Radio Window Sensor and Temperature Sensor Programming in HomeWorks QS

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1. Overview

Lutron's Radio Window Sensors and Radio Powr Savr Temperature Sensors improve occupant comfort and enhance the system's energy saving potential. The window sensor utilizes daylight measurements to maximize occupant comfort when shadows are cast on buildings as well as when dark cloudy or bright sunny weather conditions prevail. The battery-powered temperature sensor is surface mounted on the wall and monitors temperatures in the space. This app note will review the process of adding a window sensor and temperature sensor to the project and adding programming to impact lights, shades, and keypad behavior. It is important to remember that the temperature sensors are assigned to an RF link while the window sensors must be assigned to a QSM, on a QS wired link.

2. General Operation

2.1. Radio Window Sensor Communication

Radio Window Sensors are one way transmitters that monitor the amount of light at the window, measured in foot candles, and communicate with the system through the Quantum Sensor Module (QSM) (Figure 1). Although light levels are being monitored continuously, data is only transmitted and logged when there is a perceivable change in light level to the human eye.

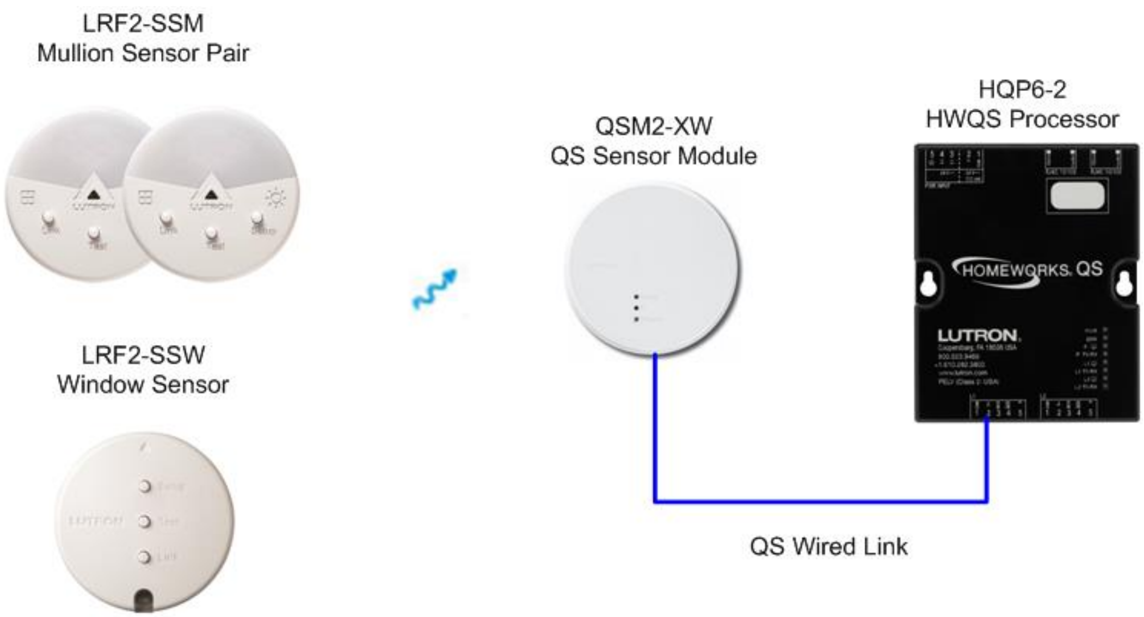

Figure 1: Radio Window Sensors Communicate with the QSM

2.2. Temperature Sensor Communication

The Temperature Sensors are one way transmitters that monitor the temperature in either degrees Celsius or Fahrenheit, and communicate with the system via a Hybrid Repeater chain on a RF Link (Figure 2). Measurements shown in the diagnostics will always be Fahrenheit as this is the unit used by the processor.

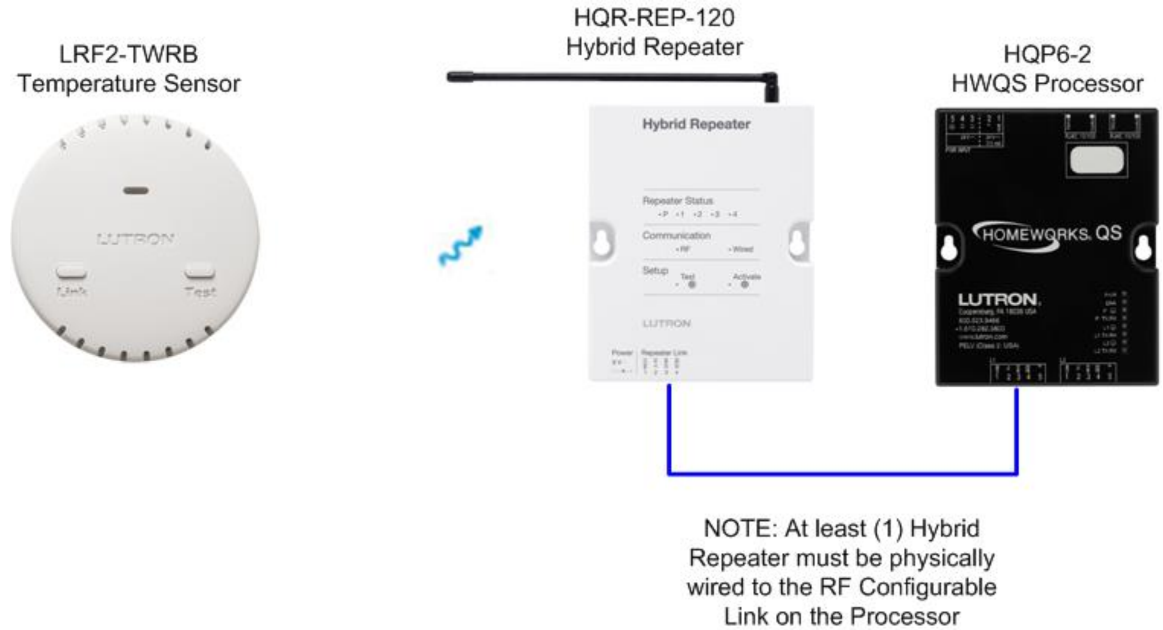

Figure 2: Temperature Sensors Communicate with the Hybrid Repeater

2.3. Programming Methods

Programming for light and temperature sensors can be completed via two methods: using the sensor as the trigger to execute programming, or using the sensor state as a variable in the conditional programming on another trigger in the system. Similar to a timeclock event, placing programming on the sensor is used to trigger events without human interaction. An example would be daylight autonomy, where the shades are automatically lowered in excessive light conditions to protect interior spaces or artwork. Alternatively, if total autonomy is not desired, conditional logic programming can be applied to buttons presses to incorporate light measurements. This allows, for example, scene buttons to become dynamic and incorporate light conditions in determining how electric lighting and shade levels are set. An example of this would be a reading scene button that adjusts light and shade levels differently depending on the level of natural light.

During programming, a table is configured to establish a range of states that the sensor readings will be compared to (see Figure 5). Each time a reading is taken by the sensor in normal operation, the measurement will be compared to that table to determine what state is currently true. The *Adding Sensors* section of this document will outline how to create this state table for each sensor. The number of sensors is limited only by the QSM or RF link device limit; however, historical data will only be logged for 10 sensors total.

3. Adding Sensors

3.1. Radio Window Sensors

As shown in Figure 3, there are two types of Radio Window Sensors to choose from: the mullion mount pair and the window mount sensor. Choosing which to use will depend on the price as well as aesthetic considerations. The single window sensor mounts directly on the window pane near the top where there is an unobstructed view of the exterior. Keep in mind that since the window mount sensor attaches to the glass, it will be visible from the outside. The mullion pair is a set of two sensors that mount on the mullion or inside the perimeter of the window on either end of the shade group, but come at a higher price point. Both sensor types can be found under the Light Sensor family within the controls toolbox as shown in Figure 4.

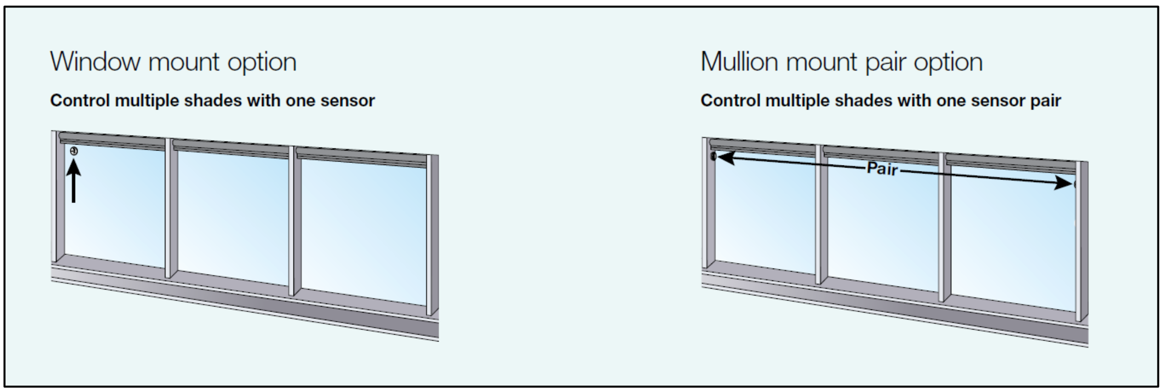

Figure 3: Window Sensor Mounting Options

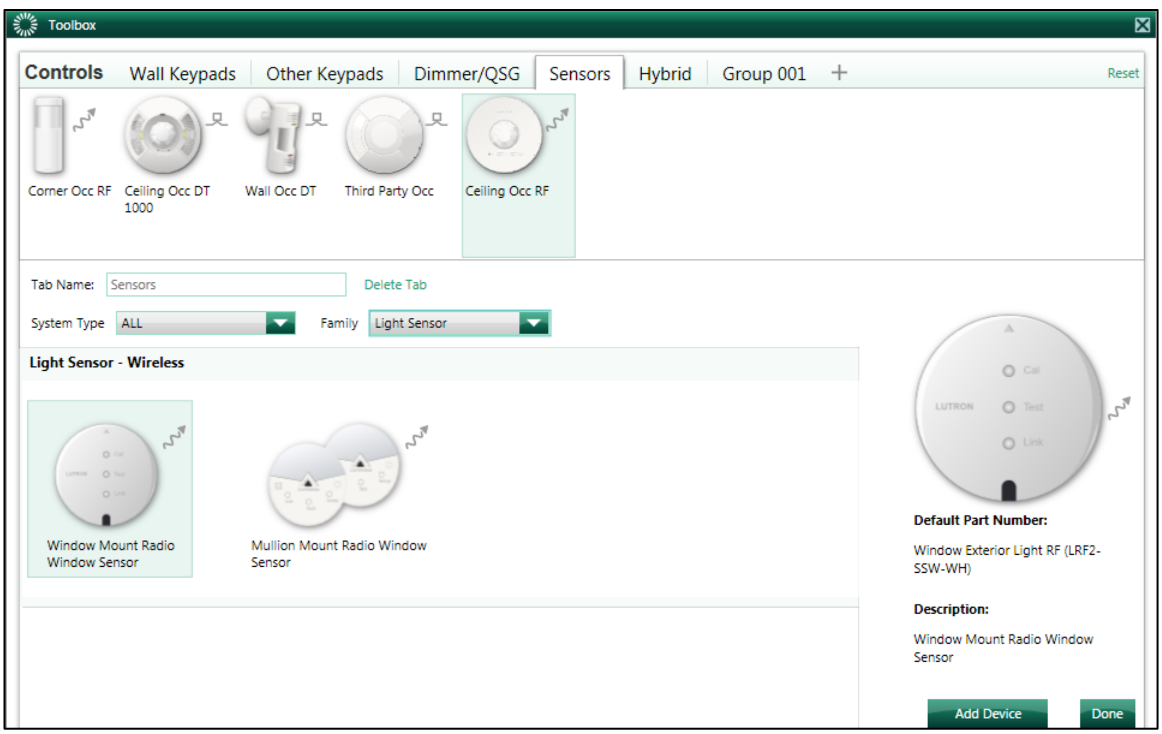

Figure 4: Light Sensor Family within Controls Toolbox

After adding each sensor to a project, before leaving the design tab to program the sensor, the state table should be configured. The state table shown in Figure 5 is where the sensor readings are separated into a range and associated with a variable. Similar to single variable programming, these states can then be used to alter programming in the system. The state names chosen for this table will be displayed on the sensor under the programming tab (Figure 6). As the light in the space moves between state ranges, the variable will change automatically. All light level values between 0 and 10,000 foot candles must be accounted for in the state table and no ranges can overlap. To help determine what these values should be, reference the diagnostics tool described in section 6 of this document. Although there is no limit on the number of states, it is recommended that no more than six states are used in order to make the programming more manageable.

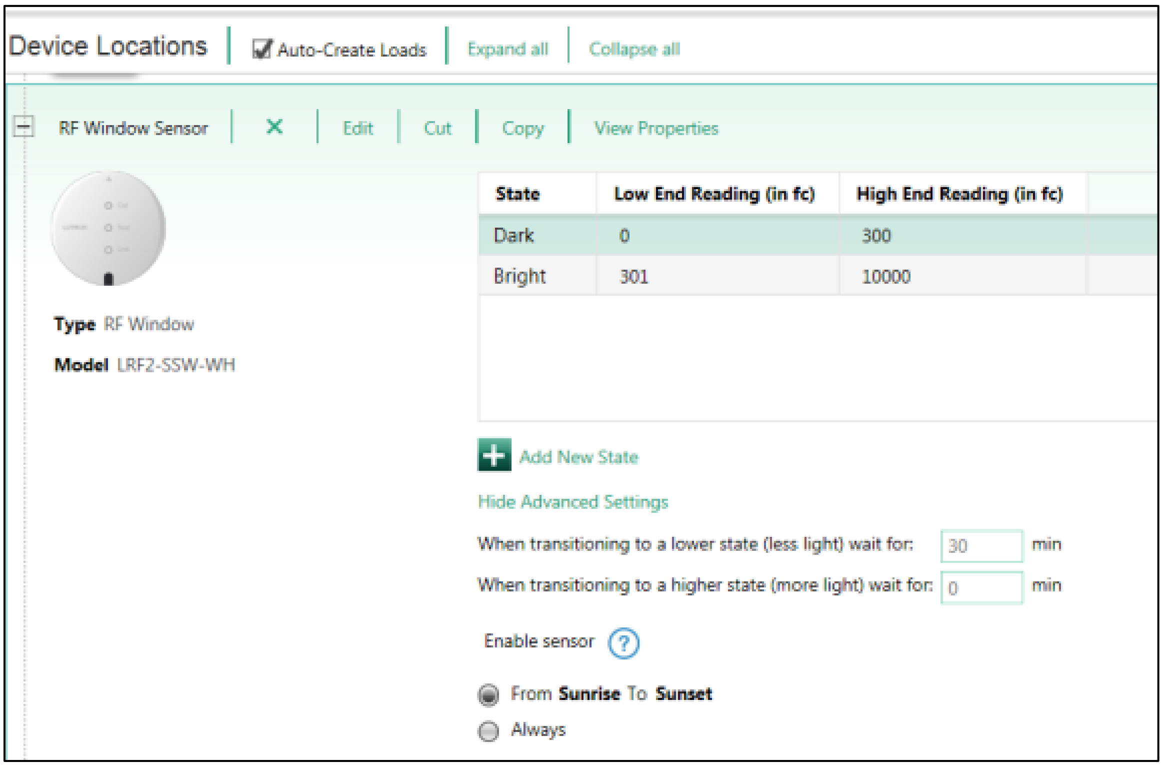

Figure 5: Adding a Radio Window Sensor to the Project

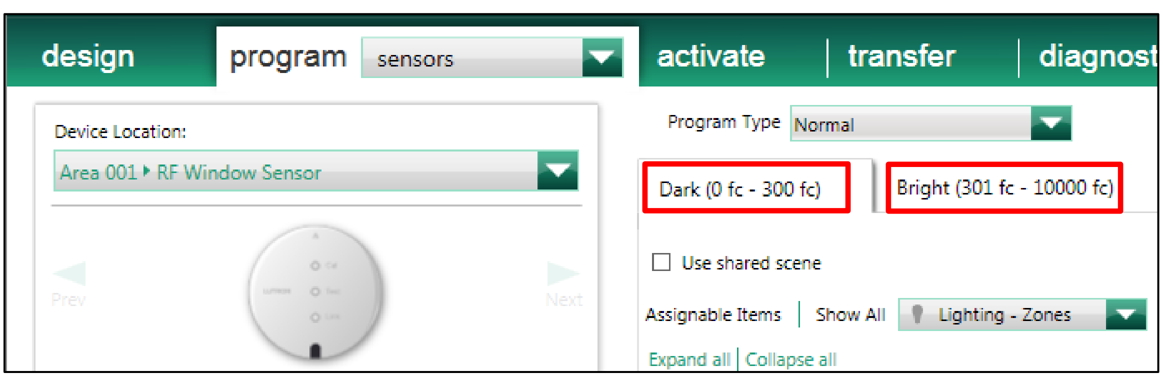

Figure 6: Programming Tab for Window Sensors

As shown in Figure 5, the advanced settings section contains options for the transition wait time and period for which the sensor will be active. The transition wait time is the amount of time that the light level must measure above or below the current state for a transition to occur. For this example, as the light level gets darker and the readings move into a lower state, by default the system will wait 30 minutes until it updates the state variable. This delay prevents short periods of darkness caused by broken clouds or passing shadows from frequently changing programming or set points. As the light level gets brighter and the readings move into a higher state, by default the system will immediately update the state variable. This quick reaction prevents exposure to glare. Each transition delay is configurable.

To remove the need for timeclock events, the time period for which the sensor is enabled can be set here as well. Limiting the time period that the sensor is active will effectively eliminate readings caused by outside sources such as landscape lighting or high glare conditions during sunrise and sunset. Due to the angle of the sun during sunrise and sunset the perceived light level will be different than that measured by the sensor, and may cause confusion. If this is a concern, it is recommended that the sensor be enabled from one hour after sunrise to one hour before sunset.

3.2. Temperature Sensors

The temperature sensor is assigned to the RF link and may be used with the Lutron HVAC controller, third party integration, or for discrete temperature readings in conditional programming. Figure 7 shows the LRF2-TWRB in the tool box editor under the temperature family.

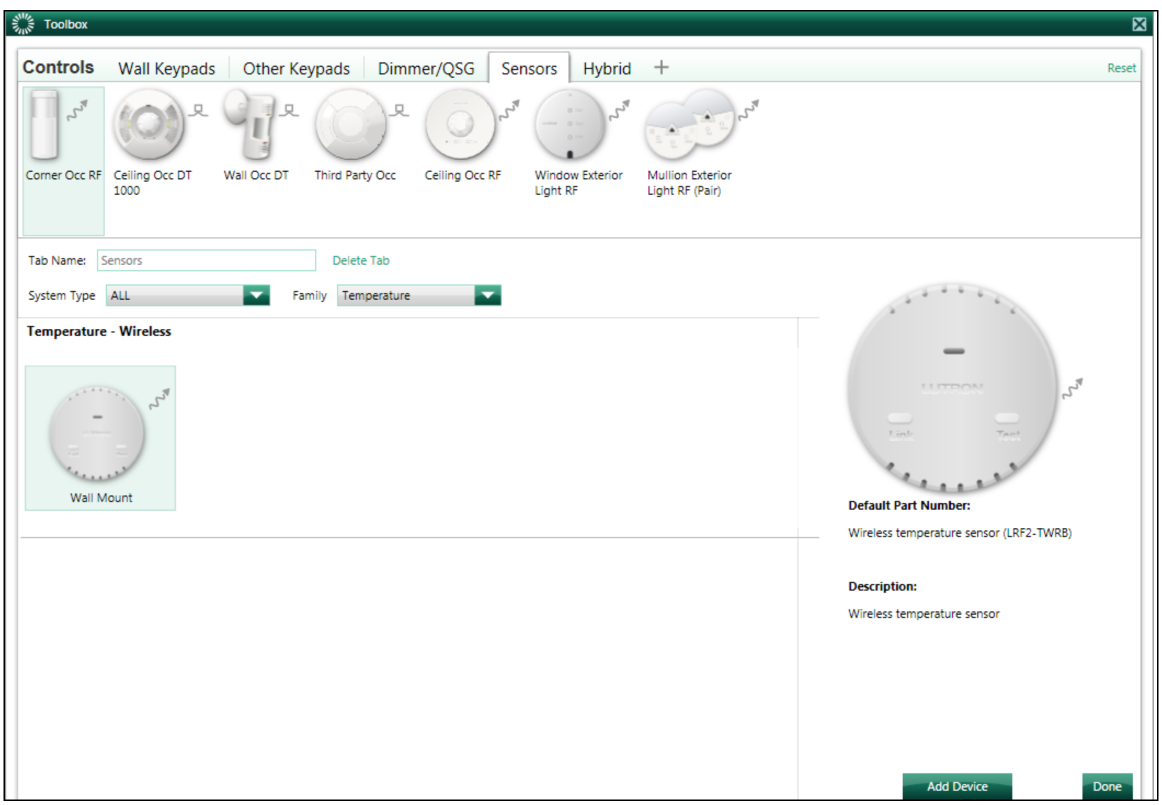

Figure 7: Temperature Sensor Family within Controls Toolbox

As with the Radio Window sensor family, when adding a temperature sensor to a project, a state table will be created. The wireless temperature sensors may now be added to a project without requiring a Lutron HVAC controller. If the sensor will only be used with a Lutron HVAC controller, however, then the state table may be ignored. For all other applications the state table shown in Figure 8 must be configured with the desired temperature ranges. All values between 40 and 100 degrees Fahrenheit or 4 and 60 degrees Celsius must be accounted for. The states names created here will act as single variables and appear on the programming tab and conditional logic for the sensor. As the temperature in the space moves between state ranges, the variable will change automatically. Although there is no limit on the number of states, it is recommended that no more than six states are used in order to make the programming more manageable. The temperature scale, either Fahrenheit or Celsius, will be based upon the selection made in the project settings. To change the current temperature scale, navigate to the project settings located under the tools menu.

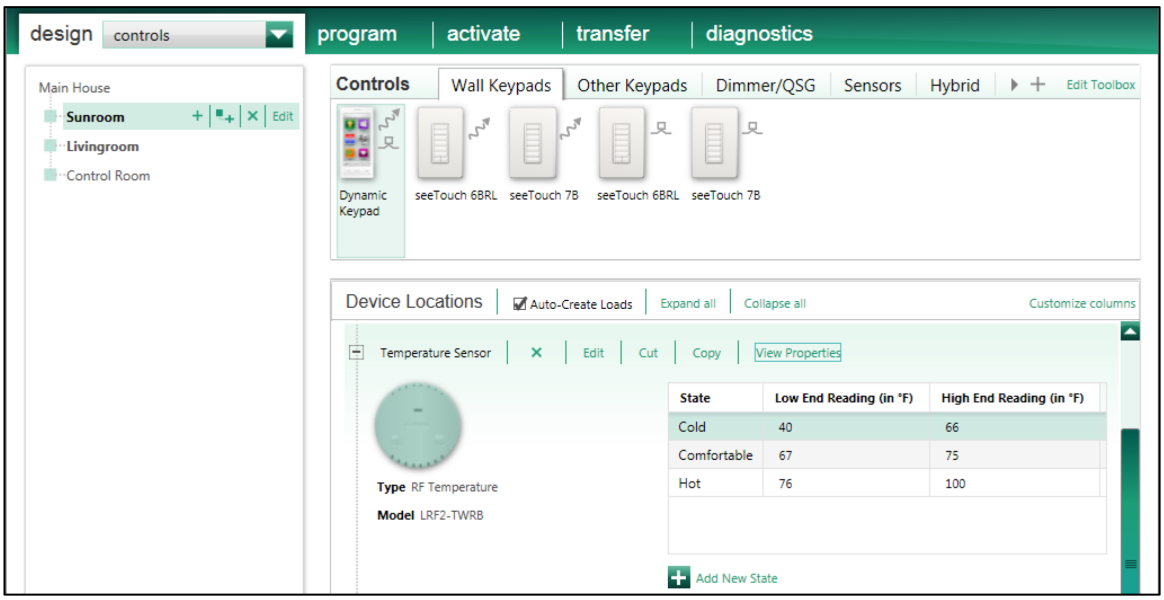

Figure 8: Adding a Temperature Sensor to the Project

4. Link Assignment and Activation

Radio Window Sensors communicate with the HomeWorks system via a QSM with wireless inputs. They cannot be assigned to the RF link through a Hybrid Repeater. Radio Window Sensors, Picos, and occupancy/vacancy sensors, up to ten each, may be assigned to each QSM within their standard 30 foot radius of wireless coverage. The single window mount sensor counts as one device whereas the mullion mount pair count as two assignments in the device limit. Figure 9 shows two Radio Window Sensors assigned to a QSM which can be found under the equipment design tab.

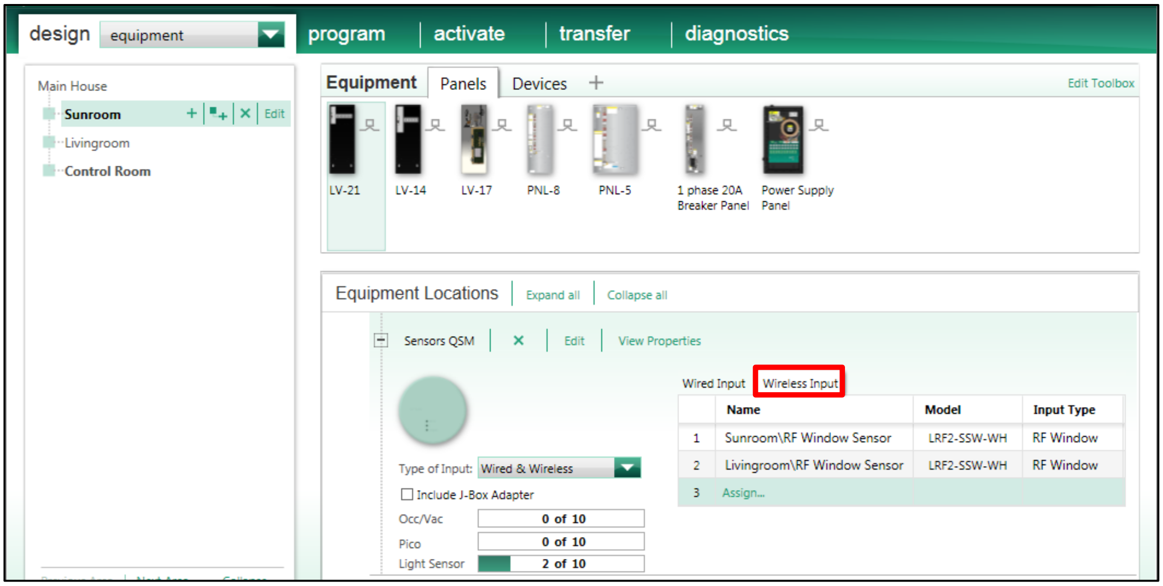

Figure 9: Assign Radio Window Sensors to a QSM Wireless Input

Although the QSM may have wired or wireless inputs depending on the model, all QSMs are assigned to the wired QS link. Window sensors and temperature sensors cannot be used with wired-only QSMs. Figure 10 shows a QSM assigned to link 2 of processor 1.

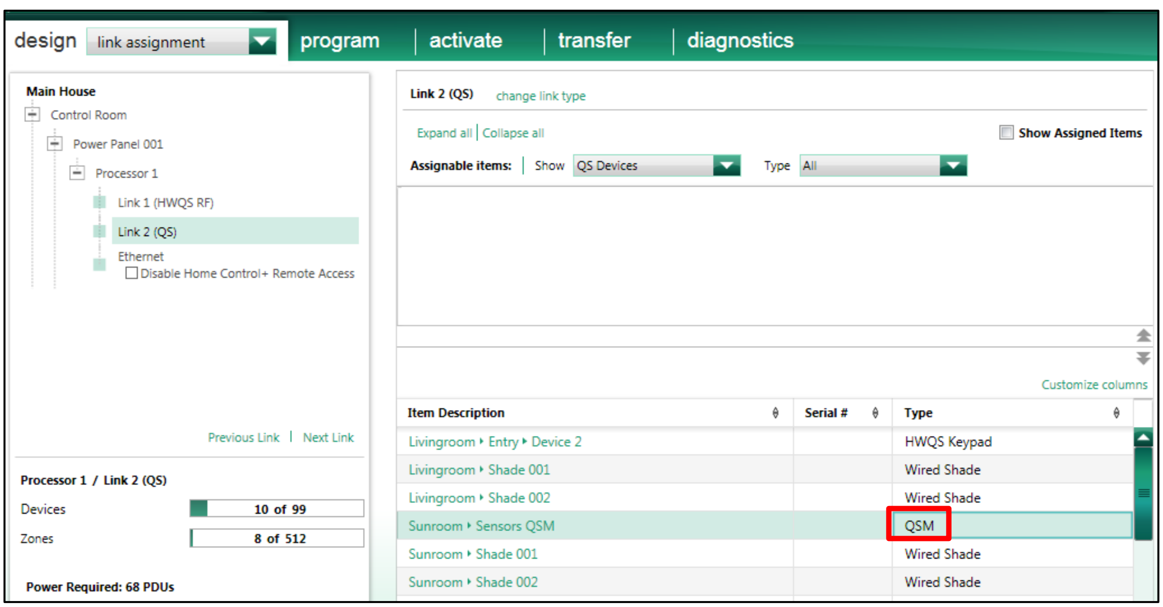

Figure 10: Link Assignment for QSM

After all devices are assigned to a link, they may be activated. Temperature sensors activate under the devices section on the RF link. The Radio Window Sensors however, are assigned to QSM's so the QSM must be activated before the associated sensors can be activated. Once the QSM is activated under the *devices* section, a full database transfer must be performed. A full transfer must be completed before the devices assigned to the QSM may be activated under the *QSM sensors* section of the activation tab (Figure 11).

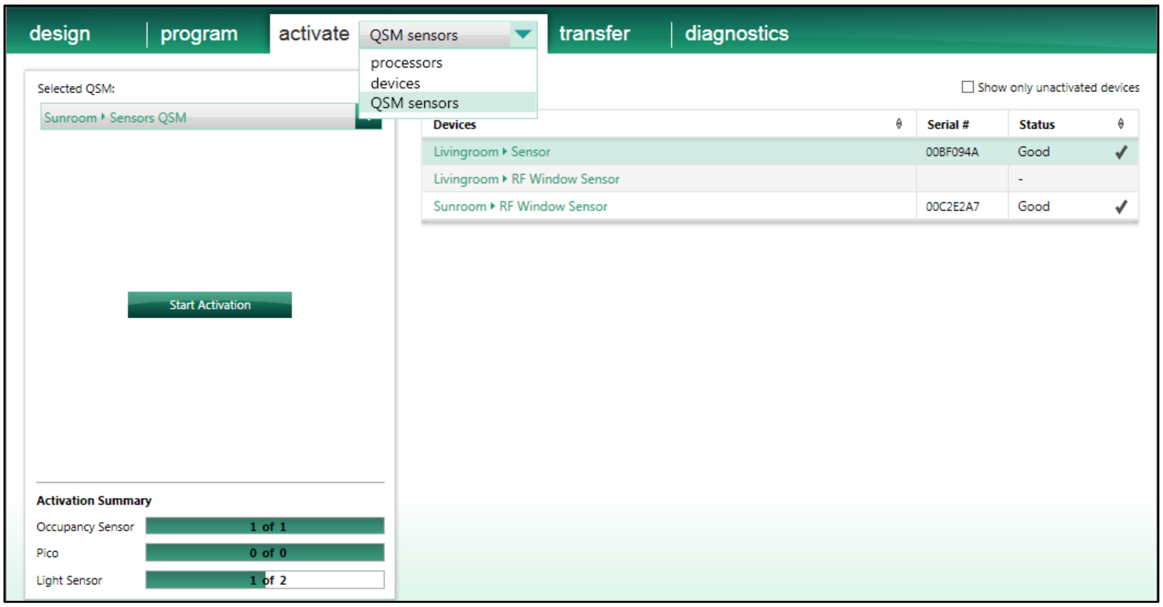

Figure 11: Sensor Activation

5. Programming

As mentioned above in the 'General Operation' section, daylight autonomy can be accomplished by applying programming to the sensor under the program sensors tab. Figure 13 shows three tabs for the three different light ranges (Dark, Average Light, and Bright) that were created in the state table for the sensor under the design tab shown in Figure 5. When creating any programming that will complete tasks automatically, it is always best practice to give the homeowner a way to disable it. The simplest way to accomplish this is by programming a button to change a variable which the automatic function is dependent upon. In the example below, "Sensor Control" is a variable created to accomplish this task via a keypad button (Figure 12). If the "Sensor control" variable is set to "Enabled" (via keypad, timeclock, etc), then the program will execute an action to close the shades (created under the Actions tab) when the Radio Window Sensor reads 299 foot candles [fc] or less.

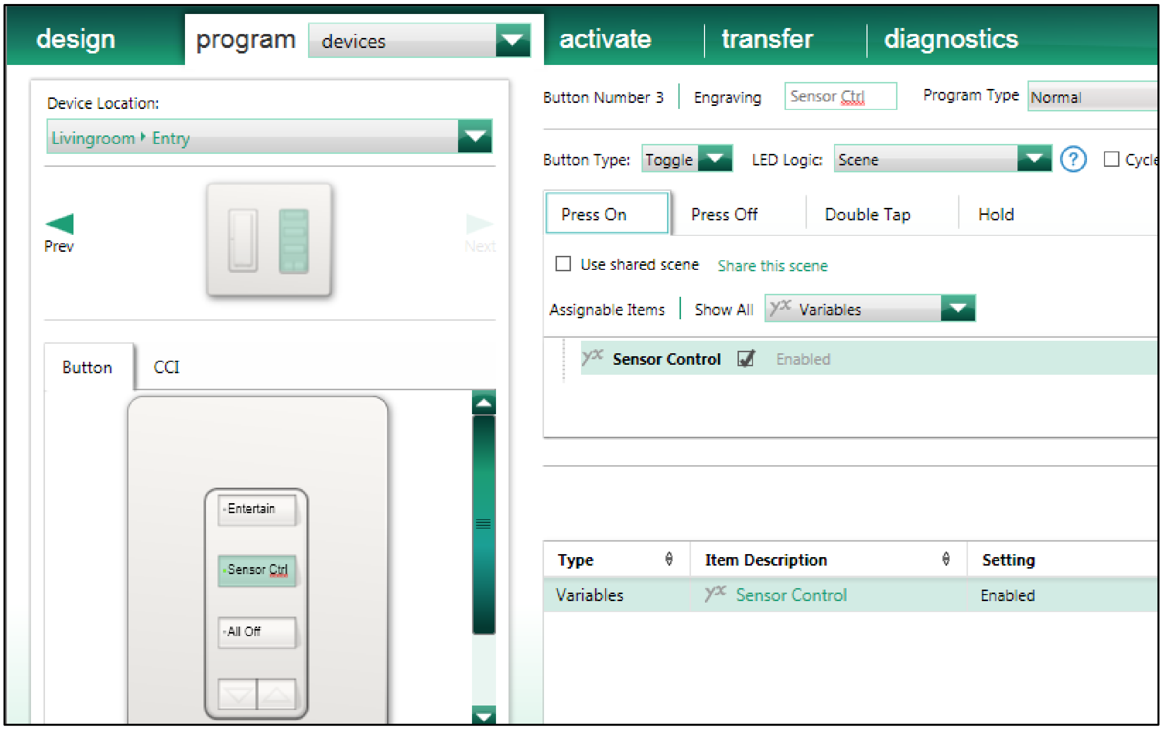

Figure 12: Variable to Control Window Sensor Programming

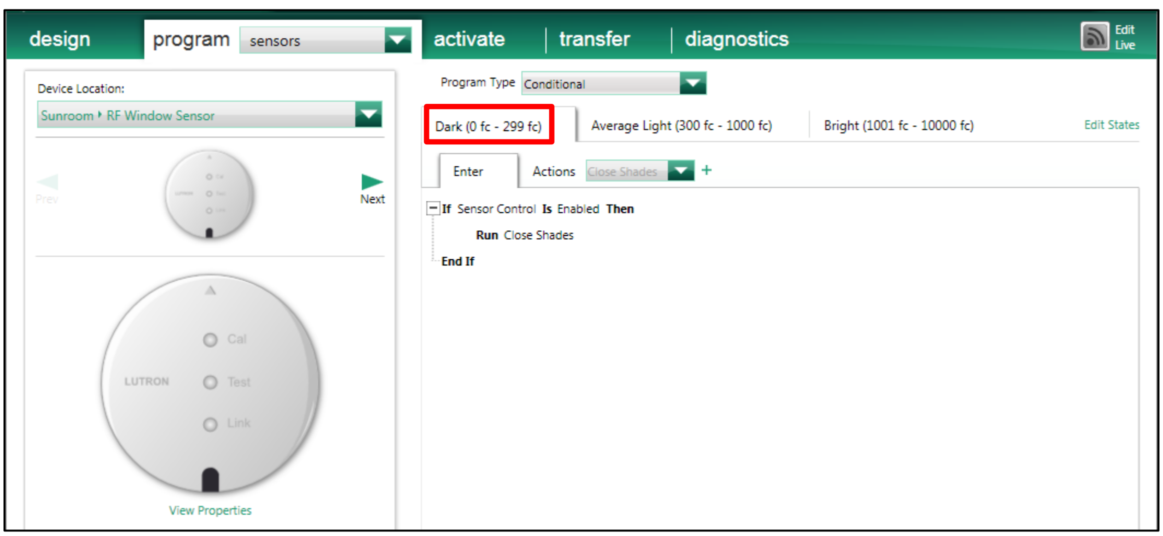

Figure 13: Sensor Programming

5.1. Example: Utilizing Light and Temperature Sensors to Monitor Solar Heat Gains

Different sensors can be used together to meet more complex criteria. Figure 14 shows an example scenario where a homeowner would like to utilize solar heat gain in the cooler months, but leave the shades closed in the warmer months to reduce solar heat gains. As done for the low light or "Dark" condition, the first line checks to see if the automatic sequence is enabled. If autonomy is enabled, it then checks if it is currently a warmer month (May – September) or cooler month (October – April). If it is currently a warmer month, then the solar heat gain from the bright light may make the space uncomfortably hot. By using a temperature sensor to check the temperature of the space as well, the shades can be automatically lowered to reduce the heat gain and strain on the air conditioning. On the other hand, if it is bright outside during a cooler month, the shades should be opened to better utilize the light to naturally heat the space.

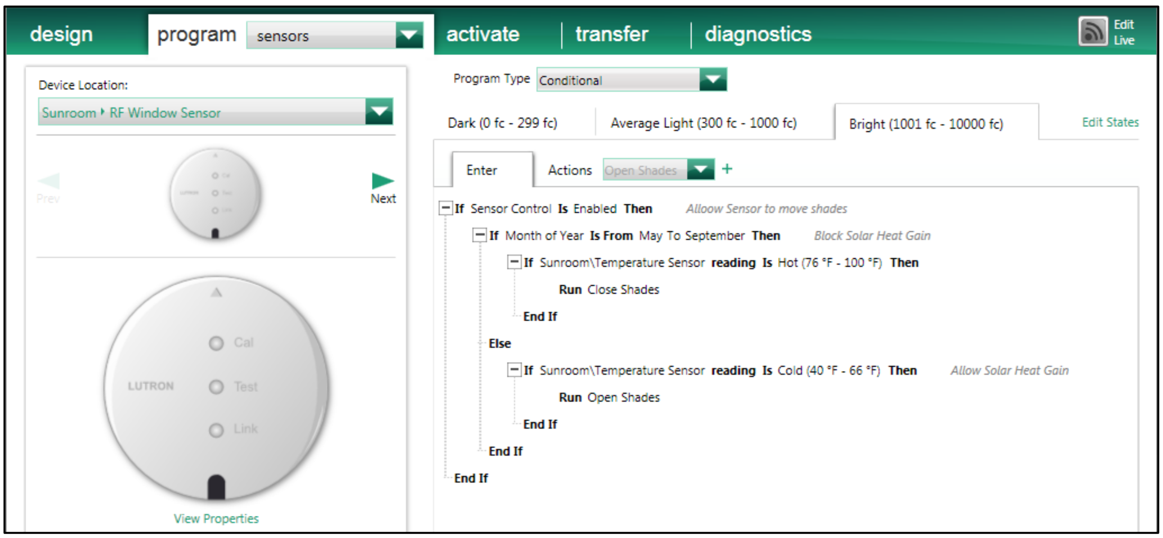

Figure 14: Radio Window Sensor Programming with Temperature Input

5.2. Example: Using Radio Window Sensors with Keypad Button Scenes

Sensor readings can also be used in conditional logic programming on keypad buttons to create different scenes based on the natural light available. The "Lights" button shown in Figure 15 is an example program that uses Radio Window Sensor readings to determine how shades should be positioned to best compliment the electric light. If there is little natural light available, the shades could remain closed for privacy. During cases where the button is pressed and there is a comfortable level of natural light, the shades should be raised. If there is too much natural light, venetians for example, could move to a preset tilt to reduce glare.

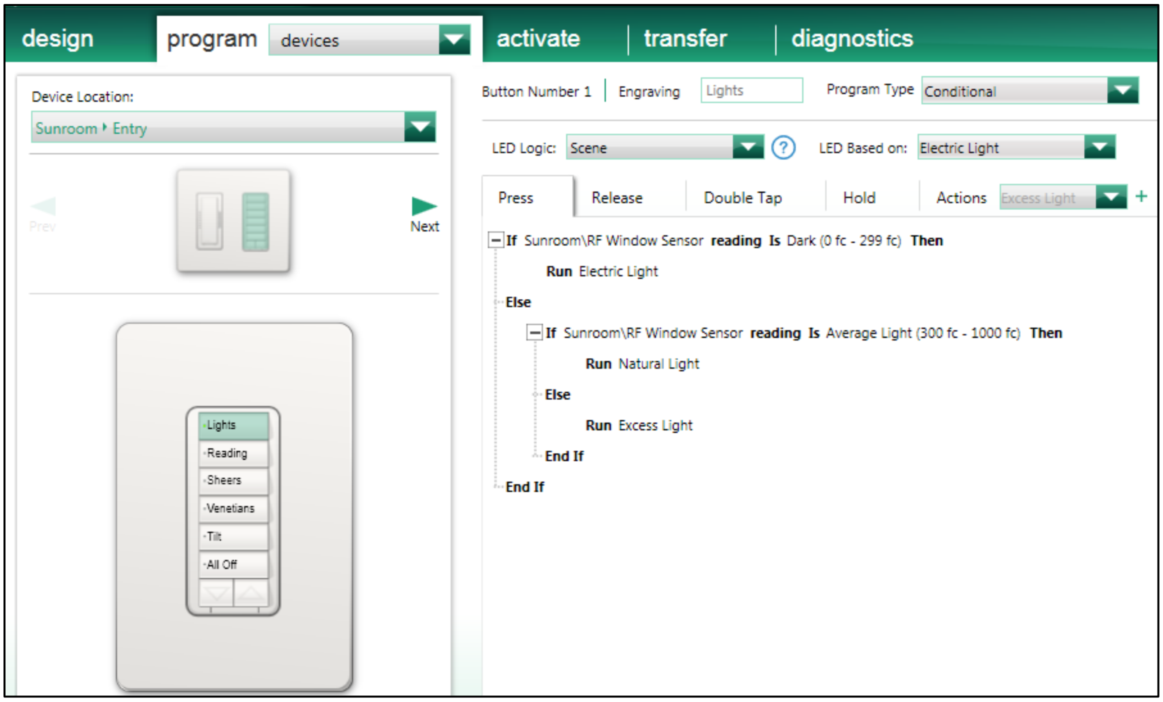

Figure 15: Keypad Button Programming

The example shown in Figure 15 is useful for applications where there is flexibility in the scene's light level such as sunroom. Button programming may be used in conjunction with sensor programming, however the last input into the system will be the last action that is executed. If the user sets a scene, but the light level later crosses a threshold in the state table, it will override the current scene. If this is not desired, either consider **not** using both button and sensor programming, or temporarily disable sensor control. See section 5.3 for an example of how this would be accomplished.

5.3. Example: Setting Scenes and Temporarily Disabling the Sensor's Control of Shading

Figure 16 is an example where the desired scene level is set, regardless of light conditions, and sensor control is disabled for two hours. This is again accomplished by setting the variable state, along with the light level, within the "Reading Scene" action. After a delay of two hours, the "Enable Sensor" action will change the variable state to re-enable sensor control of the lights and shades. This is programmed with the assumption that the user will leave the space within two hours without turning the lights off upon exiting. Additionally an "All Off" scene could be used to turn the lights off and allow the sensors to resume automatic control of the shades.

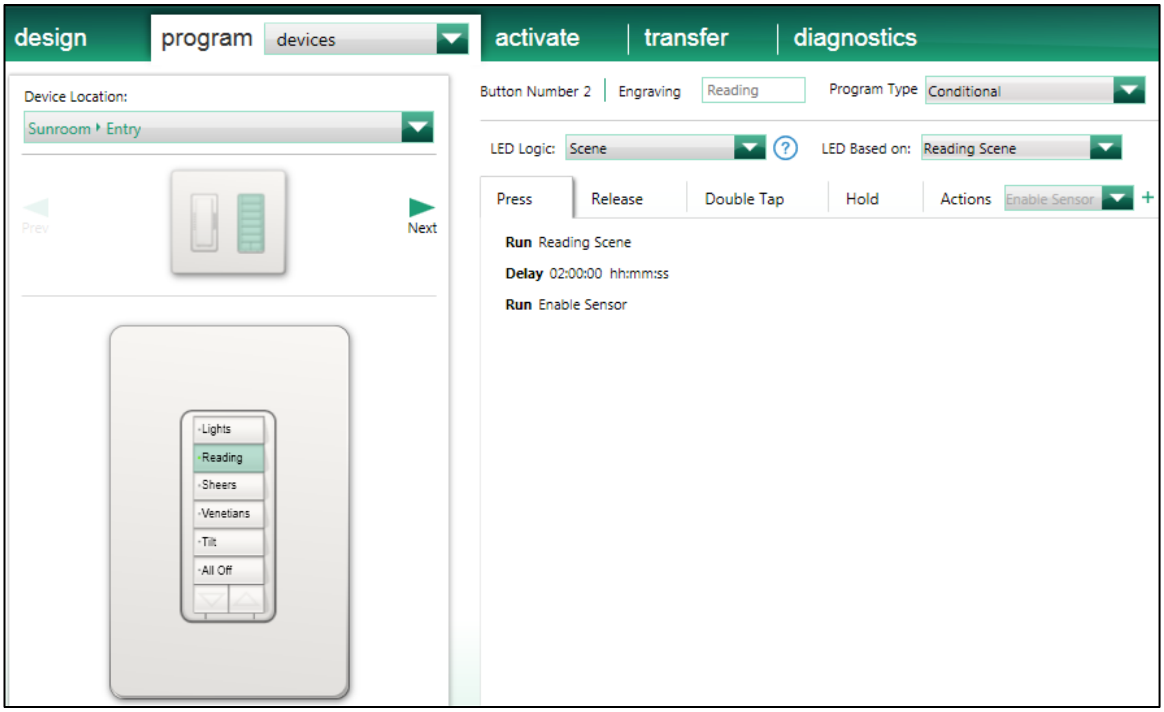

Figure 16: Keypad Button Scene

5.4. Example: Utilizing Occupancy/Vacancy Sensors

Example 5.3 makes the assumption that the space will be occupied for a maximum of two hours, during which the window sensor will not automate control of the shades. A more effective and accurate way to accomplish this is through the incorporation of occupancy/vacancy sensors. As shown in Figure 17, when the room goes unoccupied, the sensor control variable is enabled which allows the window sensor to resume operation of the shades. Likewise, the occupied tab could be used to disable control. Figure 14 shows how changing the variable state will allow or prevent window sensor control of the shades.

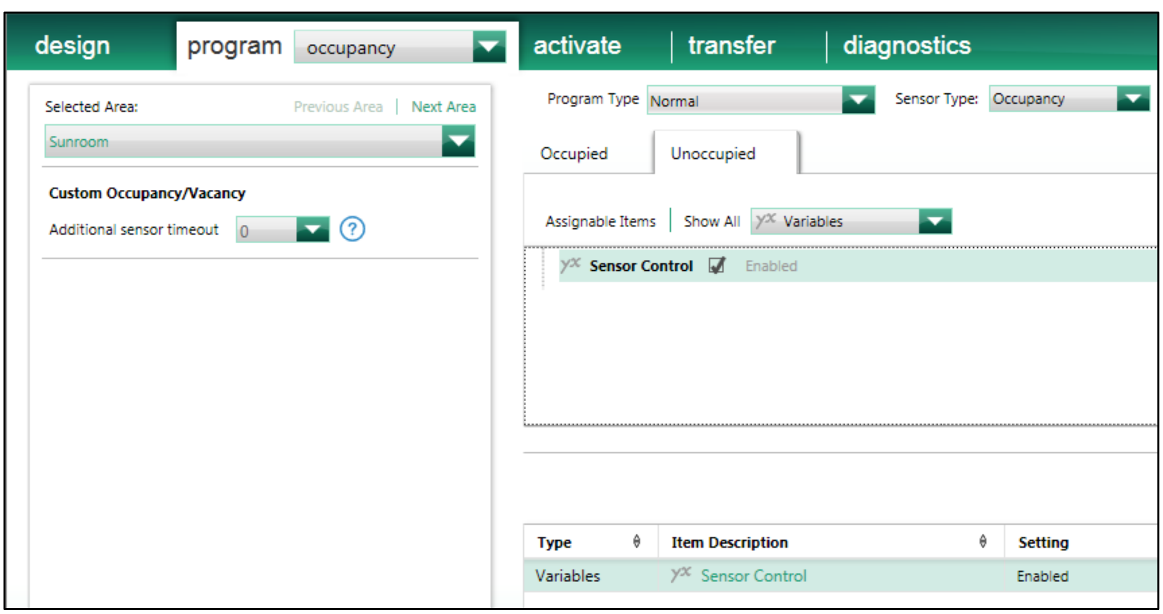

Figure 17: Occupancy Programming

6. Diagnostics

Since light intensity measurements are very sensitive to environmental conditions such as the amount of reflected light versus direct light and position relative to the sun, every façade will likely require a different state table. The diagnostic tab or terminal window can be used to extract sensor logs which can then be used to determine what range of temperatures or light each area is exposed to. Without checking these logs, some programming may never be executed because the sensor measurements may never reach all ranges entered in the table. Radio Window Sensors should be installed, and diagnostics performed, prior to finalizing programming due to the vast difference in light exposure that will exist between buildings and façade orientations. Knowing the foot candle range that each sensor will be exposed to is imperative to determine the max number of states necessary and range of foot candles that are required to achieve the desired response of the system. It is important to note that the intensity of light can vary greatly between seasons and should be considered when creating the state ranges. Measurements taken during a week in May could be vastly different than those taken during a similar time in October, for example.

By utilizing the command set shown in Figure 18, sensor logs can be displayed for the current day or past 3, 7, or 14 days. The data in the table will be displayed in the following format

Time of Sensor Reading || State Table Name || Reading in Foot Candles

Data is logged automatically when the measured light level changes by 20% from the previous reading. At low light levels early in the morning and late in the evening, the sensor will transmit at a set foot candle interval.

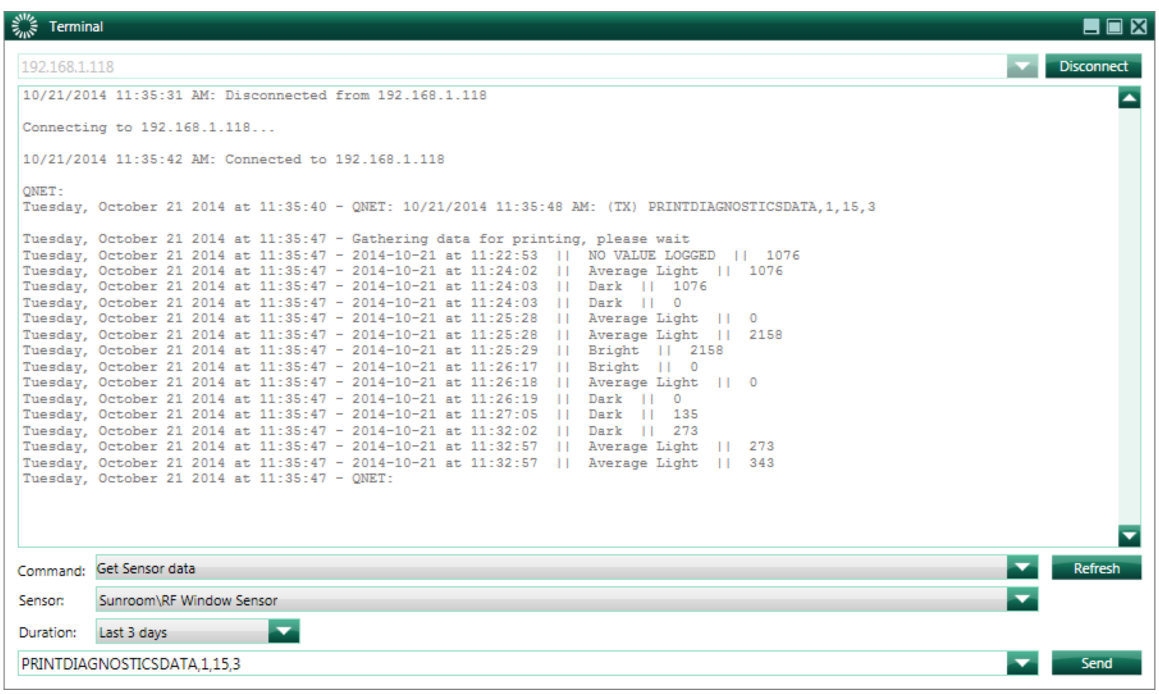

Figure 18: Terminal Window with Radio Window Sensor Data

By reviewing the data in Figure 18 it can be seen that the highest reading during this time period was 2158 fc. If there was a range in the state table from 3,000 to 10,000 fc the programming for that state would not have been executed because the sensor is not exposed to sufficient light. It is therefore important to collect lights data from the specific location to calibrate the system to the actual conditions.

7. Best Practices

When using Radio Window Sensors with battery powered shades, it is recommended that different radio frequencies are used for the hybrid repeater and QSM. Utilizing the same frequency for both the RF link and Radio Window Sensors may reduce the battery life of the surrounding shades.

7.1. Adding Sensors to Existing Projects with Battery Operated Shades

For projects where battery powered shades are already commissioned, it is easiest to change the channel of the QSM and associated sensors. Selecting a new channel for the QSM will remove the need to reactivate all of the RF devices on that repeater. The RF channel of a QSM may be changed under the device properties menu as shown in Figure 19.

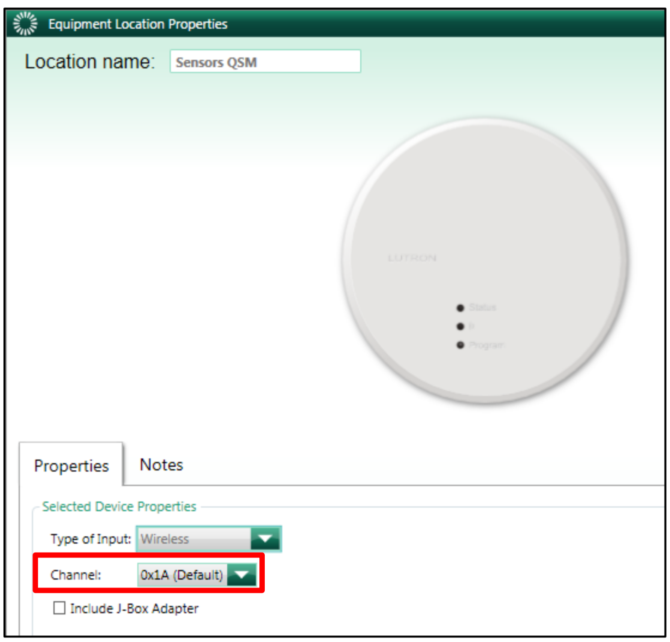

Figure 19: Selecting the RF Channel of a QSM

Refer to the “HomeWorks QS One-Way Transmitter Frequency Changing Procedures” document on the HWQS Resource Site for selecting the new channel on the associated sensors or picos during activation.

7.2. Utilizing Sensors on New Projects with Battery Operated Shades

For new projects where shades and sensors are being added at the same time, changing the RF channel on the HomeWorks QS RF link that contains the battery-operated shades is recommended. This will remove the need to manually change the frequency of the one way transmitters associated to the QSM such as picos, occupancy, or window sensors. The RF channel of a HomeWorks QS RF link may be changed under the link assignment tab as shown in Figure 20.

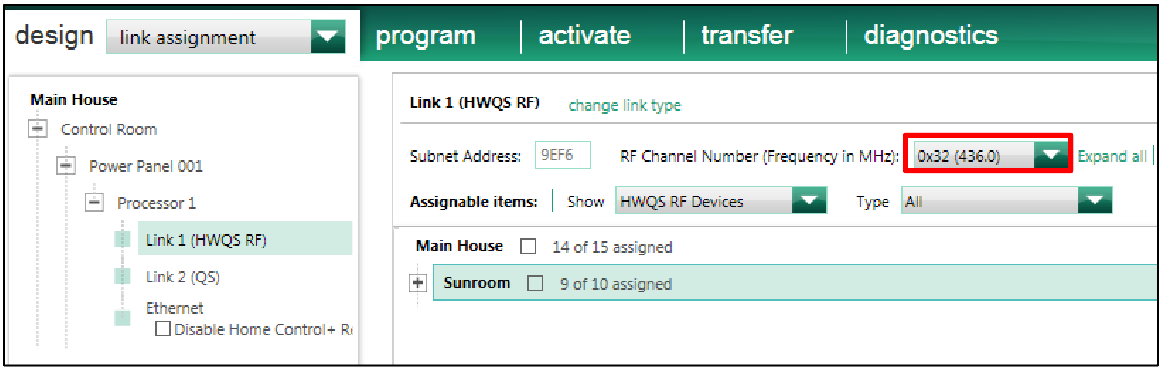

Figure 20: Configuring the RF channel of a HomeWorks QS RF link

Refer to the "HomeWorks QS One-Way Transmitter Frequency Changing Procedures" document on the HWQS Resource Site for selecting the new channel on the associated sensors or picos during activation. Since shades are not one way transmitters, there are no additional steps to be done with the shades.

8.0 Using Light or Temperature Sensor Data for 3rd Party Systems

Currently, there is no 3rd party integration support for Light or Temperature Sensor data acquisition from a direct command sent to the HomeWorks QS processor. If the Temperature Sensor is working with an HVAC Controller, current Room Temperature can be obtained by using an HVAC command. In the event of Light Sensors or Temperature Sensors without an HVAC Controller, the only way to currently get a real-time state or current room temperature is to define a variable with states that match the light or temperature states defined on the sensor(s).

Temperature Sensors are allowed to have states where the lower and upper bound matches such as "72 to 72." If a variable was defined with various temperatures as it states, including 72, the variable state could then be set to 72 every time the room temperature changes state at that sensor to 72. 3rd party systems can query the current state of the variable to then determine the current room temperature. The same process would apply for Light Sensor states.