

# [Tiny] Home IOT

Part 1 – Lights and Ambient Conditions



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# [Tiny] Home IOT

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# [Tiny] Home IOT

## Introduction

Today we will be building a smart home in miniature. We will be installing all of the real-world components onto tiny cardboard homes. When you get home today you can scale up instantly to your real-world home.

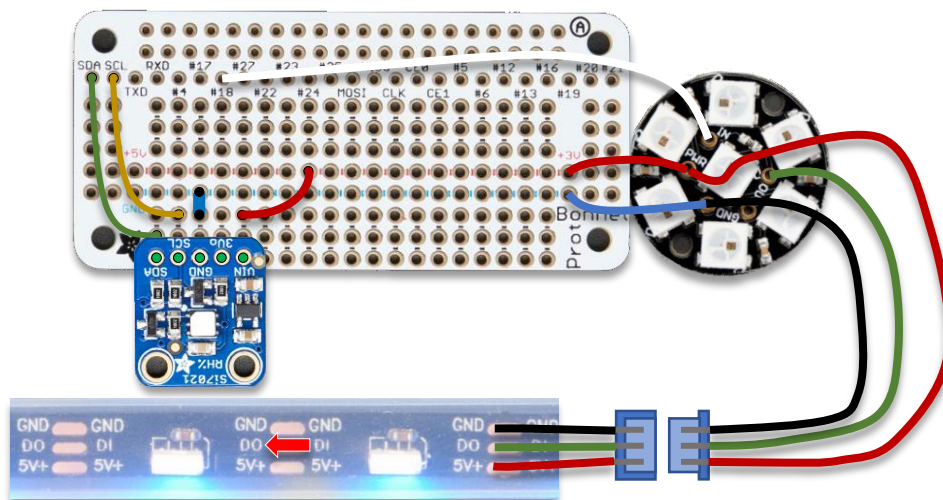
## Components

We will be working with the following components:

1. Things to monitor / measure / control
  - a. Temperature – Si7021 dual temperature & humidity sensor
  - b. Humidity – Si7021 dual temperature & humidity sensor
  - c. LED light device [indoor] – NeoPixel Jewel with 7 addressable RGB LEDs
  - d. LED light strip [outdoor] – 0.25 meters of NeoPixel strip
2. Controllers & Hardware
  - a. Raspberry Pi Zero W – WiFi controller for everything
  - b. Raspberry Pi Zero Prototype “Bonnnet” – Prototype board to organize connections
  - c. JST connectors – allows you to quickly connect or disconnect components
3. Other
  - a. Wire & soldering wire
  - b. Connectors for your Pi – mouse, keyboard, monitor, 5V 2A power supply
  - c. A cardboard house

## Assembly Instructions

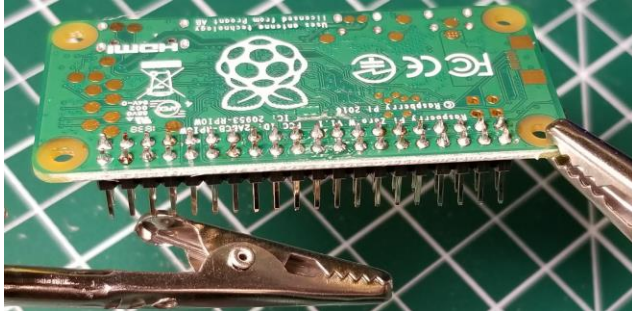
### Wiring Diagram of the Finished Product



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## Step by Step Instructions

1. Solder the male header onto your Pi Zero W (10 minutes)
  - a. Short pins go into the board from the top (solder from the bottom)
  - b. Plastic spacers are on top of the board with all the chips/components (opposite the screen printing).
  - c. Longer pins are facing up from the top of the board.
  - d. Solder from the bottom

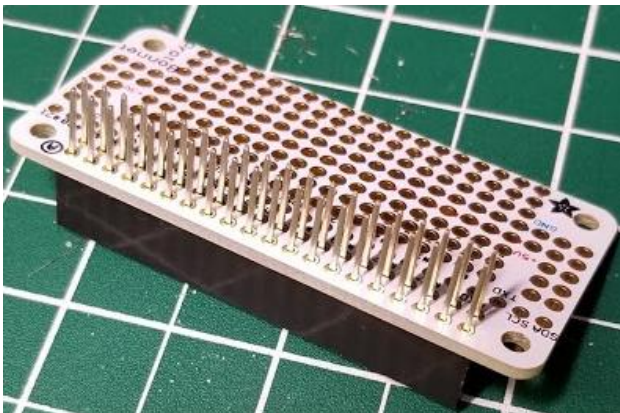


**Bottom of Pi Zero W**

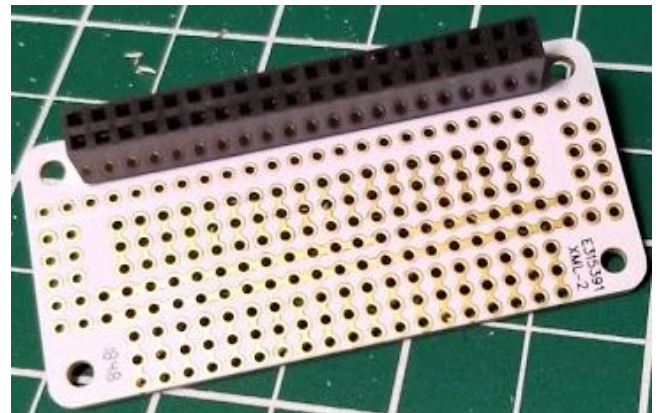


**Top of Pi Zero W**

2. Solder the female header onto your Prototype Bonnet
  - a. In this case the top has the screen printing
  - b. The long pins should insert from the bottom/back of the board up through the holes.
  - c. The plastic boot will be under the board.
  - d. Solder from the top.



**Top of Prototype Bonnet**



**Bottom of Prototype Bonnet**

3. Solder the header onto your Si7021 Temperature & Humidity sensor
  - a. The top of the board says Si7021 and has the components mounted to it
  - b. The bottom of the board is relatively flat and has the Adafruit Logo screen printed on it.
  - c. Break the header pins using needle nose pliers, so you have 5 pins in the group.



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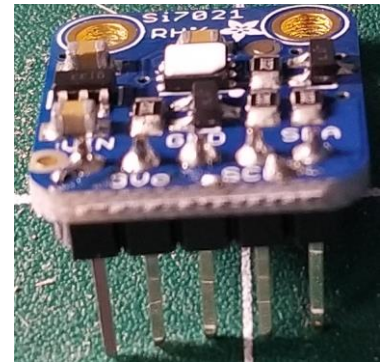
- d. Insert the short pins from the bottom of the board (logo) up and solder from the top.



Top of Si7021

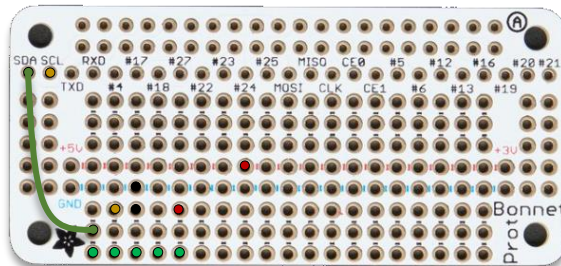


Bottom of Si7021

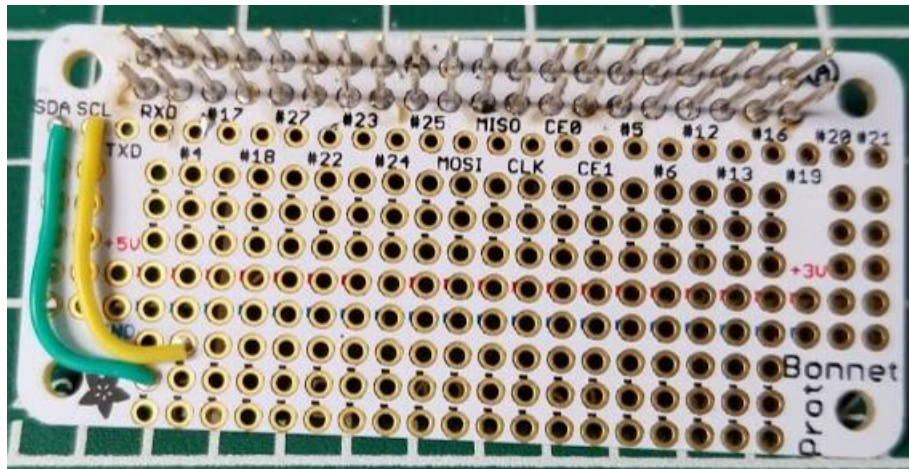


Si7021 w/Header

4. Set up the temperature sensor on the bonnet
- a. Solder a short green wire from the **SDA** hole on the top left of the bonnet to the middle hole of the first (left most) column of holes (3 to a column) at the bottom of the board.



- b. Solder a short yellow wire from the **SCL** hole on the top left of the bonnet to the top hole of the second (from left) column of holes (3 to a column) at the bottom of the board.

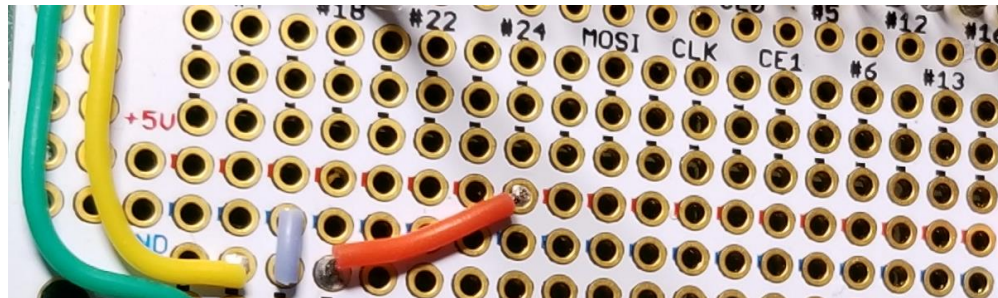


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- c. Solder a short blue wire from the ground holes (strip of holes across the middle of the board with blue paint connecting them) to the top hole of the third (from left) column of holes (3 to a column) at the bottom of the board.

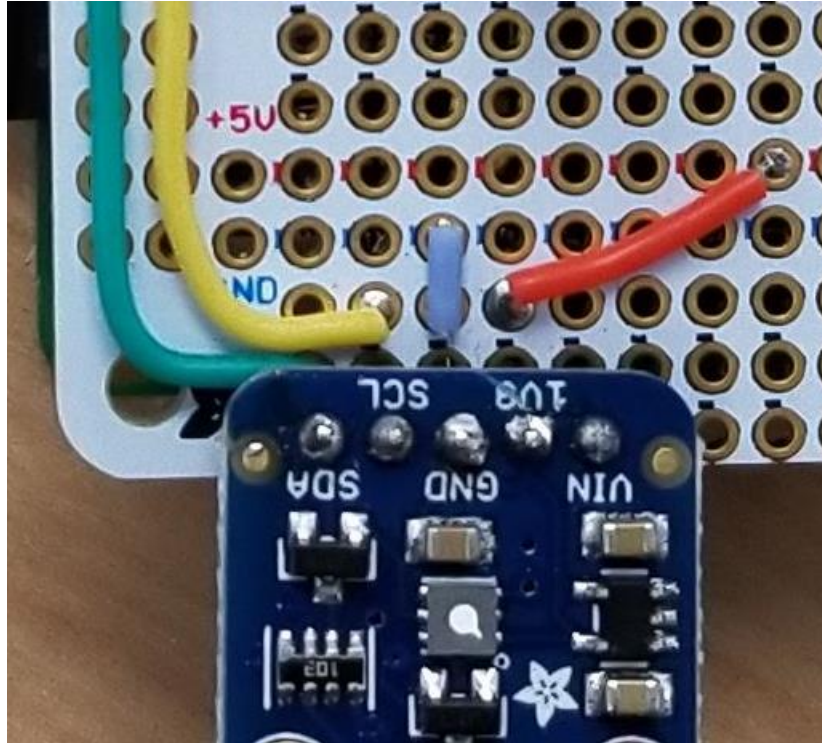


- d. Solder a red wire from the left most **3V power** holes (strip of holes across the right side of the middle of the board with red paint connecting them) to the top hole of the fourth (from left) column of holes (3 to a column) at the bottom of the board.
- Please note that while blue ground goes all the way across the board, the red power band is broken into two sides (roughly in the middle).
  - 5V power is on the left.
  - 3V power is on the right. We want the 3V power supply.



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- e. Insert the pins on your sensor into the bottom left holes on your bonnet.
  - i. **SDA** pin is on the left,
  - ii. Ground (**GND**) pin in the middle matches the blue wire,
  - iii. And the **V3** pin aligns with the red wire.



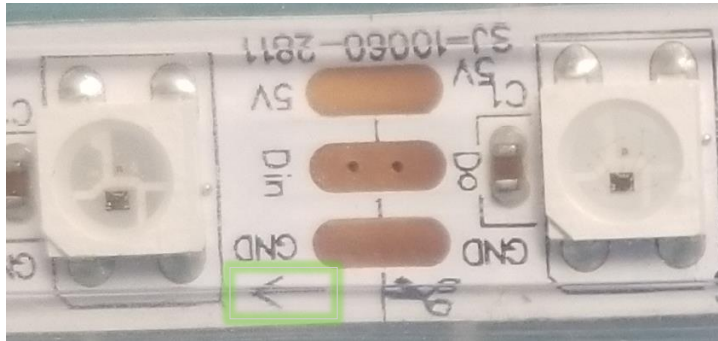
- f. Solder the pins onto your bonnet from the bottom of the bonnet.
5. NeoPixels
- a. **IF your NeoPixels DO have wires attached skip this step.**



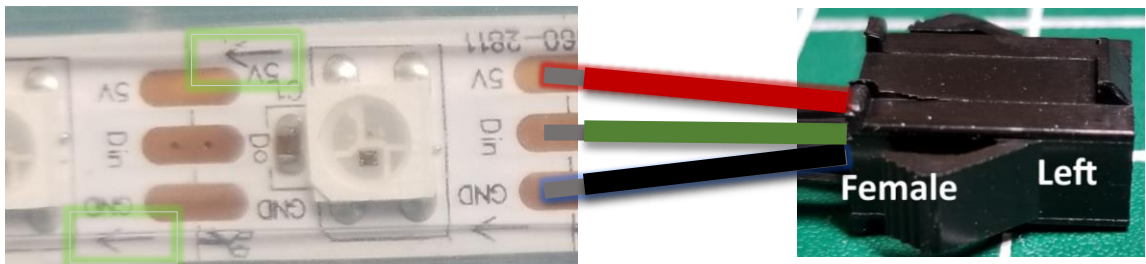


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- b. IF your NeoPixels ***DON'T*** have wires attached, carefully solder the **JST** connector wires to each pad on the strip as follows:
- Be sure you are soldering on the correct end of the **NeoPixels**
    - Look carefully at your strip and notice the arrows printed on the tape.
    - Place the strip on the table with the arrows pointing left



- The pads you want to solder to will be on the right side of the strip. **See the JST description below.**
  - 5V+** power (top/farthest away from you pad) to red wire
  - Data **Do/Din** (middle pad) to green wire
  - GND** (bottom/closest to you pad) to black wire



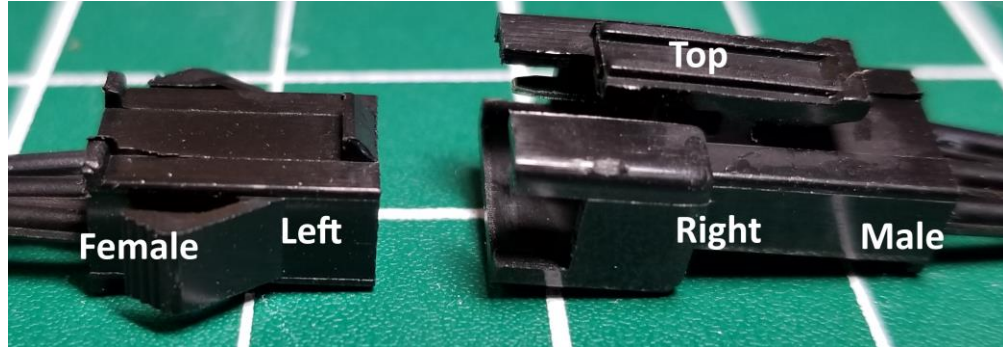
**Correct alignment of NeoPixel Strip**

- Notice the arrows are pointing left.
  - The central signal pads are labeled: Din <> Do
  - Use the wires from the left side of the JST connector.
6. Cut 4 solid core wires 6 CM long and strip each end, one each of
- Red
  - Blue
  - Black
  - White

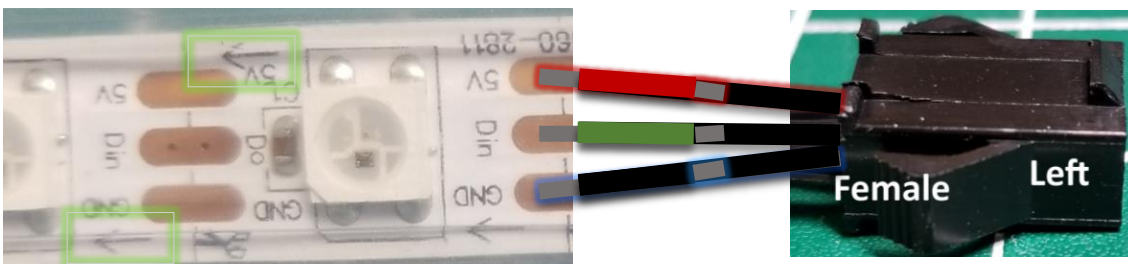


## [Tiny] Home IOT

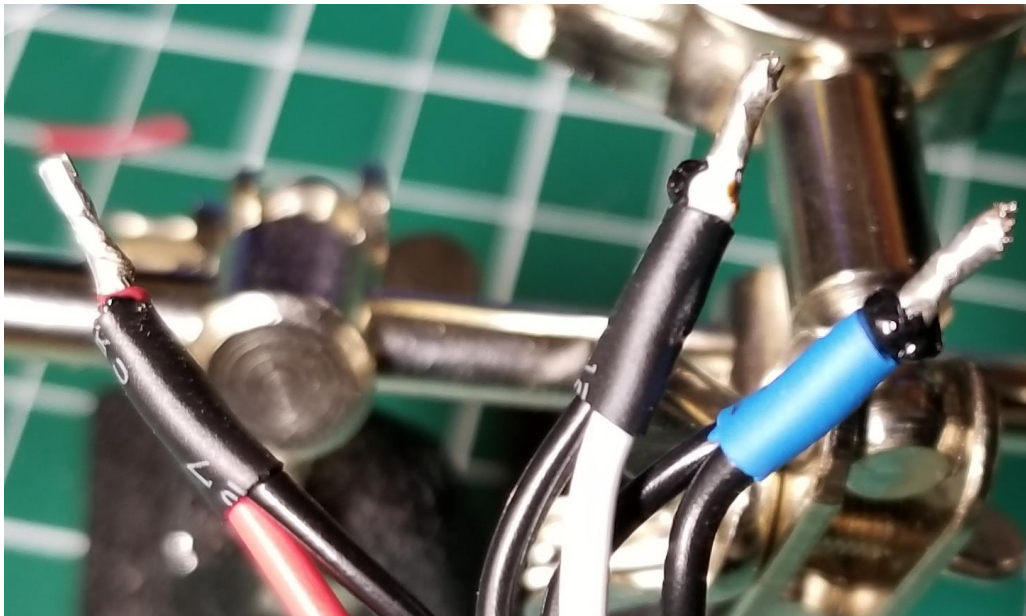
7. Place the **JST 3 pin connector** on the table and identify both sides of the connector
  - e. The **'right'** side has the clip to hold the two pieces together.
  - f. The **'left'** side doesn't have a clip but does have a small bump to capture the clip.
  - g. The **'top'** is the part with the clip or the bump for the clip to clamp to on the other side of the connector.



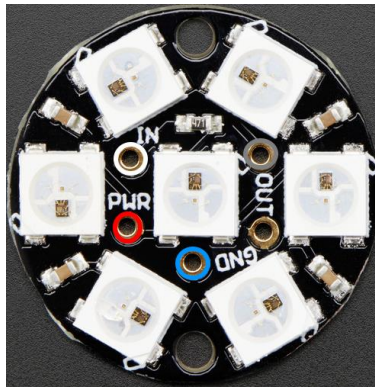
- h. Place the connector on the table with the clip up and on the right side.
  - i. The left side will go to your strip LEDs (may already be attached)
  - ii. The right side will go to your Jewel
- i. From the right (male) connector, solder each of the following connections
  - i. The top wire (furthest from you) will be power: connect to red piece of wire.
  - ii. The middle wire will be signal/data: it will not be connected to another wire.
  - iii. The bottom wire (closest to you) will be ground: connect to the blue piece of wire.
- j. Use a small bit of electrical tape and heat shrink to secure the soldered connection on the Red and Blue colored wire connections listed above.
- k. On the LEFT (female) connector wires (skip this step if you had to attach wires to your NeoPixels above). Solder each of the following wired connections.
  - i. The top [red] wire from the strip (from 5V+ on the strip) to the top wire (furthest from you) of the connector. This wire may be red.
  - ii. Repeat for the middle [white or green] (data Din/Do) wire
  - iii. and the bottom [black or blue] wire (closest to you; from GND on the strip) wire.



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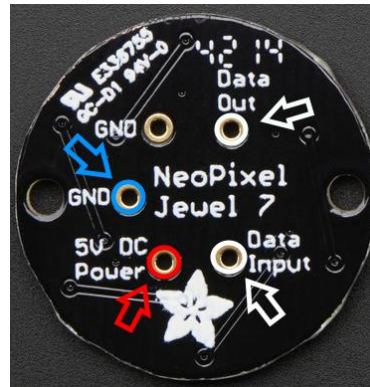


- iv. Add a piece of electrical tape and another piece of heat shrink over the soldered end to insulate them.
- 8. Using the right hand side of the JST connector,
  - I. On the Jewel
    - i. Top has the white LEDs mounted on it
    - ii. Bottom is smooth



**Jewel Top**

Insert wires from this side



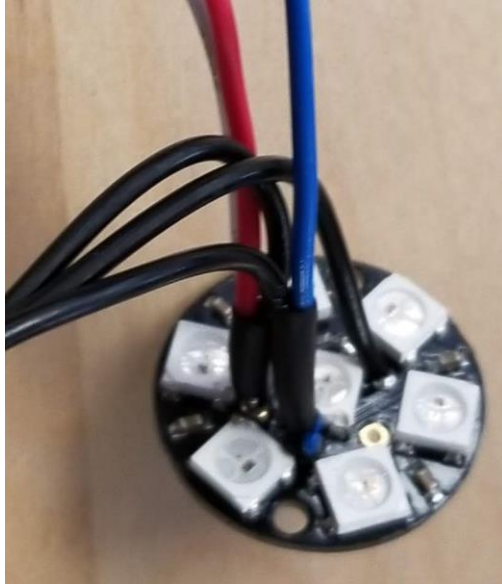
**Jewel Bottom**

Solder from this side

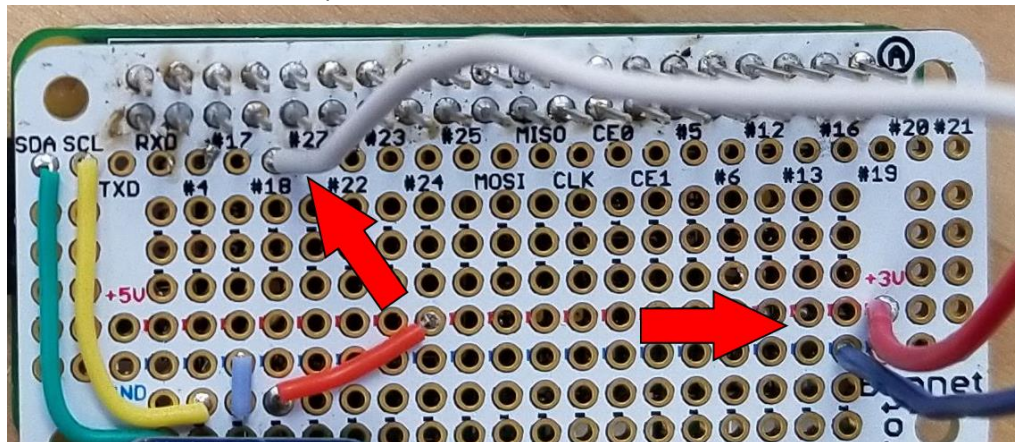
- m. Insert the dual red power wires into the PWR hole of the Jewel from the TOP and solder from the BOTTOM.
- n. Insert the dual blue ground wire into the GND hole of the Jewel from the TOP and solder from the BOTTOM.
- o. Insert the single white wire into the Digital In (DIN) hole of the Jewel from the top and solder from the BOTTOM.

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- p. Insert the middle JST wire (the one that isn't bound to another wire) into the Digital Out (DOUT) hole on the Jewel from the top and solder from the bottom.



9. From the Jewel, bend the JST Connector out of the way and focus on the unconnected wire ends
- q. Connect the red wire to the last 3V power hole on the bonnet on the far right (insert the wire from the top of the bonnet, solder from the bottom)
  - r. Connect the blue wire to the last ground (GND) hole on the bonnet on the far right (insert the wire from the top of the bonnet, solder from the bottom)
  - s. Take the white wire from the Jewel that is connected to the DIN hole of the Jewel and solder it to the hole on the middle of the bonnet labeled #18 (the hole is above the #18). Insert the wire from the top of the bonnet, solder from the bottom.

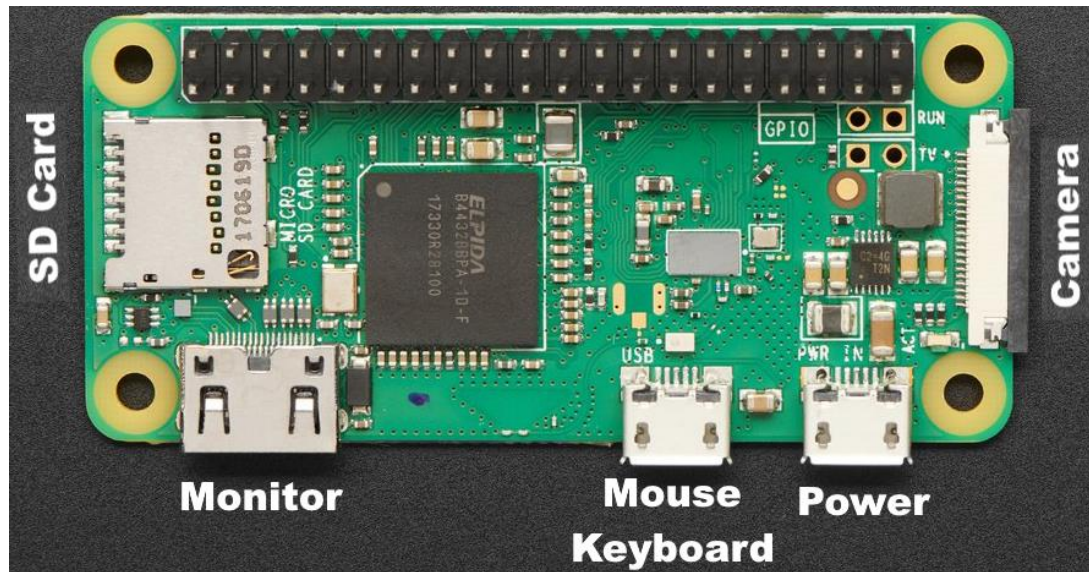




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### 10. Finish assembly

- a. Carefully insert the prototype bonnet into the female header on the Pi Zero W.
- b. Place the entire Pi assembly into your tiny home.
- c. Hook up the wires for your PI's HDMI, power, and mouse/keyboard via the rectangular hole in the bottom-right (when viewed from the front) of the back wall.
  - i. See [Connecting the Pi](#) below for information on how to connect your Pi.
  - ii. Be sure you have a pre-configured SD card inserted into your PI as well.  
<https://www.raspberrypi.org/documentation/installation/installing-images/>



- d. Thread the JST connector out the rectangular hole in the top-left (when viewed from the front) of the back wall.
- e. Tie-wrap your NeoPixel strip lights to the outside of the roof, making sure the JST connector is toward the back-left of the house (when viewed from the front).



- f. Connect the JST connector and place the roof on the house.

Congratulations! You have built your Pi Zero W home controller and tiny home.



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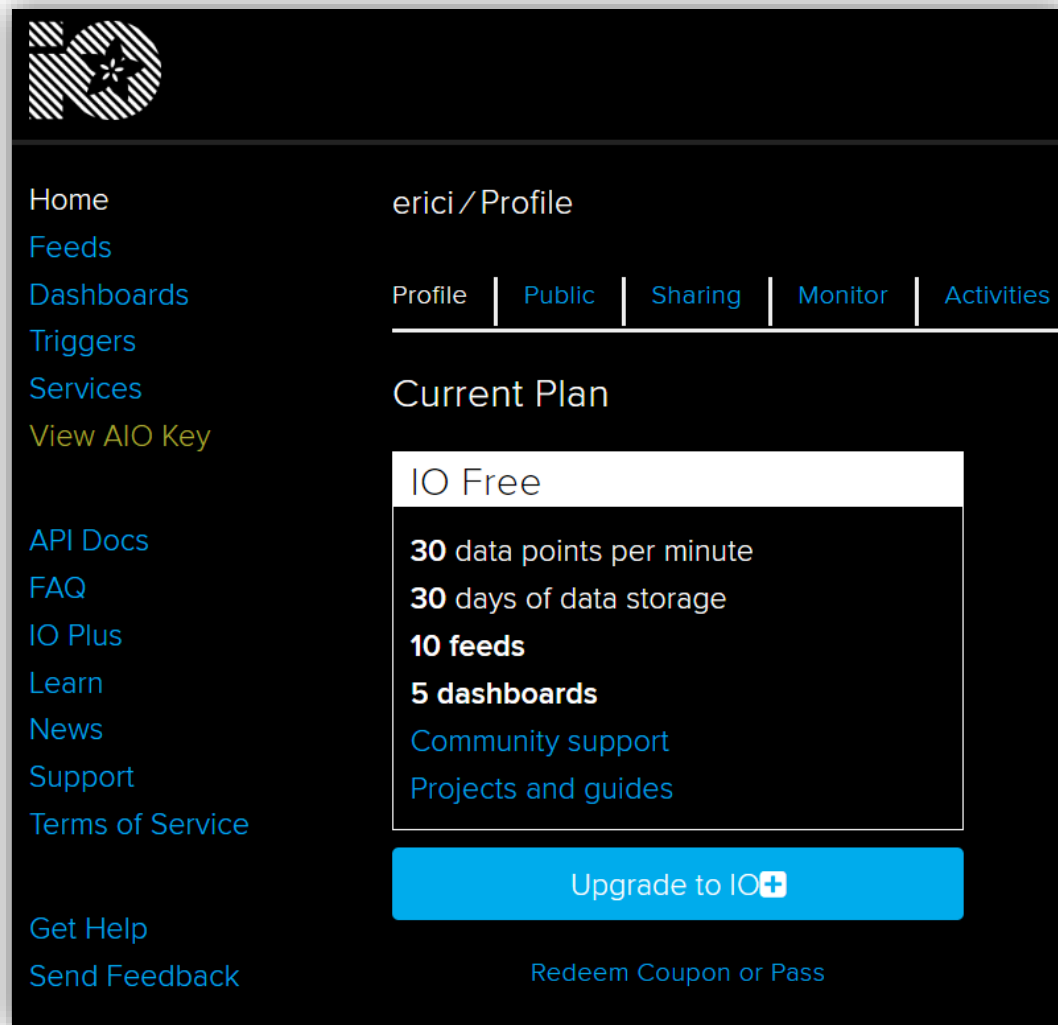
### Setup Adafruit IO

For more information on Adafruit IO see the introduction:

<https://learn.adafruit.com/welcome-to-adafruit-io?view=all>

### Create Your Account

1. Open a browser tab and go to <https://io.adafruit.com/>
2. If you have an account, go ahead and sign in.
  - a. If you don't have an account, click the Get Started for Free and create an account.
3. Open your profile page at <https://io.adafruit.com/erici/profile>



The screenshot shows the Adafruit IO web interface. On the left is a dark sidebar with a logo at the top and a list of navigation links: Home, Feeds, Dashboards, Triggers, Services, View AIO Key, API Docs, FAQ, IO Plus, Learn, News, Support, Terms of Service, Get Help, and Send Feedback. The main content area has a header with the user's profile 'erici / Profile' and tabs for Profile, Public, Sharing, Monitor, and Activities. Below the tabs, the 'Current Plan' is displayed as 'IO Free' with a list of features: 30 data points per minute, 30 days of data storage, 10 feeds, 5 dashboards, Community support, and Projects and guides. At the bottom of the main area is a large blue button labeled 'Upgrade to IO+' and a link for 'Redeem Coupon or Pass'.

erici / Profile

Profile | Public | Sharing | Monitor | Activities

Current Plan

IO Free

- 30 data points per minute
- 30 days of data storage
- 10 feeds
- 5 dashboards
- Community support
- Projects and guides

Upgrade to IO+

Redeem Coupon or Pass

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4. Press the **View AIO Key** menu item on the left.

### YOUR AIO KEY

Your Adafruit IO key should be kept in a safe place and treated with the same care as your Adafruit username and password. People who have access to your AIO key can view all of your data, create new feeds for your account, and manipulate your active feeds.

If you need to regenerate a new AIO key, all of your existing programs and scripts will need to be manually changed to the new key.

[Hide Code Samples](#)

**Arduino**

```
#define IO_USERNAME " "
#define IO_KEY " "
```

**Linux Shell**

```
export IO_USERNAME=" "
export IO_KEY=" "
```

**Scripting**

```
ADAFRUIT_IO_USERNAME = " "
ADAFRUIT_IO_KEY = " "
```

5. Notice the following (you will be using the 'Scripting' option)
  - a. ADAFRUIT\_IO\_KEY
  - b. ADAFRUIT\_IO\_USERNAME

### Set Up Feeds

Feeds store the data online for you. Each feed represents a specific variable:

<https://learn.adafruit.com/adafruit-io-basics-feeds>

1. Navigate to the **IO Feeds** page.
2. Click **Actions -> Create a New Feed**
  - a. Name the new feed **indoor-lights**
  - b. Click the **Create** button
3. Repeat for the following feeds
  - a. **outdoor-lights**
  - b. **humidity**
  - c. **temperature**

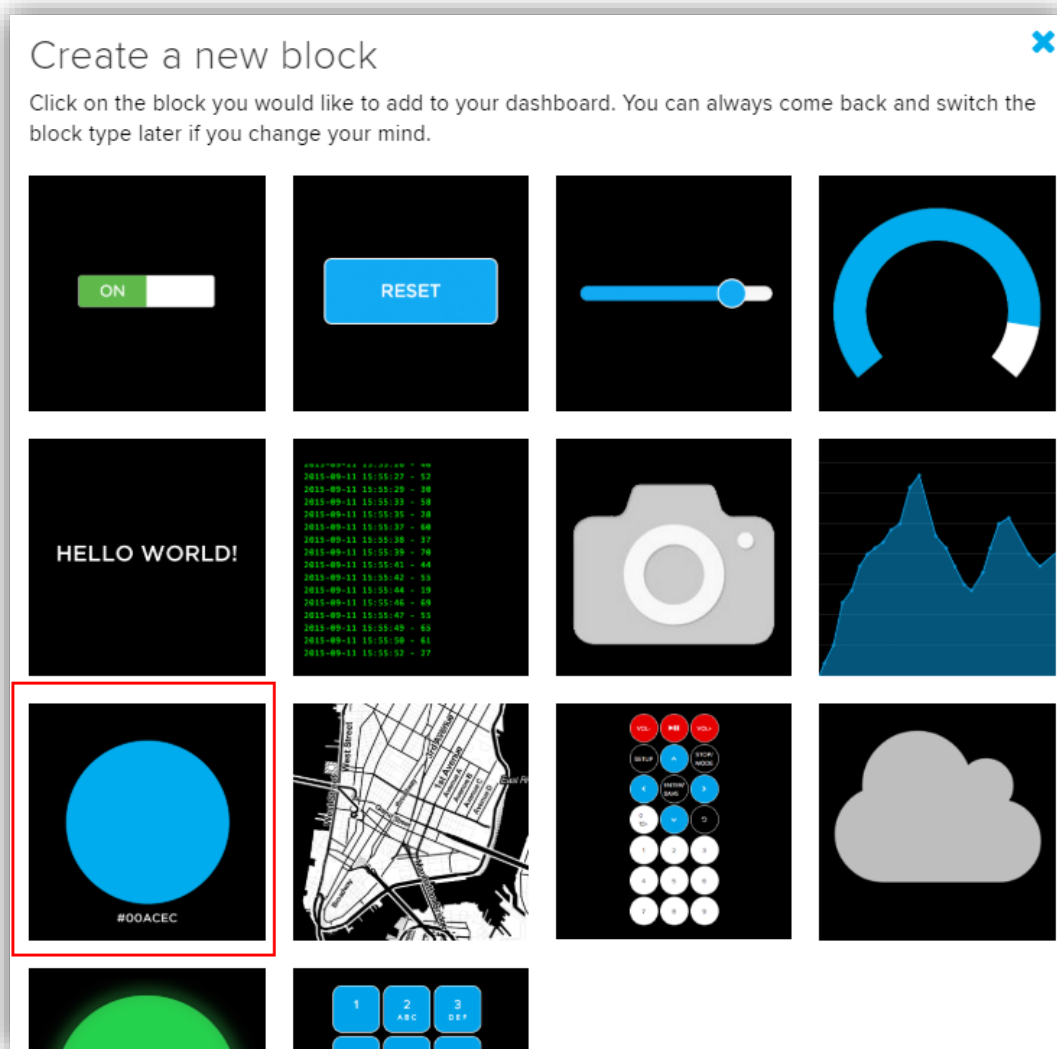
## [Tiny] Home IOT

### Create a Dashboard

1. Navigate to the Adafruit IO Dashboard page: <https://io.adafruit.com/<username>/dashboards>
2. Click **Actions > Create a New Dashboard**
  - a. Name the dashboard **Tiny Home IO 1**
  - b. Click the **Create** button
3. Create a **Color Picker** block
  - a. Click the blue plus icon



- b. Select the **Color Picker**



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- c. Select the **Indoor-Lights** feed

**Choose feed**

**Color Picker:** The color picker is used to send or view color values in hex format.

If you have lot of feeds, you may want to use the search field. You can also create a feed quickly below.

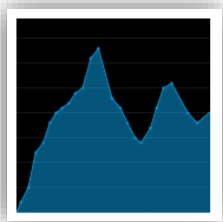
indoo

| Group / Feed                                      | Last value | Recorded          |
|---|------------|-------------------|
| My Feeds  |            |                   |
| <input checked="" type="checkbox"/> indoor-lights |            | a few seconds ago |

- d. Press **Next step**
- e. Enter **Indoor Lights** for the **Block Title**
- f. Press **Create block**
4. Repeat for the **outdoor-lights** feed
5. Next we'll add the temperature and humidity.
- a. Press the blue plus icon to add another block



- b. Choose the Line Chart block



- c. Select **humidity** and **temperature** and press **Next step**

**Choose up to 5 feeds**

**Line Chart:** The line chart is used to graph one or more feeds.

If you have lot of feeds, you may want to use the search field. You can also create a feed quickly below.

| Group / Feed                                    | Last value | Recorded     |
|---|------------|--------------|
| Lights  |            |              |
| <input checked="" type="checkbox"/> humidity    | 9          | 1 day 1 of 5 |
| <input type="checkbox"/> indoor-lights          | #00ff34    | 1 day        |
| <input type="checkbox"/> outdoor-lights         | #0024ff    | 1 day        |
| <input checked="" type="checkbox"/> temperature | 75         | 1 day 2 of 5 |
| security  |            |              |



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- d. For the Block Title enter **Temperature & Humidity**
- e. Select a period to show history for (**4 hours**)
- f. X-Axis Label is **Date Time**
- g. Y-Axis Label **Deg F or %**
- h. Y-Axis Minimum is **1**
- i. X-Axis Minimum is **100**
- j. Decimal Places is **0**

### Block settings

In this final step, you can give your block a title and see a preview of how it will look. Customize the look and feel of your block with the remaining settings. When you are ready, click the "Create Block" button to send it to your dashboard.

Block Title (optional)

Show History

4 hours

X-Axis Label

Y-Axis Label

Y-Axis Minimum

Leave blank to automatically detect.

Y-Axis Maximum

Leave blank to automatically detect.

Decimal Places

Number of decimal places to display, defaults to 4.

Block Preview

**Line Chart** The line chart is used to graph one or more feeds.

[< Previous step](#) [Create block](#)

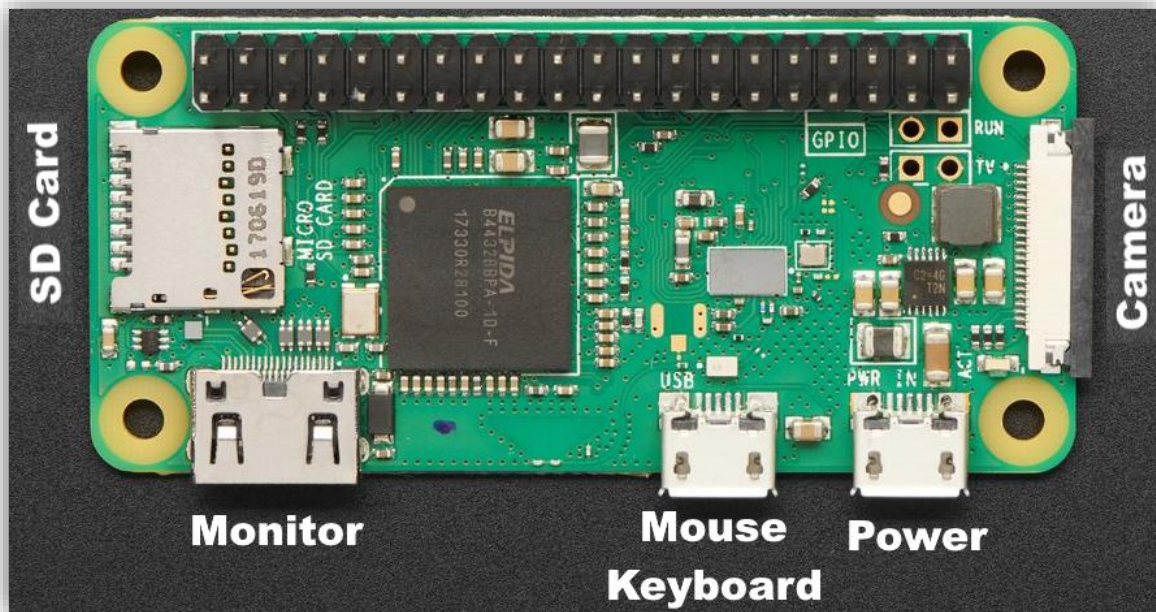
- k. Press **Create block**

At this point, your dashboard is ready.

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### PI Software Configuration

Your PI Zero W



#### Connecting the PI

1. The SD card contains your PI operating system. Insert the SD Card into your PI SD Card slot.
  - a. To start you must have your SD Card loaded with an operating system.
  - b. If you are not starting with a pre-loaded card see the instructions on the following web site to create one yourself.  
<https://www.raspberrypi.org/documentation/installation/installing-images/>
2. Connect the monitor
  - a. Insert the mini-HDMI connector to the Monitor plug on your PI.
  - b. Insert the other end into your Monitor.
3. Connect the keyboard and mouse
  - a. Connect the USB hub to the left micro-USB plug.
  - b. Insert your mouse and keyboard to the USB hub.
4. Add Power
  - a. Connect the micro-USB plug from the power plug to the right micro-USB plug.
  - b. Plug the other end into the wall.
5. At this point your PI should boot up
  - a. You will see a raspberry on your screen, some colors, then the boot command console.
  - b. A desktop GUI will display indicating your PI is booted and ready to go.

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### 6. Desktop GUI

- a. Web Browser is the blue globe.
- b. Command Prompt is the black square with >\_ in it.
- c. The raspberry icon contains command actions (like restart, configuration, etc).



### Useful Linux command line commands

1. **'pwd'** – Print Working Directory
2. **'ls'** - List current directory (kind of like 'dir' in windows)
3. **'cd'** – change directory
  - a. **'cd ..'** – goes back up one directory
4. **'man'** – give you help.
  - a. Example **'man passwd'** will give help on the password command.
5. **'nano'** – edits a specific file.
  - a. Press **'CTRL-x'** to exit the program, then press **'y'** to save the file, then press **'Enter'** to save to the specified file (overwrite).
  - b. You will see this used later.

### Software Installation

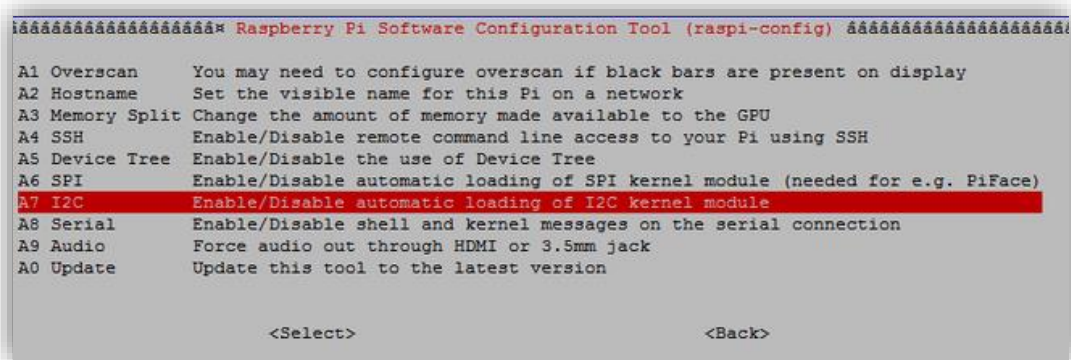
1. Log In
  - a. Default username and password are **"pi"** and **"raspberry"**
  - b. Type in **"sudo passwd"** to change your password.
  - c. Write down your new password here: \_\_\_\_\_
2. Connect to WiFi
  - a. Right click the wifi icon on the top right to open the wifi dialog.
  - b. Choose the wlan0 adapter and select your network's SSID (example: InventHQ)
  - c. Enter the network password.
  - d. You should be connected.

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3. Enable I2C Interface
  - a. From the Command Line type “**sudo raspi-config**” to open the Configuration GUI.
  - b. Go to Interfacing Options



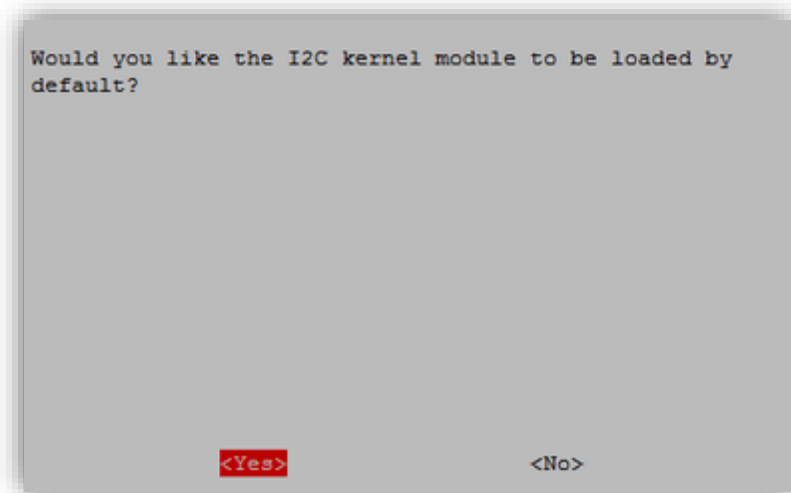
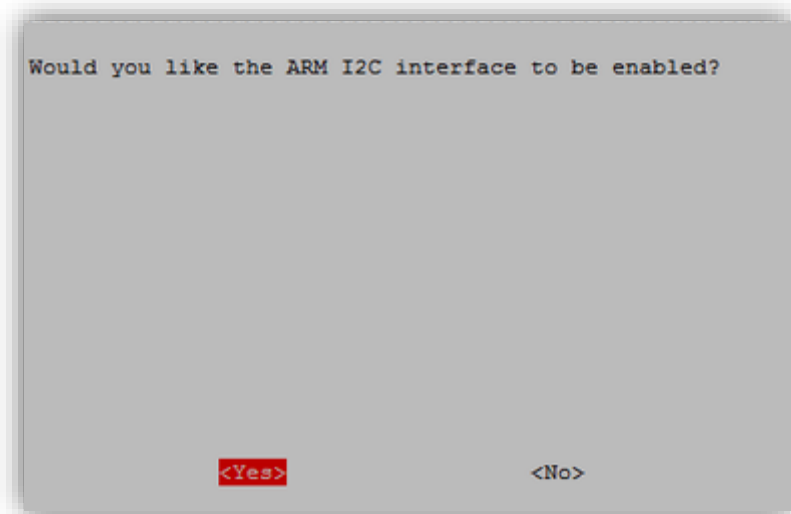
- c. Go to I2C



- d. Enable the I2C



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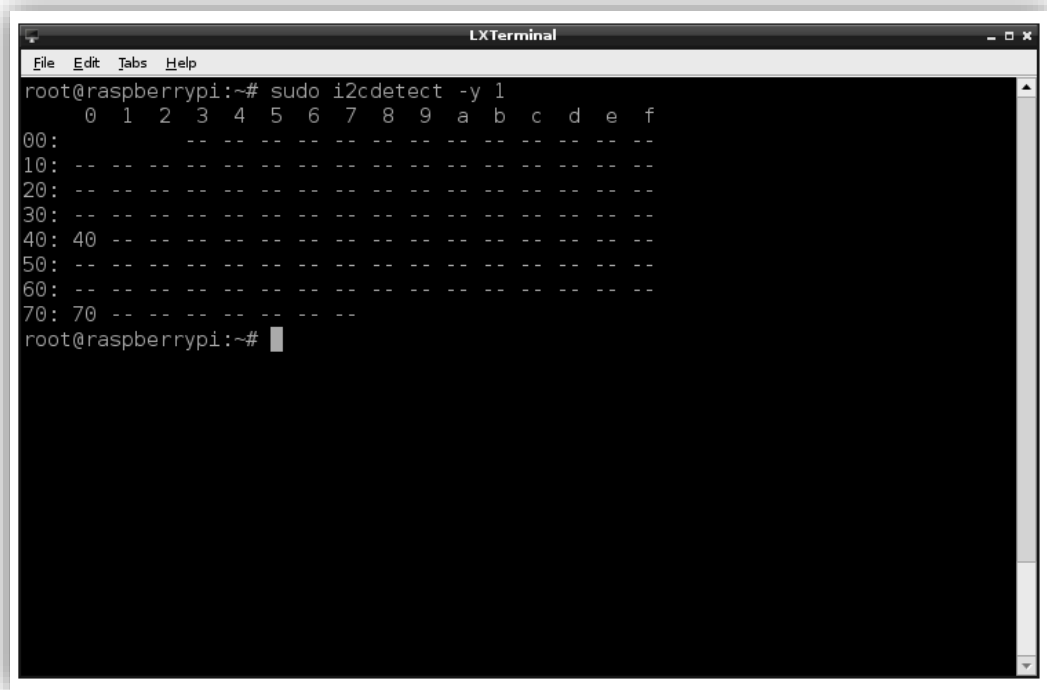
- e. Close the Raspi-Config application.
- 4. System Update (note: you must use the super-user '**sudo**' command when shown)
  - a. Open a command line window
  - b. Type "**sudo apt-get update**" to update the operating system to the latest libraries.
  - c. Type "**sudo apt-get upgrade**" to upgrade the operating system packages.
  - d. Type "**sudo shutdown -r now**" to restart the machine and allow the upgrade to complete.
  - e. Once your machine has rebooted, re-open the command line and type "**sudo pip3 install --upgrade setuptools**"

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## Install Software Libraries

Note that we are using **'pip3'** and **'python3'** commands at all times below.

1. Install **Python Blinka** Libraries: <https://learn.adafruit.com/adafruit-io-basics-digital-input/python-setup>
  - a. Type **"sudo pip3 install RPI.GPIO"** to install Raspberry PI GPIO library.
  - b. Type **"sudo pip3 install adafruit-blinka"** to install Blinka.
  - c. Type **"sudo pip3 install adafruit-io"** to install the Adafruit IO libraries.
2. Install I2C Libraries: <https://learn.adafruit.com/adafruit-raspberry-pi-lesson-4-gpio-setup/configuring-i2c>
  - a. Type **"sudo apt-get install -y python-smbus"** to install Python Bus.
  - b. Type **"sudo apt-get install -y i2c-tools"** to install the I2C Tools.
  - c. Type **"sudo i2cdetect -y 1"** to verify I2C is enabled



```
LXTerminal
File Edit Tabs Help
root@raspberrypi:~# sudo i2cdetect -y 1
    0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
10:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
20:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
30:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: 40 -- -- -- -- -- -- -- -- -- -- -- -- -- --
50:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
60:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: 70 -- -- -- -- -- -- -- -- -- -- -- -- -- --
root@raspberrypi:~#
```

3. Install the Libraries for the Temperature & Humidity Board & NeoPixels
  - a. Type **"sudo pip3 install adafruit-circuitpython-si7021"** to install the libraries for the Si7021 board.
  - b. Type **"sudo pip3 install Adafruit\_CircuitPython\_NeoPixel"** to install the libraries for the NeoPixels (the Jewel and the Strip Lights).

## Update the Code on the PI

1. Download Example Code
  - a. Change to the root directory by typing **"cd ~"**
  - b. Type **"git clone <https://github.com/eironside/IO-House-Series>"** to download the code for this class.

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2. Edit the example python file
  - a. Type **"cd IO-House-Series"**
  - b. Type **"cd Lights\_and\_Temp"**
  - c. Open a web browser on your Pi and go to <https://io.adafruit.com/<username>/profile>
    - i. Press the **View AIO Key** menu item on the left to view your key.
    - ii. Note: you can highlight the key and press your mouse right button and select copy to copy this long value.
  - d. To edit the code, type **"nano io\_house\_light\_temp.py"**
  - e. Scroll down to the **Adafruit\_IO\_KEY** variable, copy the following from the IO web page.
    - i. Set your **Adafruit IO Key** from above.
      1. Use the arrow keys to navigate to the key, delete everything between the two **"**, position your caret between the two **"** then right mouse button and select paste.
    - ii. Set the **Adafruit\_IO\_USERNAME** to your Adafruit IO Username.
  - f. When you're done editing the values, save the file by pressing **"CTRL + x"**.
    - i. When prompted to save the modified buffer, type **Y** and press **Enter**.
    - ii. At the File Name to Write prompt, press **Enter** and you should be directed back to the terminal.
3. Run the Code
  - a. Back in the command prompt, type **"sudo python3 io\_house\_light\_temp.py"**
  - b. It should run without an error and print out the various values
    - i. It may ask you to set a color on the dashboard
      1. Set the color on your dashboard for both the indoor and outdoor lights.
    - ii. If you get an error about **"setRed"** edit the file again and change the following:
      1. Change all **"setRed("** to **"set\_red("**
      2. Change all **"set\_green("** to **"set\_green("**
      3. Change all **"setBlue("** to **"set\_blue("**
4. Check your dashboard
  - a. The temperature and humidity should start to show on the graph.
  - b. Set a color for the two lights and notice that they change on the house.
5. Check your code and make any changes you want to make

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### Set up for Auto-Start

Sometimes it is nice to have your device boot up and start doing something. This will show you how to make your PI run your python script on startup. There are numerous ways to accomplish this, I'm showing you the **systemd** option.

1. Create a "Unit File":
  - a. Type in the command prompt "**sudo nano /lib/systemd/system/homeio\_lights.service**"
  - b. In the editor make sure your file looks like the following:

```
[Unit]
Description=My Home IO Lights Service
After=multi-user.target

[Service]
Type=idle
ExecStart=/usr/bin/python3 /IO-House-Series/Lights_and_Temp/io_house_light_temp.py

[Install]
WantedBy=multi-user.target
```

- c. Exit and save the file
    - i. **CTRL - x, Y** to save the changes, and press **Enter** to write to the unit file.
2. Configure **systemd**
  - a. Enable the unit file via system control
    - i. Type "**sudo systemctl daemon-reload**"
    - ii. Then type "**sudo systemctl enable homeio\_lights.service**"
  - b. Reboot the machine by typing "**sudo reboot**"
  - c. Upon reboot, your house should light up and be running your code