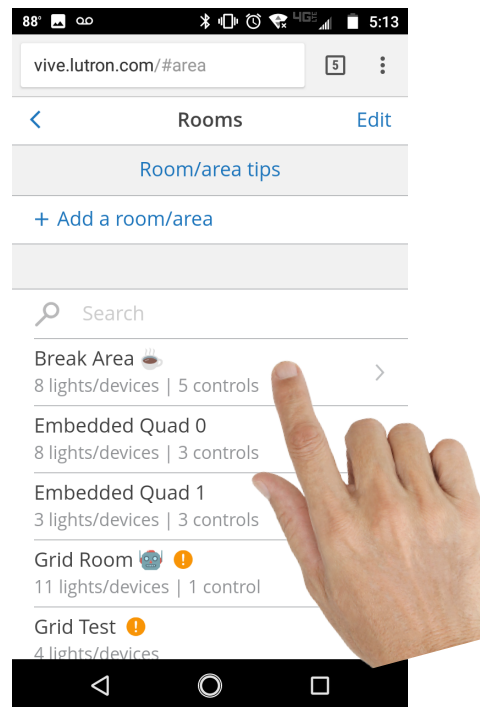
Full Daylight Test (NA-7.6.1.2.1Bm-q) and Partial Daylight Test (NA-7.6.1.2.1Br-w)

Once the daylight level is set for evaluation, the daylight harvesting control has to be enabled to allow for evaluation. This requires the lights be turned on and daylight sensor readings to stabilize. To do this, first turn the lights on, and then wait for up to 60 seconds. To turn the lights on use an associated control or the Vive Hub as follows:

1. Select Rooms/Areas

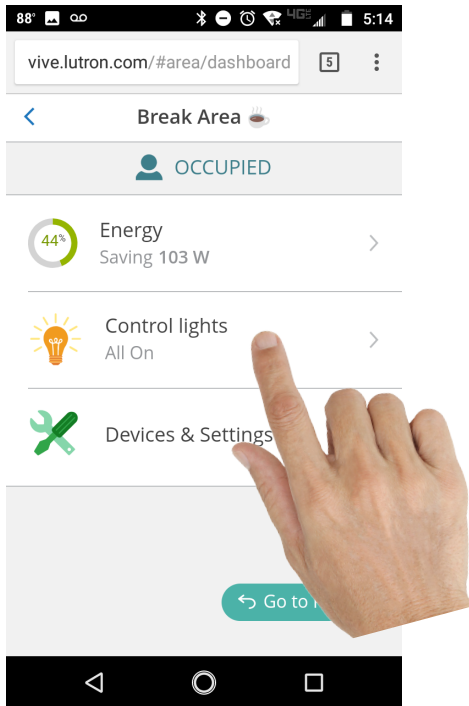


2. Select the area under evaluation

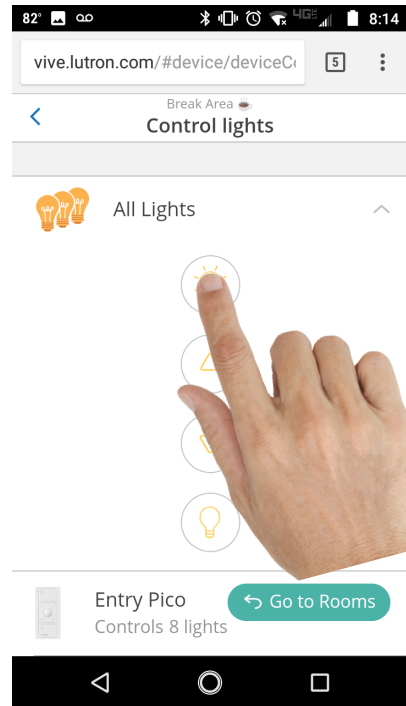


Full Daylight Test (NA-7.6.1.2.1Bm-q) and Partial Daylight Test (NA-7.6.1.2.1Br-w) (continued)

3. Choose Control Lights



4. Turn the lights on with the on button; do not use raise and lower buttons as this can suspend daylight harvesting



Troubleshooting

In the event that the controls do not appear to be daylighting, there are three possible causes:

1. Daylight harvesting is currently in an override condition.
2. Daylight harvesting is currently disabled, see the last step in the No Daylight Test section for instructions to re-enable it.
3. Lutron Individual Fixture Controls have not completed their auto-calibration process and will only daylight in response to large amounts of daylight in the space.

Diagnosing either condition requires the same tool, a bright flashlight; preferably one that can be focused on a small area. To diagnose do the following:

1. Shine a bright light on the daylight sensor in question.
2. Watch the output of the fixtures under control of said daylight sensor.
3. While holding the light on the sensor, wait 60 seconds and see if the light levels change.
 - A. If the light levels change, then daylight harvesting is enabled. If the control in question is an individual fixture control and it does not otherwise appear to dim in response to daylight see the section below for instructions on how to force automatic daylight calibration. This will result in the fixture dimming in response to less daylight.
 - B. If the light levels do not change, then daylight harvesting is overridden. There are multiple ways to clear the override:
 - i. Power cycle the controls by doing one of the following:
 - a. For devices with a FASS, turn the device on and off via the FASS.
 - b. For devices without a FASS, triple tap and hold for 15 seconds until devices reset.
 - c. Cycle the power supplying the controls in question.
 - ii. Enter and exit daylight test mode via the LRF2-DCRB-WH wireless daylight sensor button.
 - iii. Wait for up to two hours for the override to clear automatically.

Initiating Automatic Daylight Calibration

Individual fixture sensors perform an automatic daylight calibration after installation. If the calibration is not performed, defaults in the device are intentionally set to keep spaces over-lit, which can interfere with code compliance. The calibration starts after the fixture has been powered up and the following events occur:

1. An occupancy to vacancy transition (e.g. the space under the sensor goes vacant).
2. The integrated daylight sensor readings are under 10 fc when the fixture under control is off. This requires the room be fairly dark.

If the control attempts to complete the automatic calibration more than 5 times it will halt until the calibration is started per the instructions below. In this case, the fixture will still daylight harvest but will ensure a large amount of task illuminance is available. To some occupants it will appear like the fixture is not harvesting any daylight.

Take the following steps to restart automatic daylight calibration:

1. Reset the Automatic Daylight Calibration retry counter. Perform any of the following operations:
 - A. Via the hub change the high-end trim. The setting can be reverted immediately after changing it, the counter will remain reset.
 - B. Restore factory defaults for the control in question, then re-program.
2. Force an occupancy to vacancy transition, by not moving under the fixture in question. To speed this setup up, set the timeout to 1 minute.
3. Darken the room as much as possible.
 - A. Turn all the other fixtures in the area off. This may require reprogramming.
 - B. Cover fenestration to block natural light. Use of either in place window treatments or temporarily applied coverings is acceptable.
 - C. Wait for conditions with little natural light.

Adjust Daylight (NA-7.6.1.2.1Bs-t)

In order to complete the partial daylight test, sections “r” through “w” in CEC-NRCA-LTI-03-A, the daylight contribution must be between 60% and 90% of the reference illuminance. Follow the instructions above in the Measure Daylight Contribution section for taking that reading. If the reading is outside the range required for the Full or Partial Daylight Test attempt the following adjustments in the following order:

1. Apply partial fenestration covering, or place obstructions between the measurement location and the source of daylight.
2. Restart the evaluation with the reference location changed.
 - A. If there is too much daylight, move the reference location further away from the source of daylight.
 - B. If there is too little daylight, move the reference location closer to the source of daylight.
3. Wait for weather conditions to change.
4. Adjust high-end trim in the area under evaluation, and restart the evaluation. This will adjust the reference level and produce different percentages for the same amount of daylight. *Do this only as a last resort as certain controls will require an occupied to vacant transition and low ambient light before daylighting starts again. See Initializing Automatic Daylight Calibration for details on how to complete this task successfully.*
 - A. If daylight levels are too low, reducing high-end trim will reduce the reference level, and produce a higher percentage daylight contribution for the same amount of daylight.
 - B. If daylight levels are too high, increasing high-end trim will increase the reference level, and produce a lower percentage daylight contribution for the same amount of daylight. Lutron recommends using partial fenestration covers in this condition, and not resorting to adjusting high-end trim.

Evaluation (NA-7.6.1.2.1C)

Refer to section NA-7.6.1.2.1C for the evaluation criteria. This requires going back through all the measurements made in the previous sections. This document is not a substitute for training, accreditation, or licensing required by the CEC for the evaluation of a lighting control system.

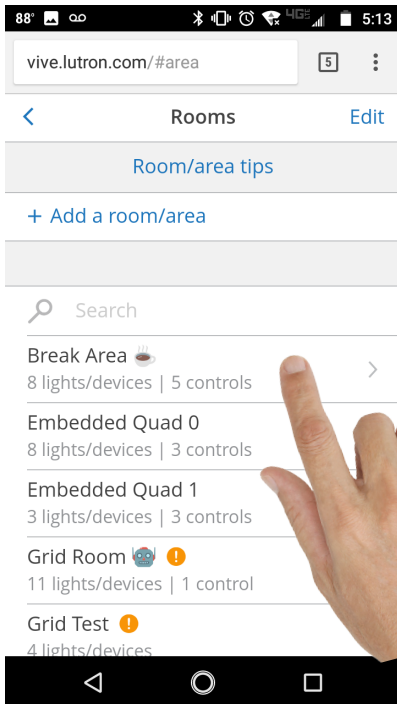
Make Daylighting Adjustments

In the event that a Vive system is evaluated against an Energy Standard's daylight harvesting requirements and found non-compliant, there are multiple adjustments available which will alter the behavior of the system and bring it into compliance.

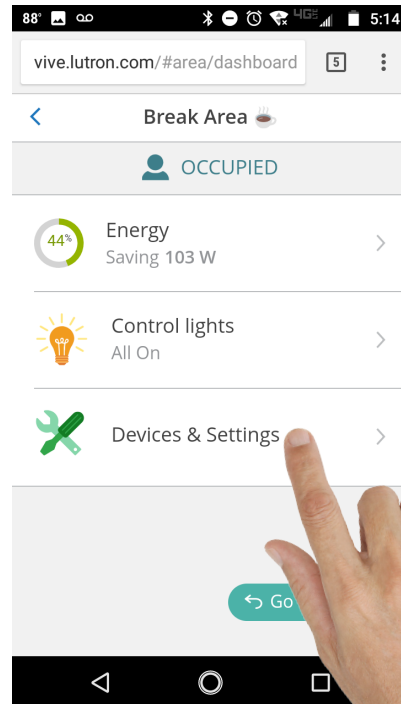
Common Adjustment Option - Target Brightness

For all Vive devices, a target brightness adjustment alters the total amount of electric light delivered to a surface. Try using this adjustment first on all devices as it is a simple change that occurs quickly and can easily be reverted to previous settings. Control output is directly proportional to this setting, meaning if more fixture light is required increase the setting and visa versa. Accessing the adjustment requires the following steps:

1. Select the area with the controls in question

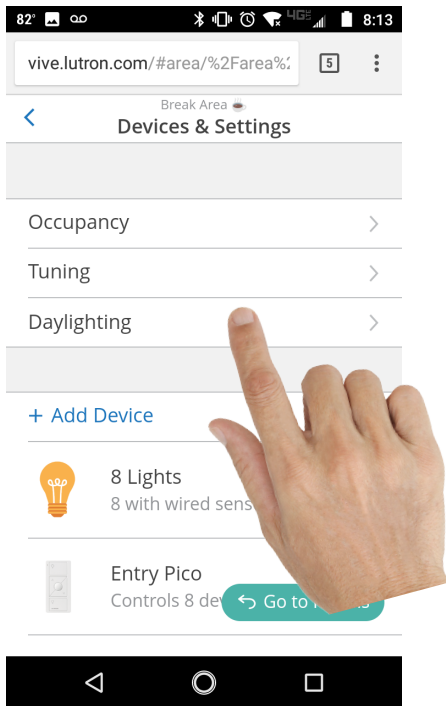


2. Select Devices & Settings

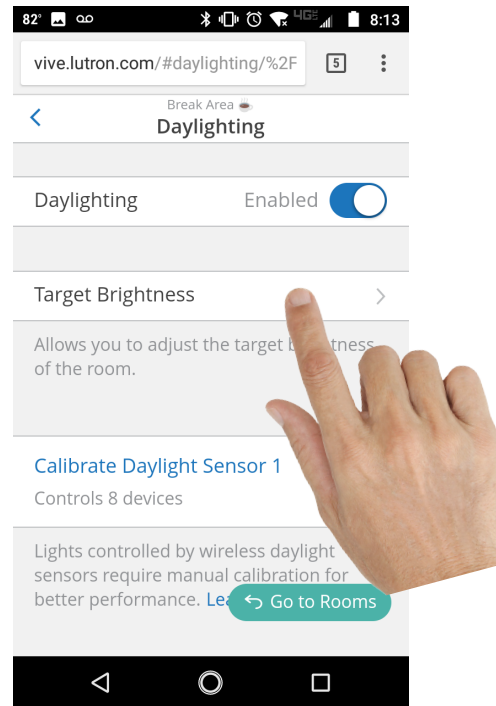


Common Adjustment Option - Target Brightness *(continued)*

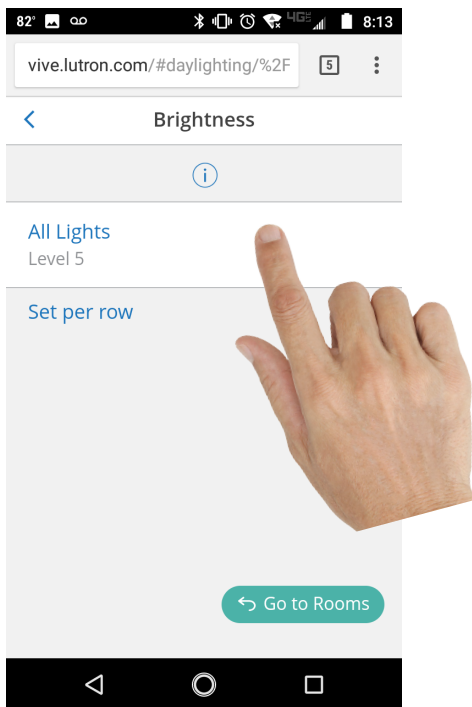
3. Select Daylighting



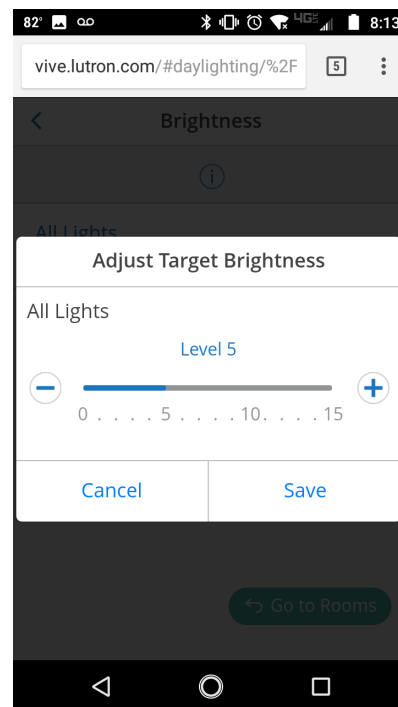
4. Select Target Brightness



5. Select the lights you are evaluating. Additional adjustments are available if you set daylighting per row, but compliance is possible without this additional adjustment



6. Adjust the Target Brightness as necessary



Lutron Fixture Control Adjustment Options

Individual fixture controls have a limited number of daylight harvesting adjustment options. In the event that a non-compliant system is under evaluation, those options are:

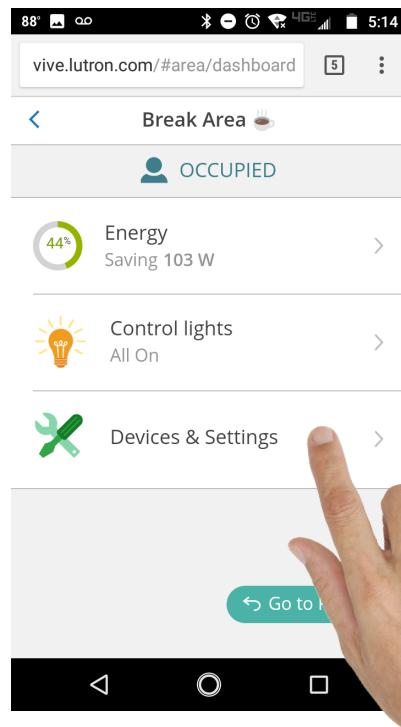
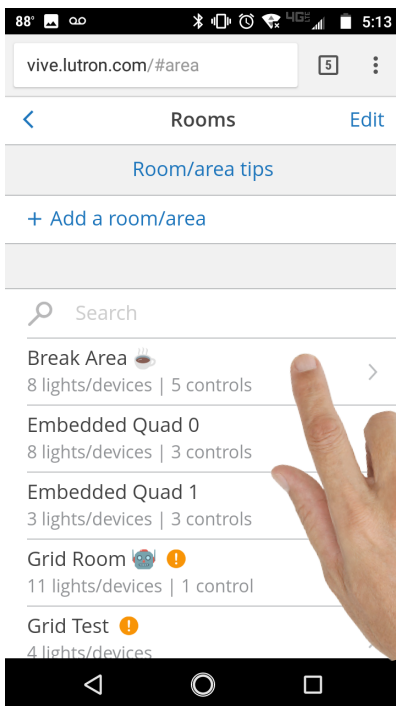
1. Adjust target brightness as instructed above.
2. Adjust high-end trim.
 - A. This will change the Reference Level and alters the acceptance criteria
 - B. This action will require that automatic calibration be executed with the new high-end trim
3. Add a Lutron Wireless Daylight Sensor to the system to obtain access to all the available daylight harvesting adjustment options.

Lutron Wireless Daylight Sensor Adjustment Options

Wireless daylight sensors offer the widest range of adjustments for daylight harvesting controls. In the event that a non-compliant system is under evaluation, those options are:

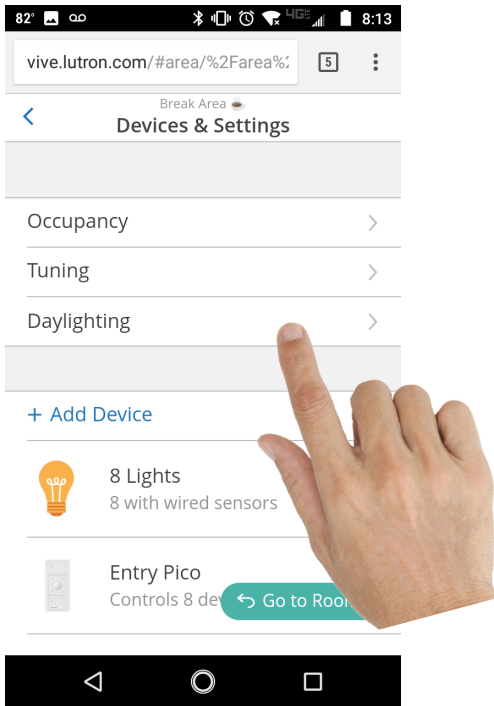
1. Adjust target brightness as instructed above.
2. Calibrate daylighting via the Vive Hub.
 - A. Prepare the space for calibration.
 - i. Verify the wireless daylight sensor is placed in accordance with the recommendations in the specification submittal and instruction sheet.
 - a. Lutron recommends placing the sensor 1-2 window heights back.
 - b. It can be placed facing the window or into the space; test both to determine best orientation.
 - c. The sensor performs best when placed near the point where the Reference Level is being measured.
 - ii. Have the Reference Level measurement ready, as calibration works best when the total surface light level is approximately the Reference Level.
 - B. Start the calibration process on the Vive Hub:
 - i. Select the area with the controls in question

ii. Select Devices & Settings

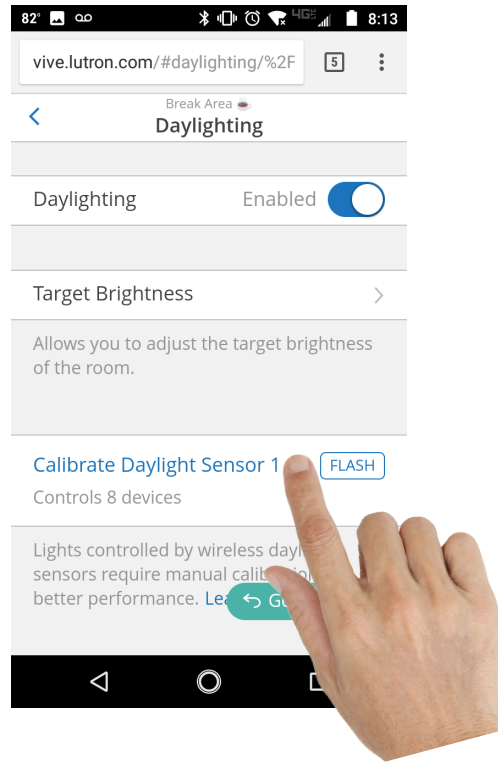


Lutron Wireless Daylight Sensor Adjustment Options *(continued)*

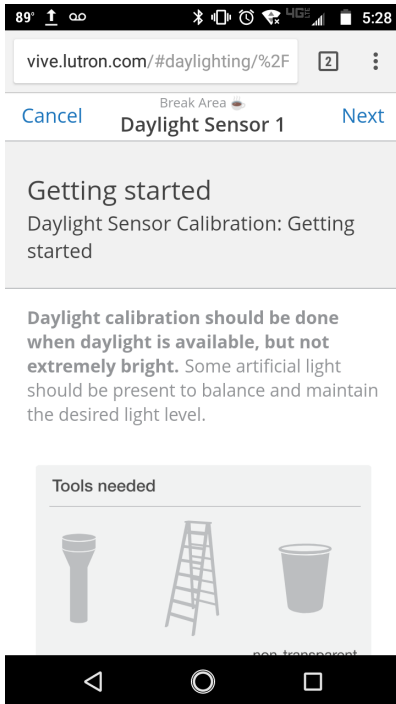
iii. Select Daylighting



iv. Select the daylight sensor you wish to adjust



v. Follow the wizard



Lutron Wireless Daylight Sensor Adjustment Options *(continued)*

- vi. During step 2, "Set Room Brightness" the following conditions produce an optimal calibration result
 - a. A surface light level approximately equal to the Reference Level for that area
 - b. A daylight contribution of approximately half of the Reference Level measurement for that area
 - c. These two conditions set the daylight contribution to approximately half of the Reference Level
3. Exit test mode
 - A. Upon successful completion of daylight calibration, the lights will enter test mode. This means:
 - i. Controls will respond faster than normal to daylight
 - ii. Controls will daylight to off with a very short delay
 - iii. Controls will ignore user input
 - B. To exit test mode, which is required to evaluate the system against most energy codes
 - i. Wait 2 minutes, and the lights will exit automatically
 - ii. Tap the test button on the Wireless Daylight Sensor that just completed calibration

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