Spin Project: Home Automation

Level: Intermediate
Skills Required: Soldering, Basic Electronic Circuits, Home Electrical, SPIN programming
Hours to Complete: 8+

View this project's YouTube video on the ParallaxInc YouTube channel.

This project shows you how to control home electrical systems using relay switches – specifically, light switches. In this project we also use two sensors: one to monitor sunlight and one to read outdoor temperature. These types of sensors are often used in modern "smart home" systems. If you are looking for more control over your home lighting and a simple way to monitor and display outdoor temperature readings at the same time; then this project will provide a good starting point.

In my case, I had a couple goals in mind when I started working on this Home Automation project. Mainly I wanted a way to automatically turn on and off my porch lights and to have a display that showed me the temperature outside. I wanted the porch lights to be automatic because I keep them on during the night, and each evening I had to manually turn them on. Having to personally monitor time of day and be home to turn on and off my porch lights accordingly led to my lights staying on even during daylight hours, especially on the weekends when I like to sleep in.

Below is an image of the finished wall-plate.

Some of the useful benefits I found that came out of this project are:

- Reduced electrical costs
    - With this system in place I was able to reduce the amount of hours my porch lights were on by 120+ hours per month!
- Remote control of lighting
    - Using an XBee module, lighting can be controlled from any place in or around the house.
- Automated light-control based on sunlight levels
    - This not only saves electricity, it's good security. The lights go on even when we are not home. As a local officer told me, "The more lighting around your house at night, the less likely criminals will be to do something." It's also really nice not to have to keep track of when to turn off and on this type of lighting.
- Display outdoor temperatures on your wall switch
    - I really like knowing the current outside temperature. Using my smartphone for a local temperature report isn't accurate enough; I want to know what the temperature is right outside my house.

What's Required

- (3) - 7-Segment Green LED (#350-00027)
- (3) - 74HC595 Serial to Parallel Shift Register (#602-00009, discontinued)
- (1) - Propeller Mini (#32150)
- (2) - Light Pipe (#720-28001, not sold online – call sales to order)
- (1) - Switch Plate "Blank" (Leviton 88025 Wallplate Standard Thermoset)
- (1) - Switching Power Supply 25.5W 7.5V 3.4A (EPS-25-7.5)
- (1) - 8-Channel 12-Bit SPI Serial Interface A/D Converter (#604-00062, discontinued)
- (1) - LM34 Temperature Sensor (#604-00011, discontinued)

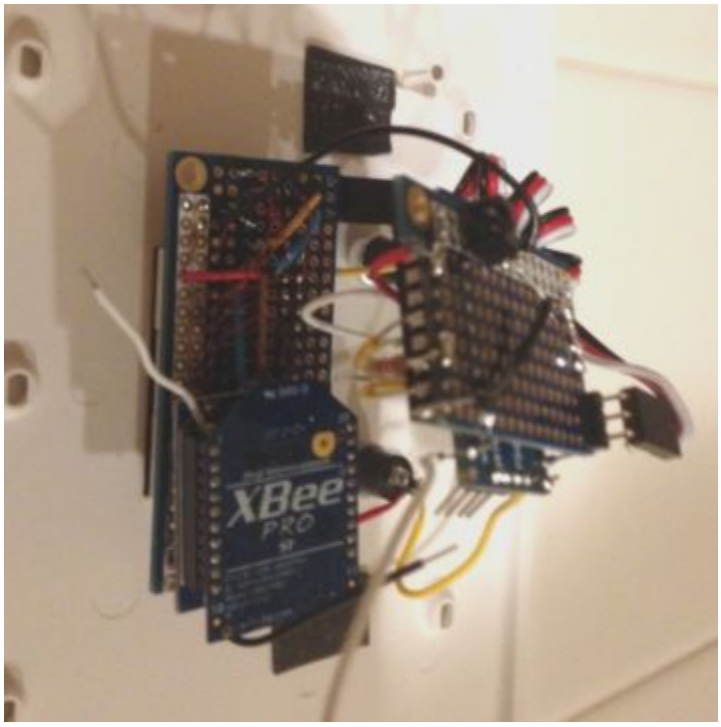
- (1) - 850NM T1 3/4 Phototransistor (#350-00029)
- (1) - Pushbutton OFF - (ON) SPST 3A

Note: Many of these parts are discontinued for sale or manufacture by Parallax, but may be found through other retailers, or have suitable replacements available through Parallax or other retailers.

Wire Up the House

The building and wiring of the unit is going to be based on your unique needs. All home outlets are different and the inside wiring is not always the same. The schematic and instructions below are a **guide** (but are not to be used as explicit instructions as every home is unique) and are there to aid in success with your own system.

TIP: It's also a good idea to first build the design on a breadboard. Use the sample code contained in this blog.



Below are the steps I took when physically wiring my personal system:

WARNING: TURN OFF THE BREAKER FIRST!
The first thing you want to do is locate the breaker switch for your outlet, and turn it off before proceeding. I marked my breaker so that I was sure I was turning off the correct section of the house. This step is a huge safety step and absolutely **should not be skipped**.

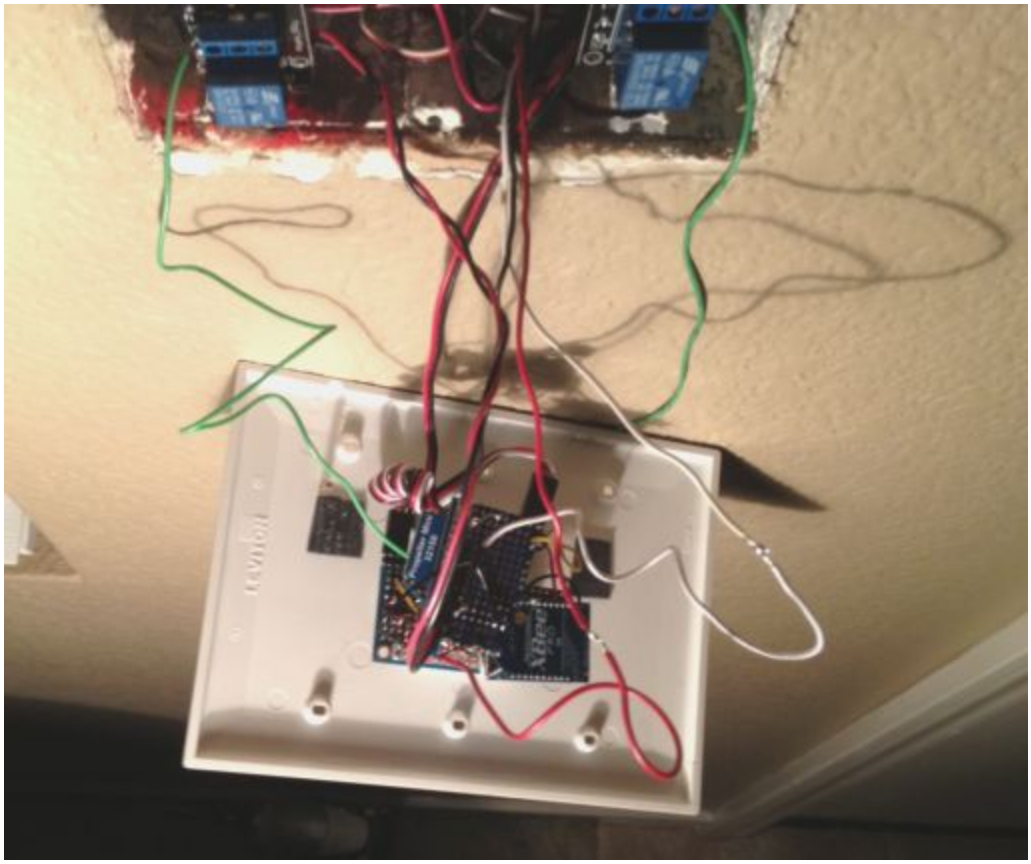
1. **Locate the breaker switch for your outlet and shut it off. Verify at the outlet that it is truly off before proceeding.**
2. I started by removing the old switches from the wall outlet.
3. Next I took apart the AC-DC power adapter and installed it in the wall box. I hooked up the AC 120 V to the wall plug ends of the adapter. Once this was done, I took a moment to turn power back on in order to test the adapter and make sure it was delivering the proper DC voltage.
4. Now I made room to drill the hole through the wall for the light and temperature sensor. Once the hole was there I installed both.
5. Then I installed the "Single Relay Boards" into the wall box. The connections were made per the schematic.
6. Next I installed the Propeller Mini along with the support circuits and power as per the schematic. Now all the the connections to the sensors and relays can be made.
7. Once that was done I cut and drilled out my wall plate to hold the two push button switches, the 7-Segment LEDs, and the "light pipes" that indicate which relay is on. After all of the holes and cuts were made in the wall plate, I installed each of the parts on the plate.
8. Once the rest of the parts were ready, I connected the pushbuttons and Serial to Parallel IC's to the Propeller Mini, per the schematic.

Now it is time to move on to the next section to program and test the system.

Test Your Automation Circuit

After the system is built, it is time to load and test the code.

- ✓ You will need a computer, along with a "Prop Plug" to talk to the Propeller Mini. Use the sample code provided and load that into the Propeller Mini. Remember that you will need to turn on power to load the code to the Propeller Mini.
- ✓ Test the light sensor by holding a finger over it to cover it (during daytime) or shining a bright light on it (during nighttime), to trigger the light to activate/deactivate. Also, check to make sure the display is running, and check that the pushbuttons are properly turning the relays on and off.
- ✓ Once everything is working right, close up the wall box by screwing in the new wall plate.



The demo code provided is designed to work with the way the schematic (see previous section) is laid out, adjustments may need to be made depending on your house's wiring.

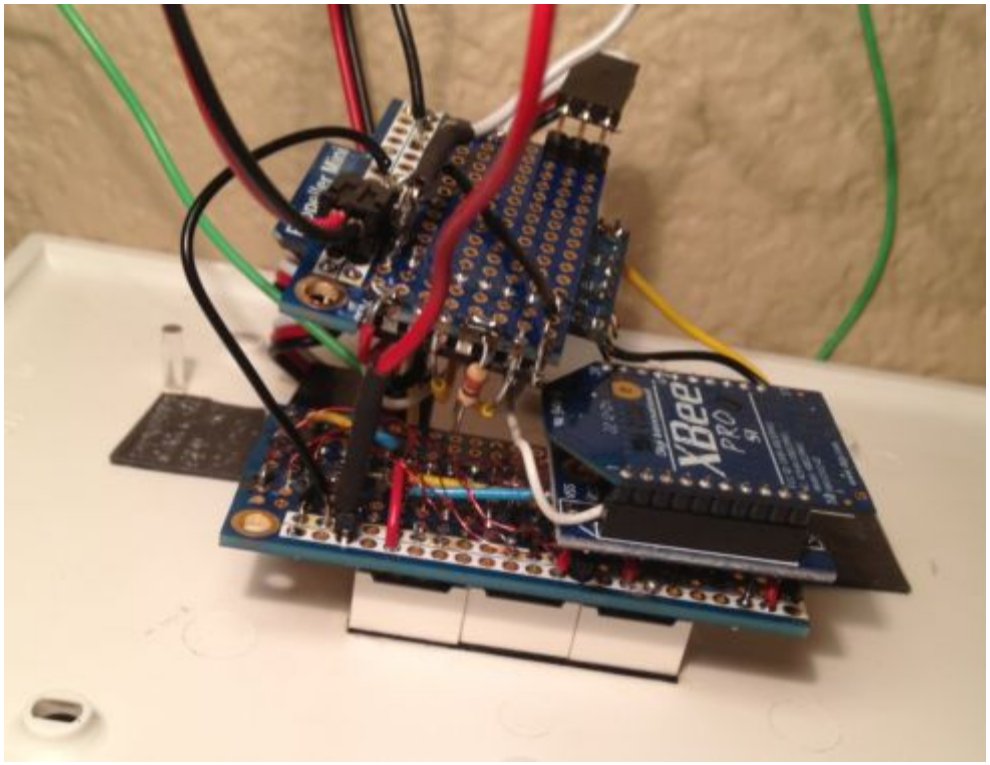
TIP: If you want to display and debug the code for any reason, use the "Parallax Serial Terminal" along with F12 hotkey to bring up the serial terminal window. As an example, if you wanted to see whether your temperature sensor is working right, the Parallax Serial Terminal can show you its status. You could start the object with PST.Start(9600) and in the main loop add PST.dec(Temp).

How the Automation System Works

In this project we are taking out two regular home light switches and replacing them with relay switches. With a relay switch, you don't need to turn them on and off manually; these relays can be switched on and off by 3.3 VDC. The 3.3 VDC here comes from the I/O pins of the microcontroller (Propeller Mini).

We also have two sensors: a temperature sensor (LM34) and a light sensor (phototransistor). The sensor data is monitored by the Microcontroller; temperature is displayed on the 7-Segment LEDs. Since we don't want to lose the ability to manually switch on and off the lights, we have also installed two low voltage push buttons. These are also monitored by the microcontroller.

Notice that the microcontroller is the "heart" of this project. It takes in all of the data from the sensors, buttons, and any other items we want to include, and then it outputs that data where we want it to go.



Additional upgrade idea: although not included in the instructions for this project, adding an XBee Module (wireless transceiver) makes this project much more useful. With it we can not only re-use the sensor data, but we can also control the system remotely.