RhythmCloud Build Instructions

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Overview

RhythmCloud is a cloud powered learning system for playing the drums. It leverages AWS technology, particularly IoT Greengrass, to power the system.

LED lights on the drum set lights up to prompt a user when to strike a given drum. Sensors on the drums detect the hits and sends data to a backend infrastructure in AWS to analyze the user's performance. The user may then look at a dashboard generated by Elasticsearch to see the performance of accuracy.

Inventory of Materials

- 8 piece drum set[1]
  - 10” Tom drum
  - 12” Tom drum
  - 14” Snare drum
  - 16” Floor tom drum
  - 22” Base drum
  - 14” Hihat cymbal
  - 14” Crash cymbal
  - 18” Ride cymbal
- Crash cymbal[2]
  - https://www.amazon.com/gp/product/B01E36LHNU/
- Cymbal stand[3]
  - https://www.amazon.com/gp/product/B00HX9EZ98/
- Clear snare drum head[4]
  - https://www.amazon.com/gp/product/B0002D0H94/
- Tablet mount
  - https://www.amazon.com/gp/product/B07DWV67PJ/
- Drum Stick Holder[5]
  - https://www.amazon.com/gp/product/B07TYLQXZ9/
- Microphone shelf
  - https://www.amazon.com/gp/product/B07HM8Q5FR/
- Raspberry Pi 4
  - https://www.amazon.com/dp/product/B07XLNXW6R/
- Piezo sensors x 8
  - https://www.amazon.com/gp/product/B07B8PFJCX/
- LED connectors
  - https://www.amazon.com/gp/product/B075K3M1TB/
- 16 pin header box
  - https://www.amazon.com/gp/product/B01N8XTFB5/
- 20 guage wire spool (red and black)[6]
- Analog to Digital Converter for Raspberry Pi[7]
  - https://www.robotshop.com/en/8-channel-17-bit-analog-to-digital-converter-raspberry-pi-zero.html
- 5V power supply
  - https://www.amazon.com/gp/product/B07Q26YG61/
- LED Light strips x 2

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[1] The exact composition of the drums does not really matter. The important thing is the number. Each drum/cymbal is a channel in the system. These instructions cap out at 8 channels or a total combination of 8 drums and cymbals

[2] We had to buy a crash cymbal since our drum set actually didn’t come with one

[3] We had to buy a cymbal stand for the crash cymbal since our drum set didn’t come with one

[4] Clear snare drum head is not fully necessary. But, depending on the make of the snare drum head, it may help with viewing the drum lights.

[5] Optional.

[6] The suggestion is to get two colors of wire to keep track of the positive and negative connections. Solid wire is OK if you do not plan on moving the drums much. Get braided wire if you plan on moving the drums at all.

[7] Not explicitly needed, but we found that this was very helpful in debugging.

    - https://www.amazon.com/gp/product/B00JY2P672/
- Connectors
- Standoffs
    - https://www.amazon.com/gp/product/B073ZC6PB9/
- Double sided foam tape 1” wide
    - https://amazon.com/dp/B0007P5G8Y/
- Raspberry Pi cluster case
    - https://www.amazon.com/gp/product/B07MW24S61/
- Blue painters tape
- Electrical tape
- 22 Gauge RGB Extension cable
    - https://www.amazon.com/dp/product/B00L67YQ9W/
- Micro HDMI Adapter
    - https://www.amazon.com/gp/product/B00B2HORKE/
- Zip ties
- Mini Black Hat Pi splitter
    - https://www.adafruit.com/product/3182
- Fire 7 Tablet
    - https://www.amazon.com/dp/product/B07FKR6KXF/
- 9” x 9” Plexiglass sheet[8]

Materials…If You Absolutely Must[9]

- Drum mutes
- Cymbal mutes

Equipment Needed

- Soldering iron[10]
- Wire strippers
- Wire cutters
- Drill
- ½” Drill bit[11]

[8] You can find this at a home supply store like Home Depot or Lowes. These sheets can be hard to cut without shattering and cracking them. Stores will usually offer to cut them free of charge.
[9] Let’s face it. Playing the drums isn’t about being quiet. But, we needed to quiet them down for showing them at re:Invent. These are the options we chose. Trust us, they will come off at every possible chance.
[10] Our suggestion is to get a very fine point on your soldering iron. It makes things so much easier, particularly when soldering to the boards.
[11] You’re going to want a ½” hole. Depending on your drum, you may need to drill a hole with a smaller drill bit first, then enlarge the hole. This is true if you drum is wrapped in vinyl like ours. We used a 1/8” drill bit for the pilot hole.

Build Instructions

Hardware

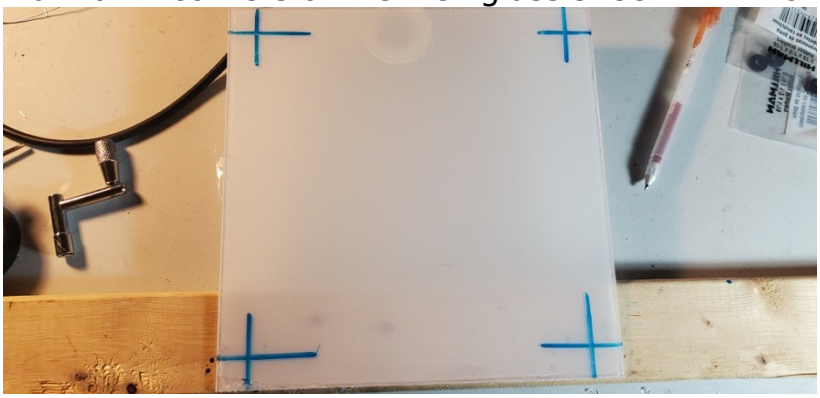
This section will provide all of the instructions to complete the physical build of the drum set.

Drum Set

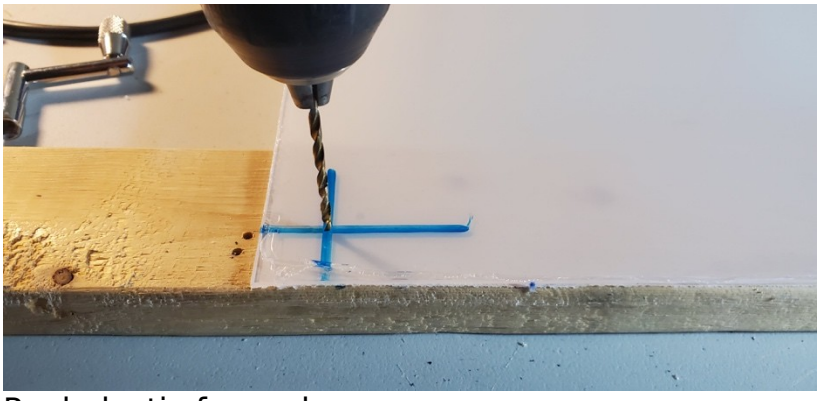
Build the drum set following the manufacturer's instructions. These instructions assume 7 piece drum set consisting of a small tom drum, large tom drum, floor tom drum, base drum, snare drum, hihat cymbal, and a ride cymbal. We had to order and assemble a crash cymbal as well to complete an 8 piece drum set. If your drums have few components, just follow the section for the components that you have.[12]

Microphone stand

1. Mark all 4 corners of the Plexiglass sheet 1" in from each side

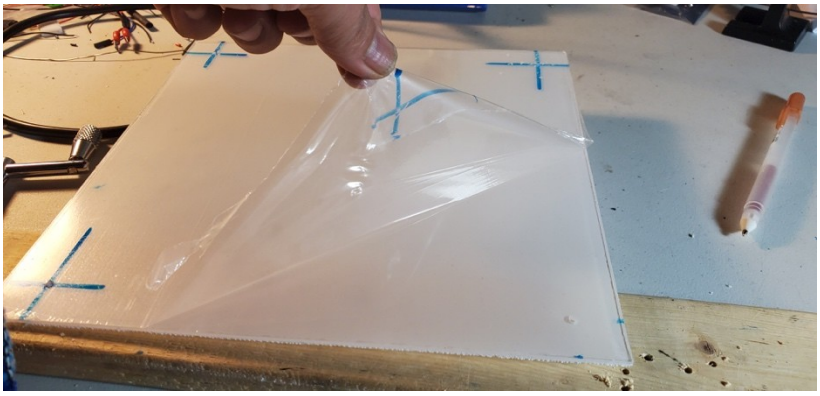


2. Drill holes



3. Peel plastic from plexy

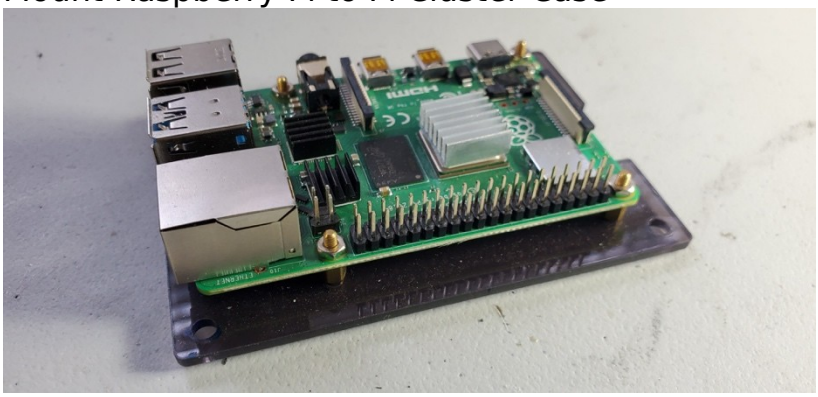
[12] If your drum have more than 8 components, you will need to decide which 8 you will use. RhythmCloud only supports 8 components in v1.0.



4. Mark matching holes in the microphone stand
5. Drill holes in microphone stand
6. Install extra-long standoffs into newly drilled holes
7. Follow instructions for the Raspberry Pi including mounting it to the microphone stand
8. Follow instructions for the Analog to Digital Board including mounting it to the microphone stand.

Raspberry Pi

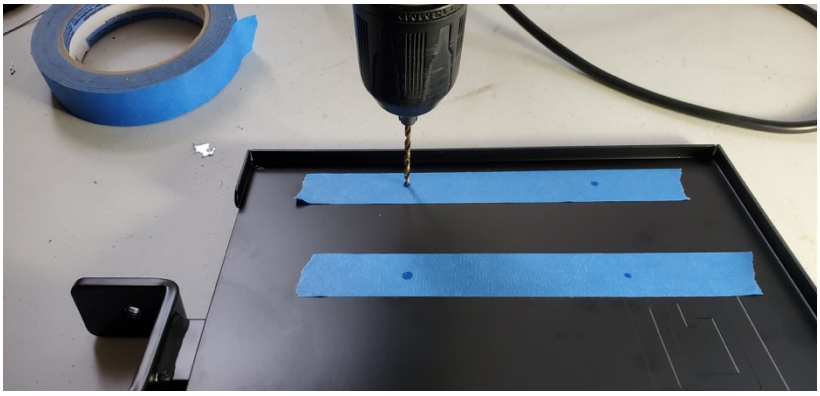
1. Mount Raspberry Pi to Pi Cluster Case



2. Measure Pi and mark holes for drilling on the mic shelf

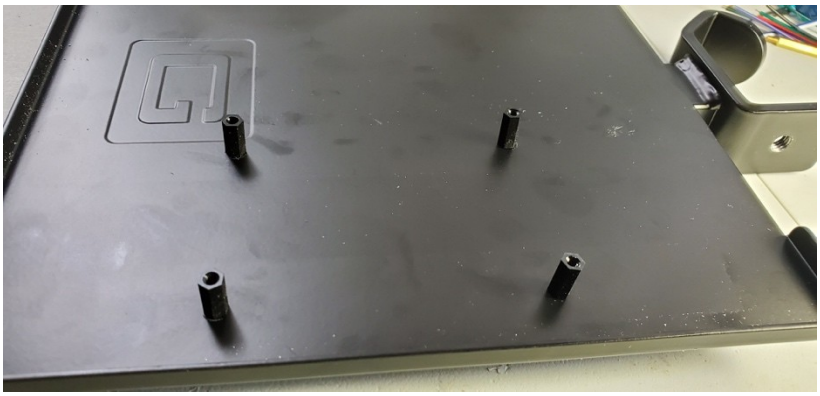
Position the pi on the mic shelf where you would like it to main once mounted. Applying a masking tape or painters tape on the shelf will help you mark where the holes should be.

3. Drill holes

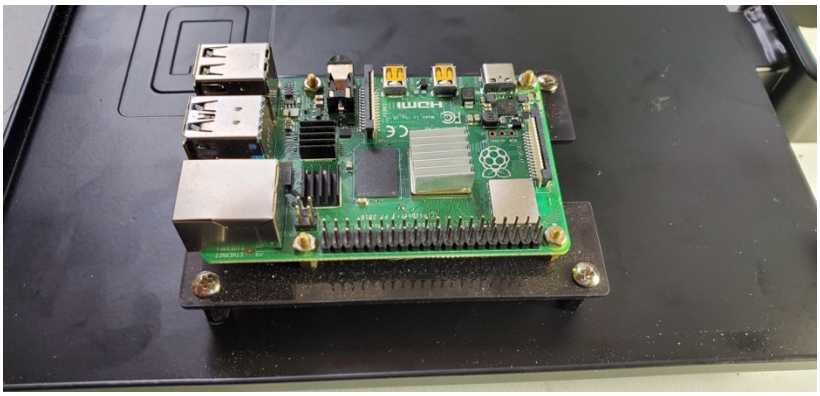


Remove the tape after drilling to see 4 cleanly drilled and well placed holes.

4. Mount standoffs to mic shelf

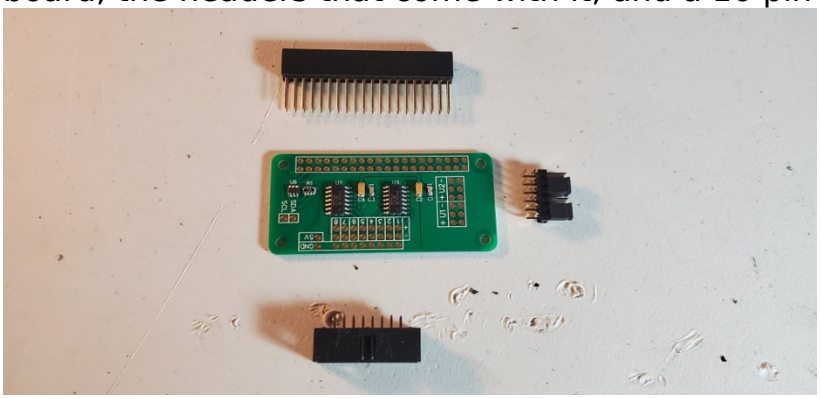


5. Mount Pi to standoffs

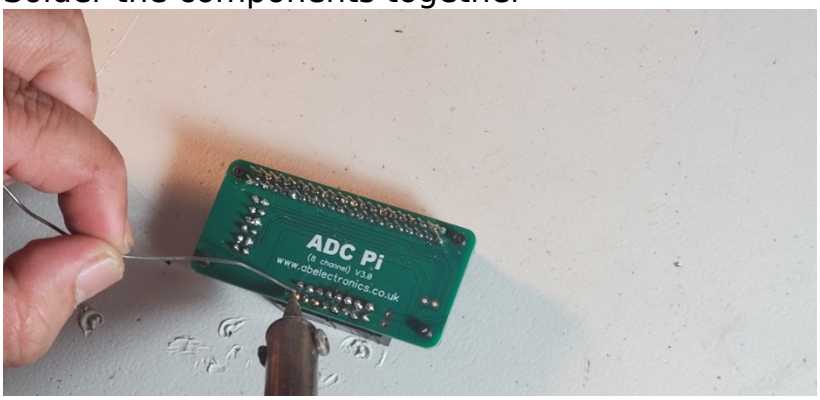


Analog to Digital Board

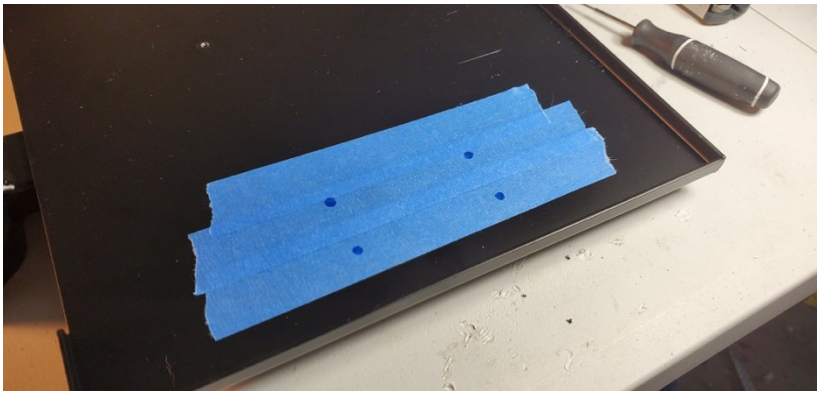
1. Gather components for the Analog to Digital Board. You will need the board, the headers that come with it, and a 16 pin header box



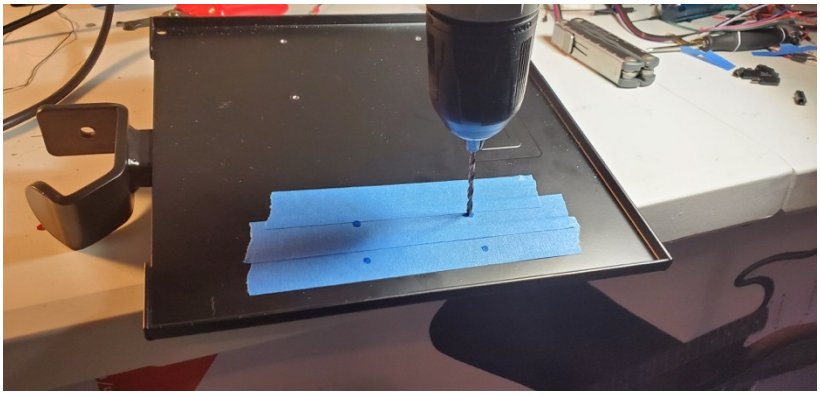
2. Solder the components together



3. Mark the locations for standoffs on the mic stand



4. Drill holes for standoffs



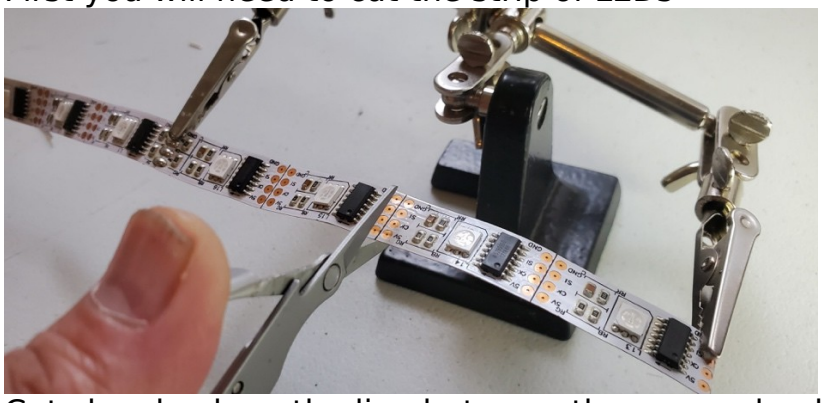
5. Install standoffs
6. Attach Analog to Digital Board to the standoffs

10” Tom

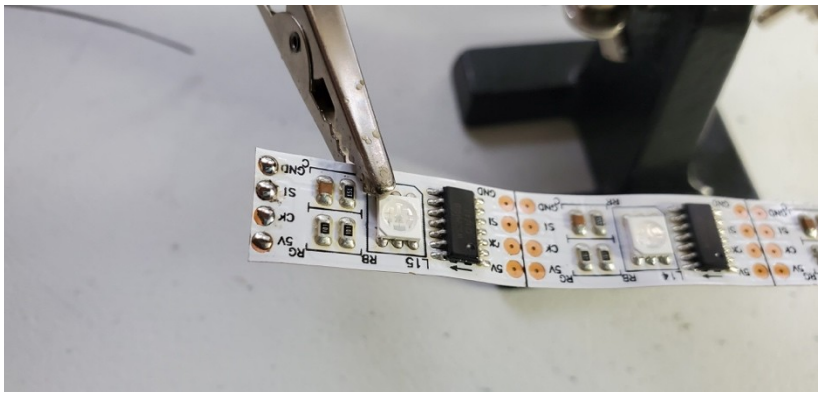
All five of the drums are assembled almost identically. However, the 10” tom is a little trickier than the rest because it has the power adapter for the LEDs.

1. Drill hole for wires
    a. Drill a ½” hole into the side of the drum head. The hole should be centered about 2” from the top of the drum[13]

2. Solder LED light strip
    a. First you will need to cut the strip of LEDs

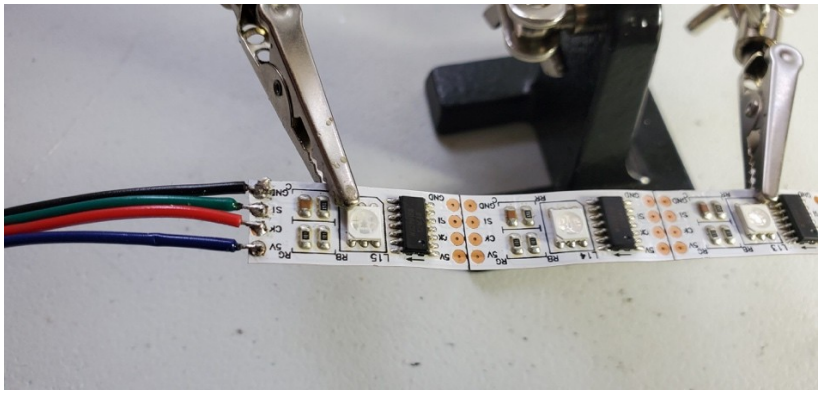


    Cut cleanly along the line between the copper leads.
    b. Add solder onto all of the leads on both ends of the LED strip



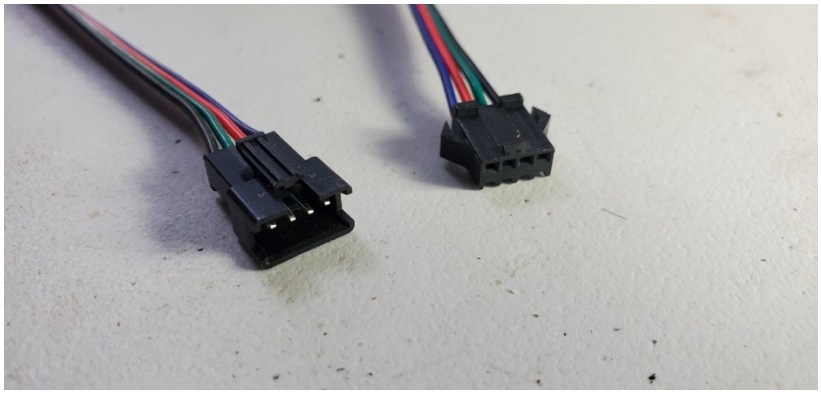
    c. Solder both ends of the LED strips with the LED connectors

[13] Some drums are wrapped in vinyl or other material. If your drum is like that, you may want to drill a 1/8” pilot hole first. Be sure that you go slow so that you don’t rip the vinyl.

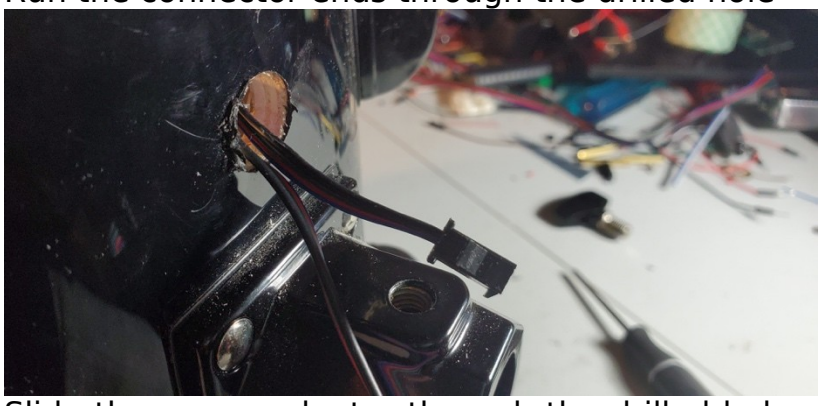


Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

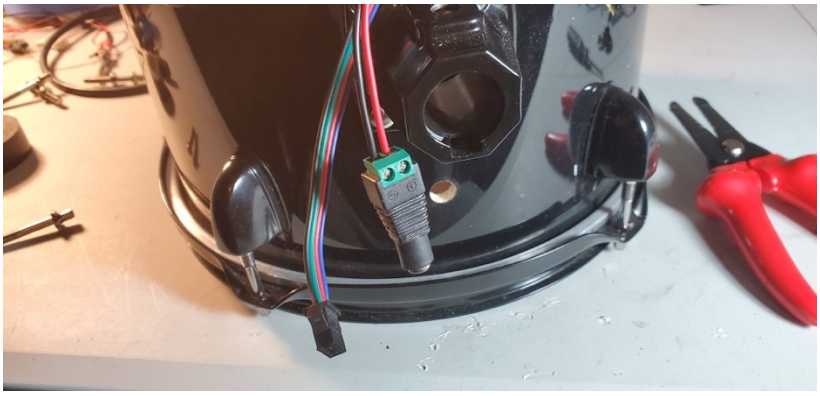
d. Be sure that one end has a male end and the other has a female end



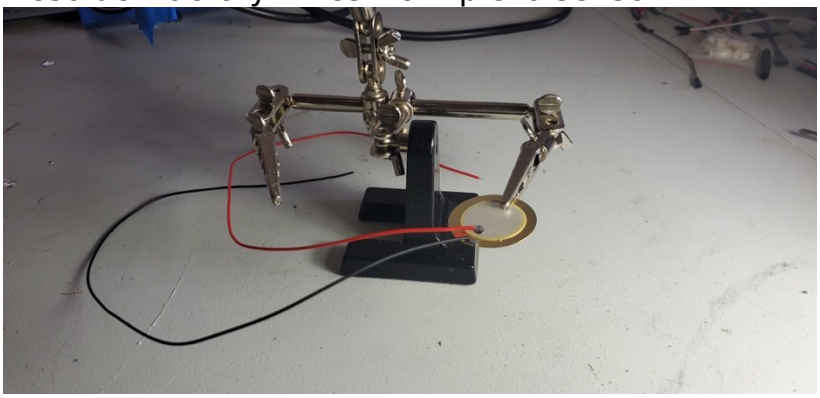
3. Mount LED light strip
    a. Line the inner edge of the drum with double sided tape
    b. Mount the LED strip to the tape
    c. Run the connector ends through the drilled hole



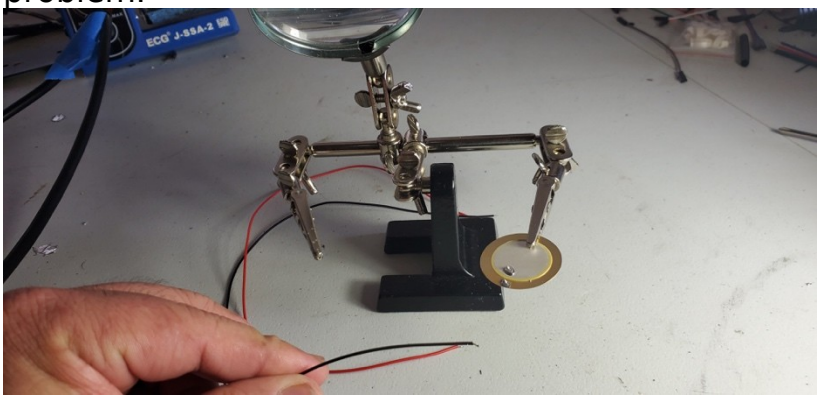
    d. Slide the power adapter through the drilled hole. You may need to remove the power adapter and reattach after the wires are through the hole.



4. Solder piezo sensor
    a. Cut and strip extension wire[14]
    b. Desolder factory wires from piezo sensor

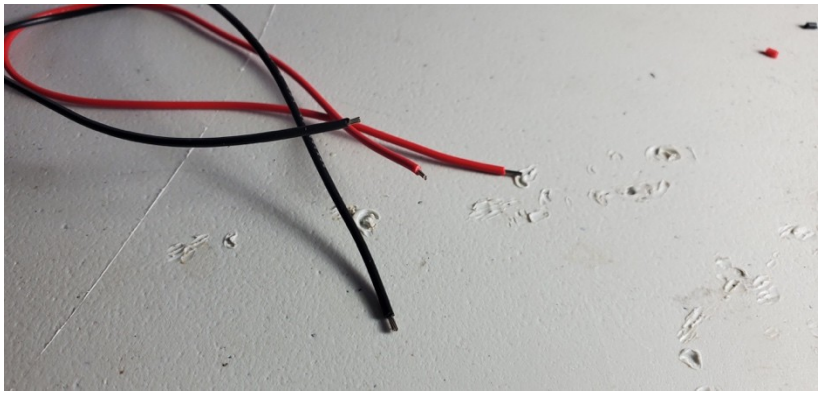


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

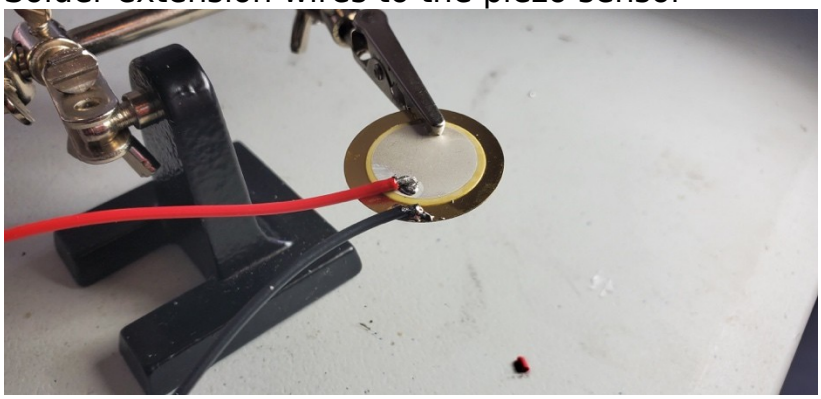


    c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

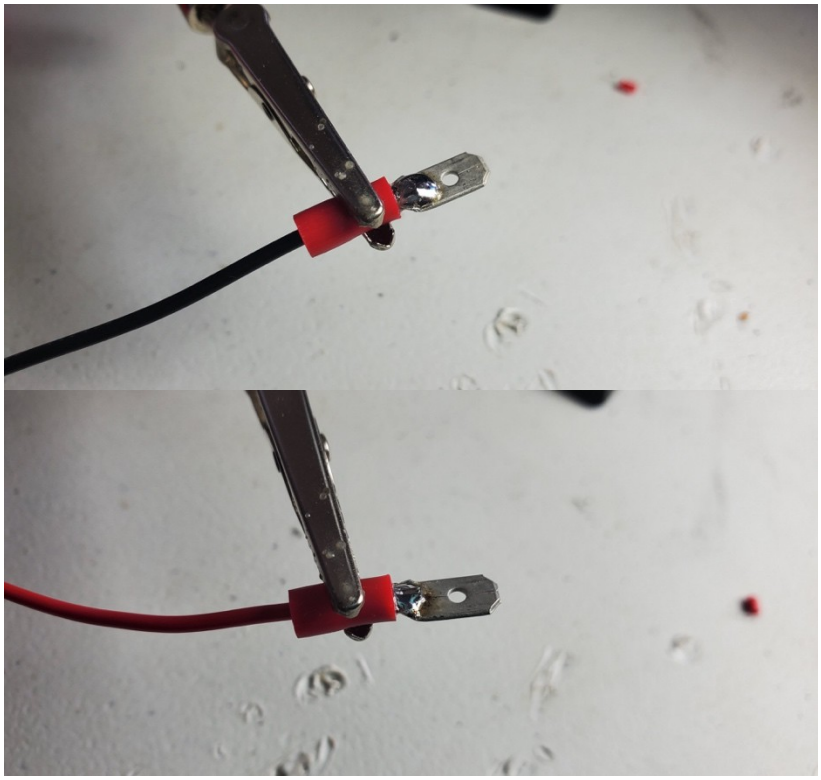
[14] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you’ve been hitting the drum quite a bit.



d. Solder extension wires to the piezo sensor

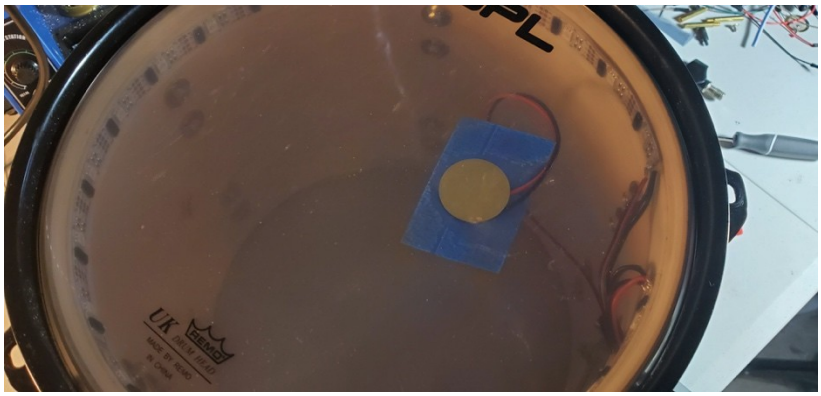


e. Solder a male connector to each of the extension wires.



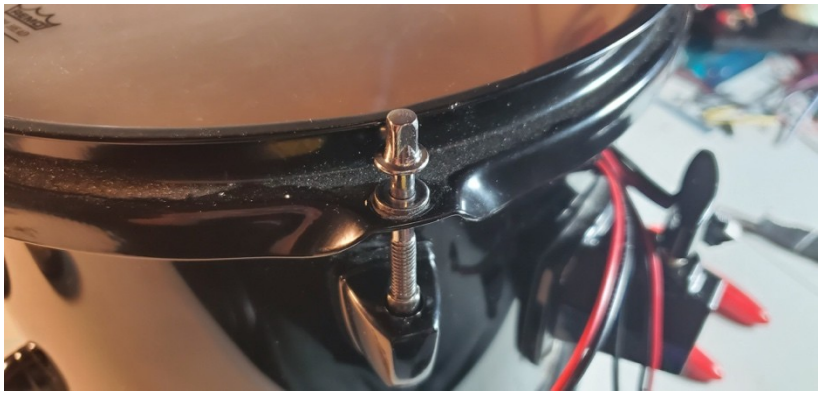
5. Mount piezo sensor

a. Tape the piezo sensor to the inside of the drum head. Make sure the metal side of the sensor touches the drum head.



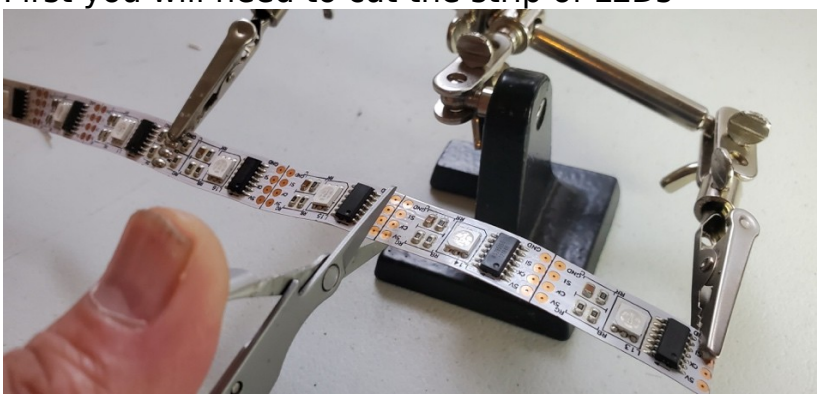
b. Run the piezo sensors through the drilled hole

c. Mount the drum head



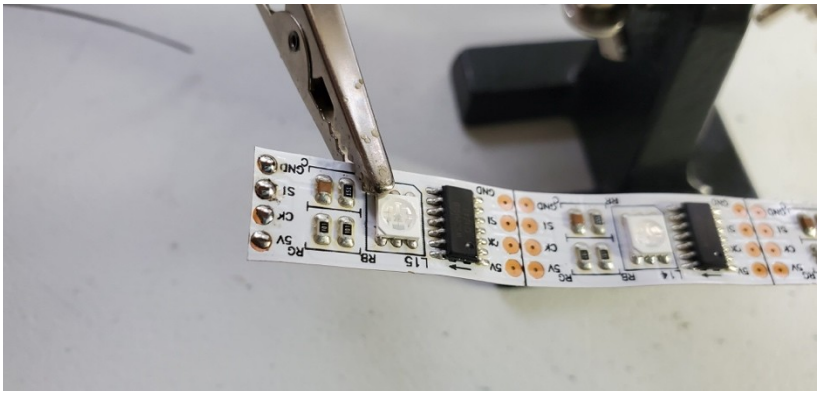
12” Tom

1. Drill hole for wires
    a. Drill a ½” hole into the side of the drum head. The hole should be centered about 2” from the top of the drum[15]
2. Solder LED light strip
    a. First you will need to cut the strip of LEDs

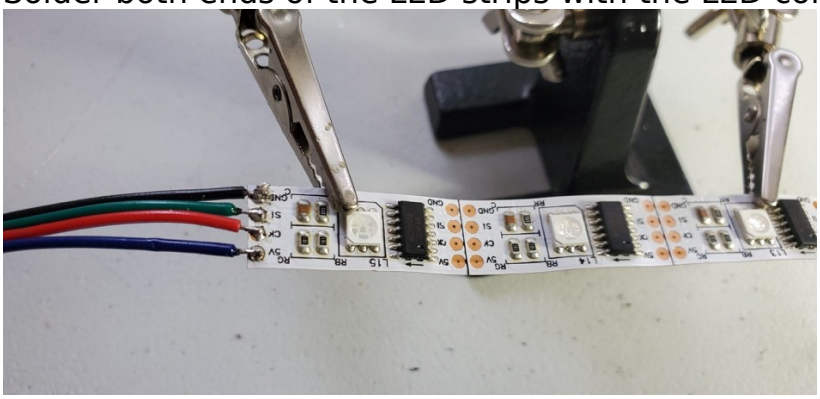


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip



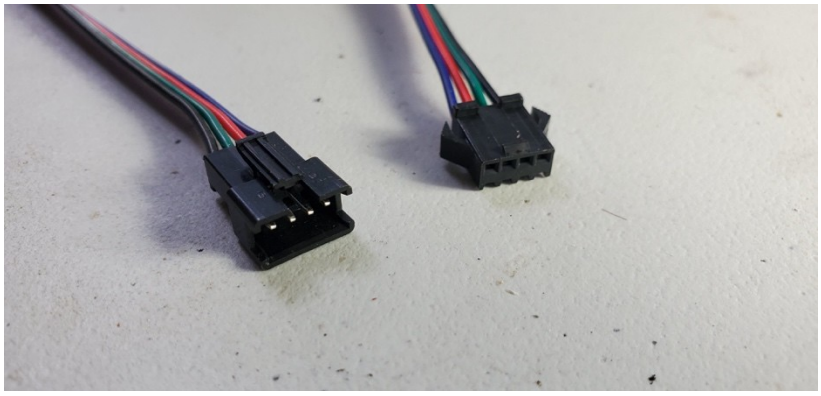
    c. Solder both ends of the LED strips with the LED connectors



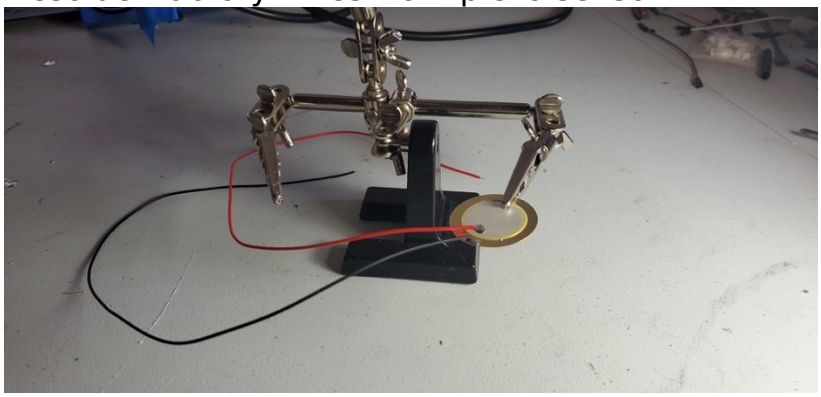
Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

    d. Be sure that one end has a male end and the other has a female end

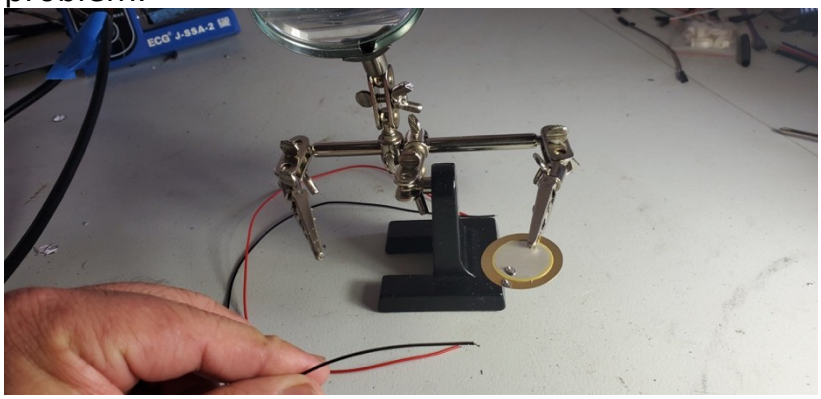
[15] Some drums are wrapped in vinyl or other material. If your drum is like that, you may want to drill a 1/8” pilot hole first. Be sure that you go slow so that you don’t rip the vinyl.



3. Mount LED light strip
    a. Line the inner edge of the drum with double sided tape
    b. Mount the LED strip to the tape
    c. Run the connector ends through the drilled hole
4. Solder piezo sensor
    a. Cut and strip extension wire[16]
    b. Desolder factory wires from piezo sensor

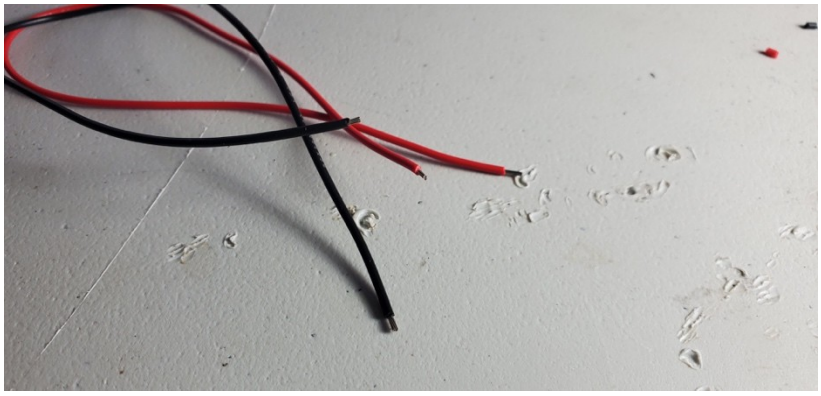


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

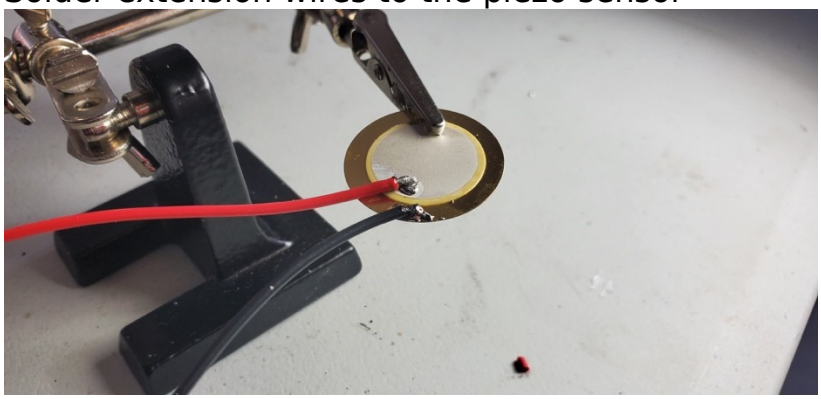


    c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

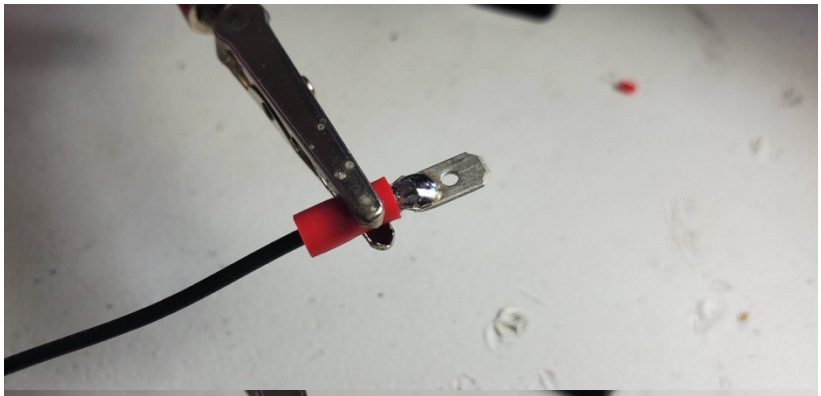
[16] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you’ve been hitting the drum quite a bit.

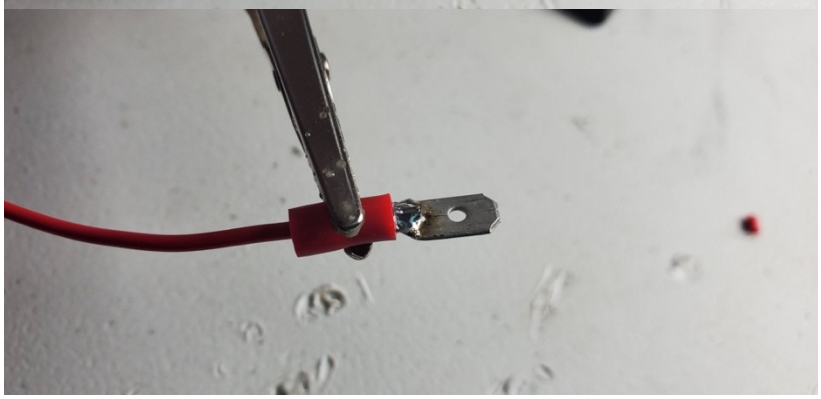


d. Solder extension wires to the piezo sensor



e. Solder a male connector to each of the extension wires.





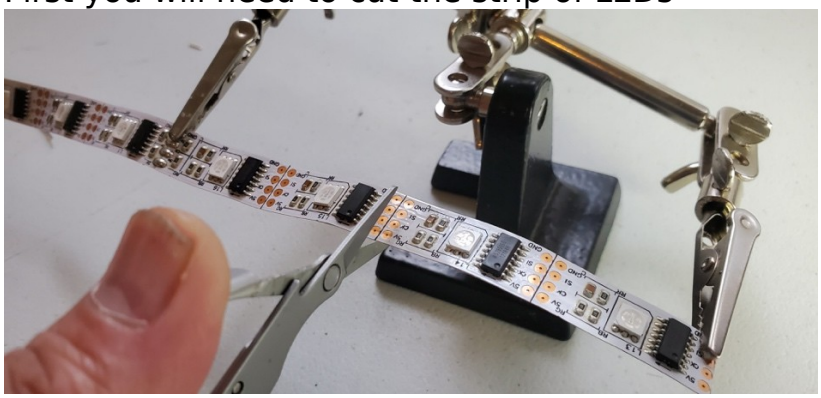
5. Mount piezo sensor

a. Tape the piezo sensor to the inside of the drum head. Make sure the metal side of the sensor touches the drum head
b. Run the piezo sensors through the drilled hole
c. Mount the drum head

Snare Drum

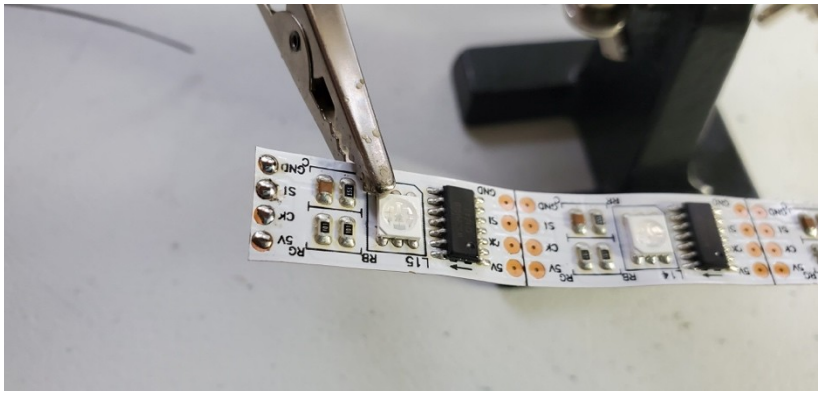
1. Drill hole for wires
    a. Drill a ½” hole into the side of the drum head. The hole should be centered in the middle of the drum[17]

2. Solder LED light strip
    a. First you will need to cut the strip of LEDs



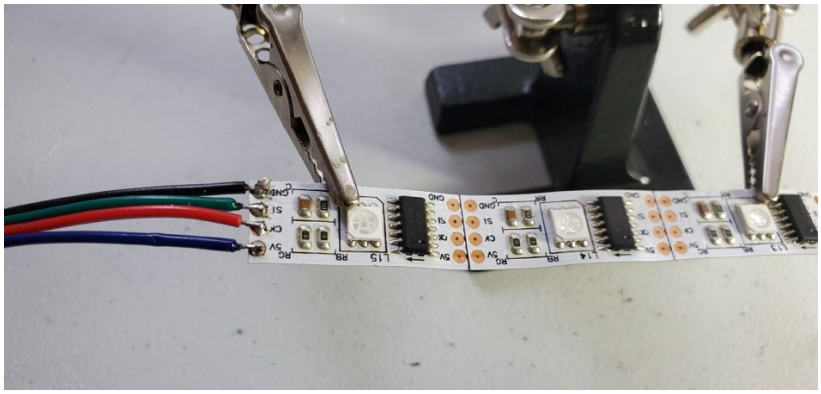
Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip



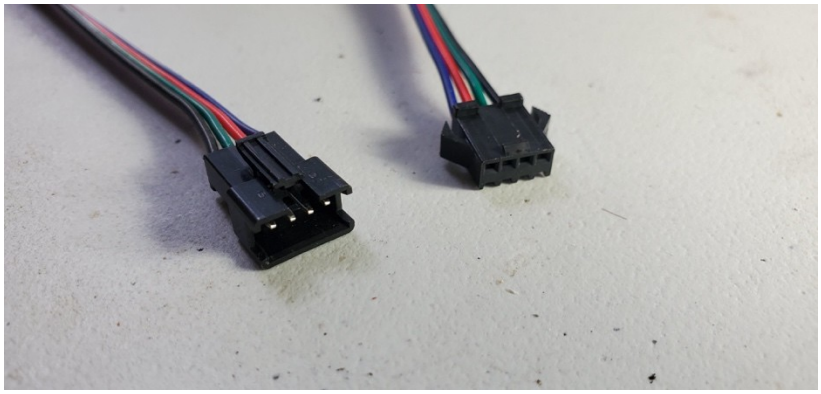
    c. Solder both ends of the LED strips with the LED connectors

[17] Some drums are wrapped in vinyl or other material. If your drum is like that, you may want to drill a 1/8” pilot hole first. Be sure that you go slow so that you don’t rip the vinyl.

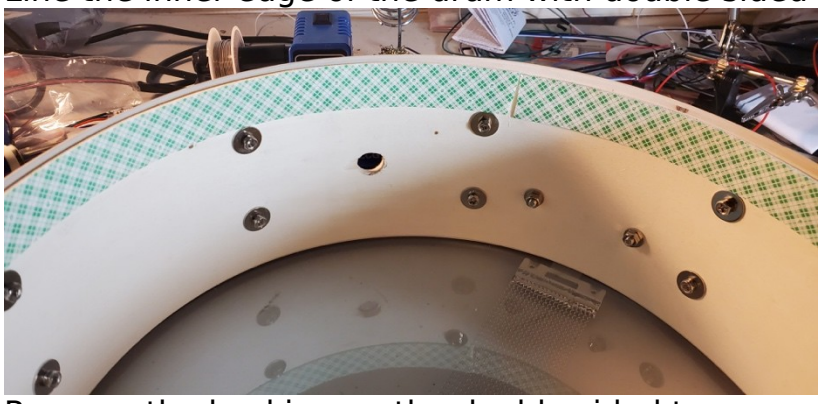


Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

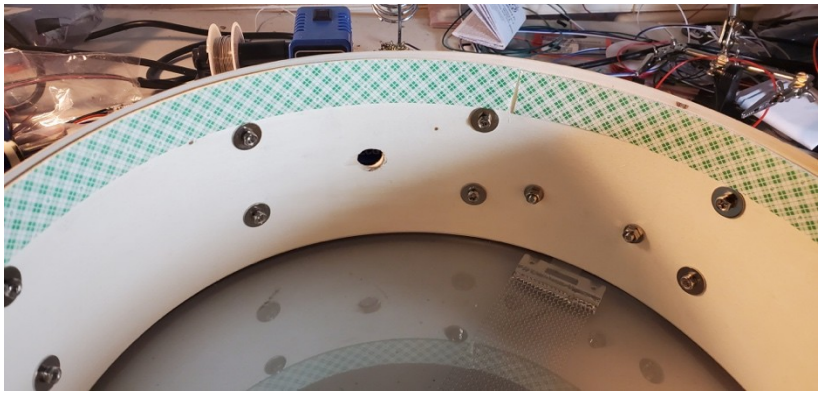
d. Be sure that one end has a male end and the other has a female end



3. Mount LED light strip
    a. Line the inner edge of the drum with double sided tape

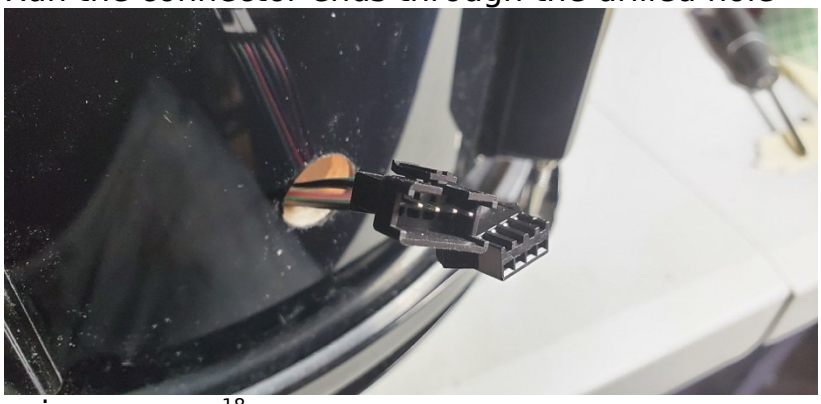


    b. Remove the backing on the double sided tape



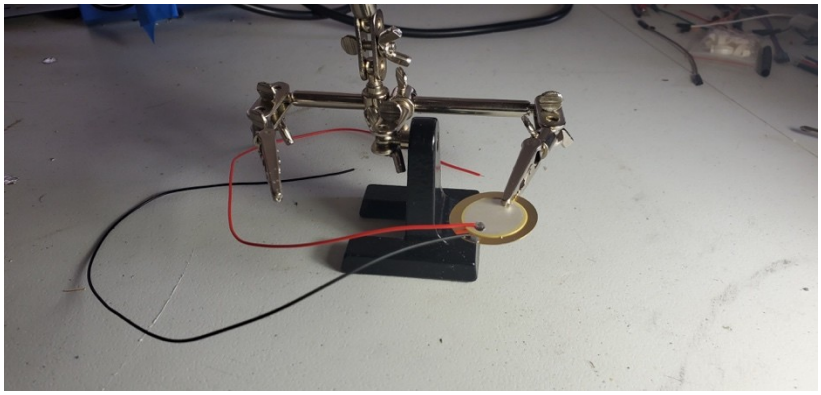
c. Mount the LED strip to the tape

d. Run the connector ends through the drilled hole

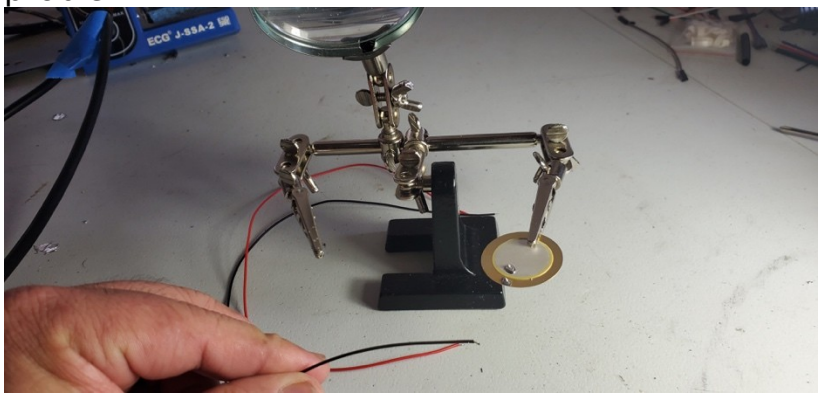


4. Solder piezo sensor[18]
    a. Desolder factory wires from piezo sensor

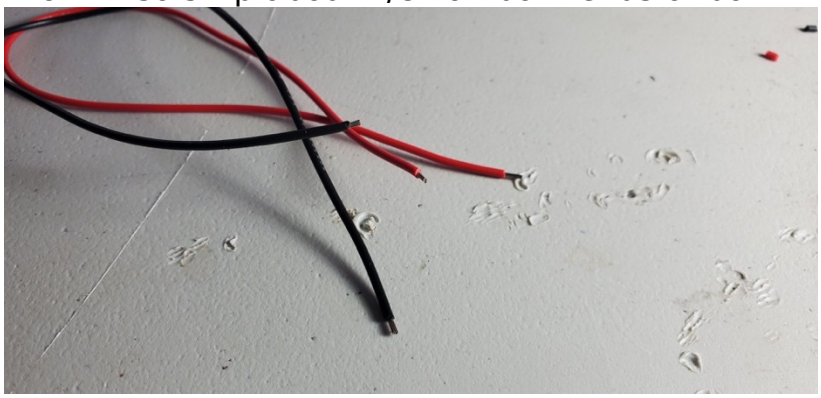
[18] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you've been hitting the drum quite a bit.



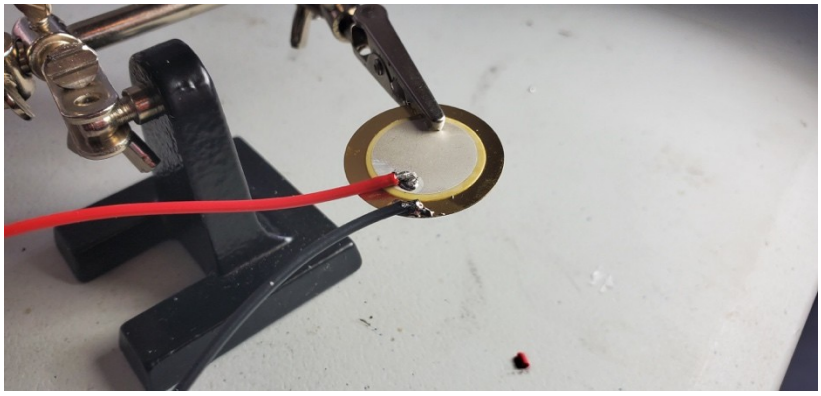
The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.



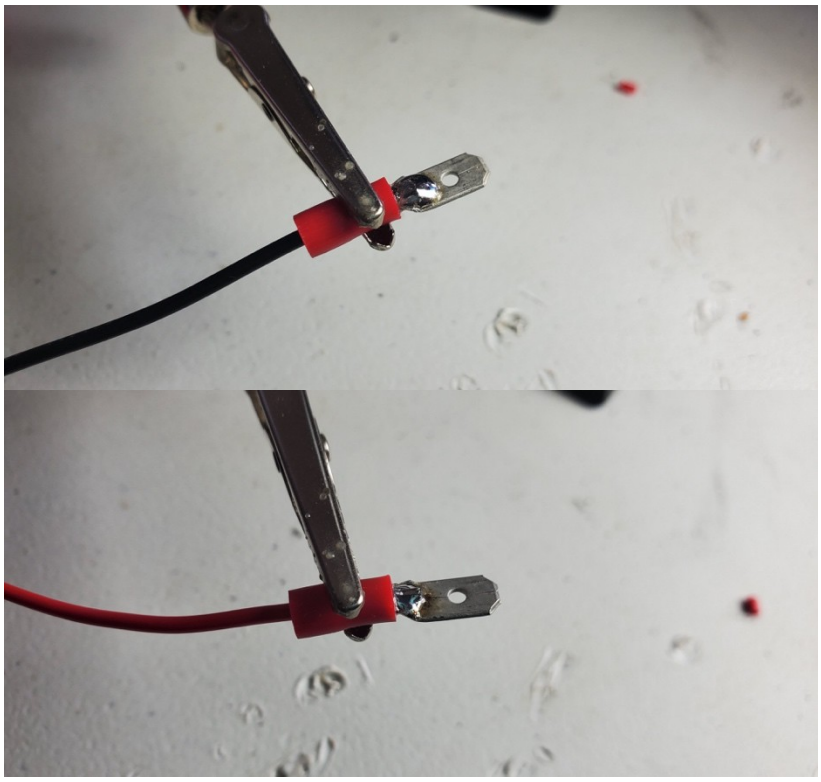
b. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires



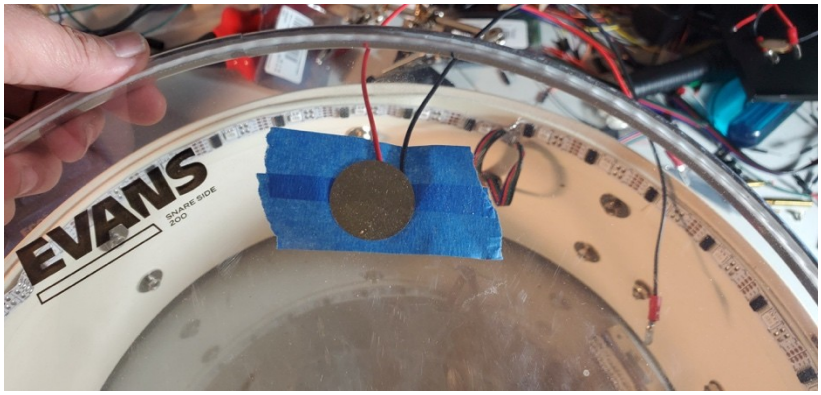
c. Solder extension wires to the piezo sensor



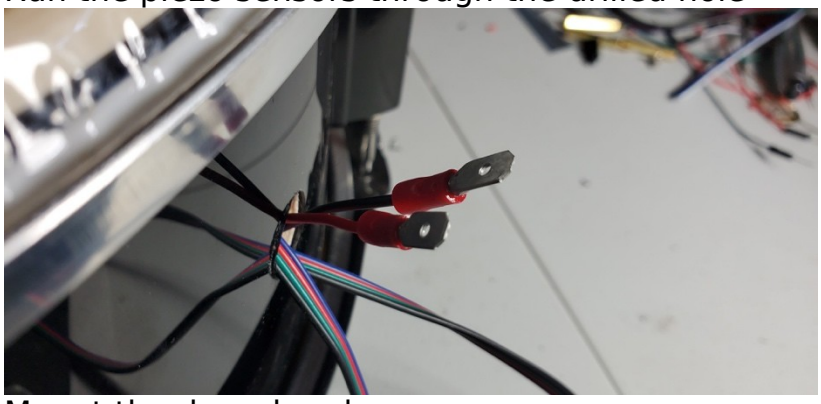
d. Solder a male connector to each of the extension wires.



5. Mount piezo sensor
    a. Tape the piezo sensor to the inside of the drum head. Make sure the metal side of the sensor touches the drum head



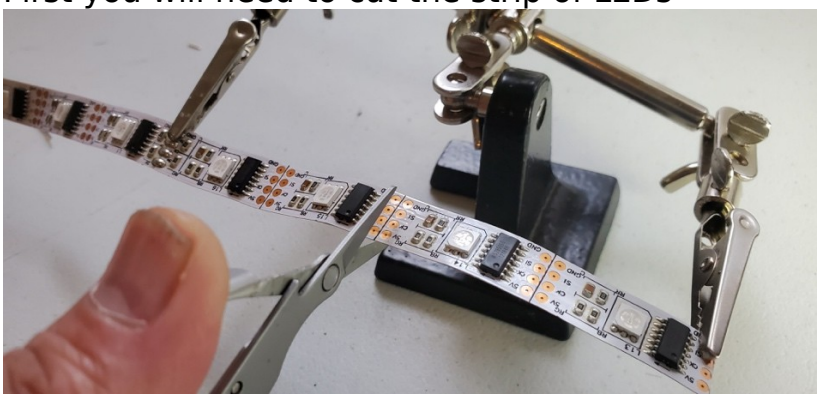
b. Run the piezo sensors through the drilled hole



c. Mount the drum head

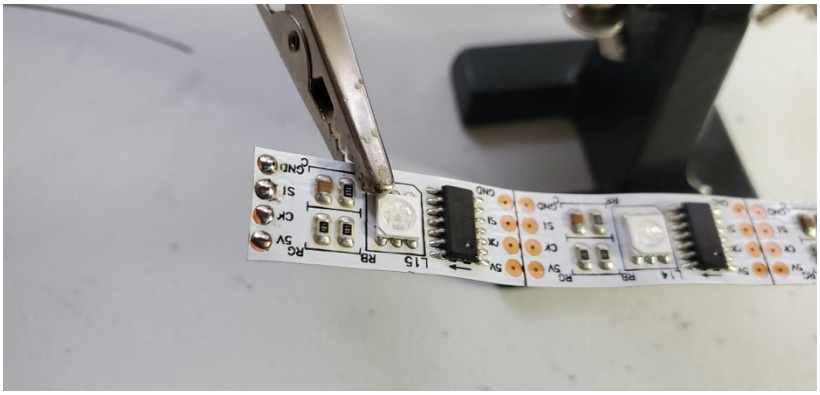
Kick Drum

1. Drill hole for wires
    a. Drill a ½” hole into the side of the drum head. The hole should be centered about 2” from the top of the drum[19]
2. Solder LED light strip
    a. First you will need to cut the strip of LEDs

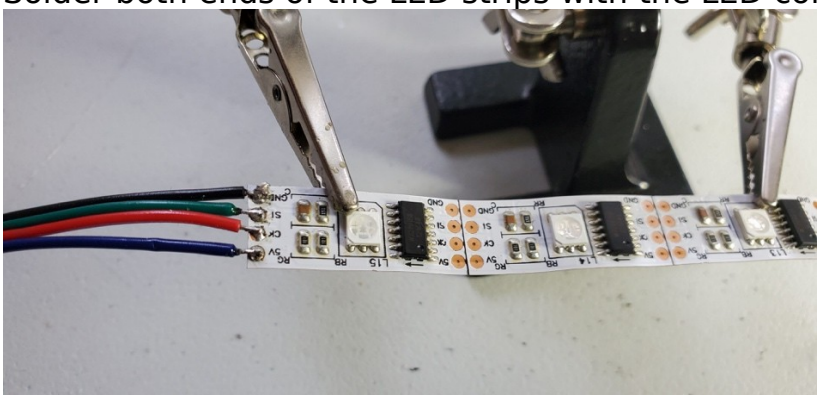


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip



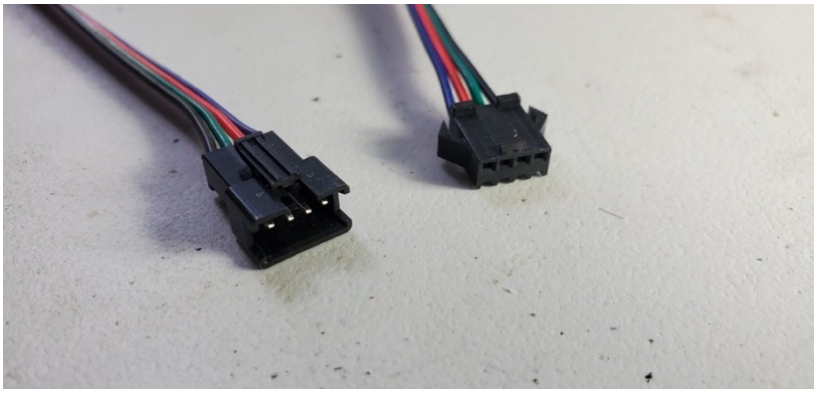
    c. Solder both ends of the LED strips with the LED connectors



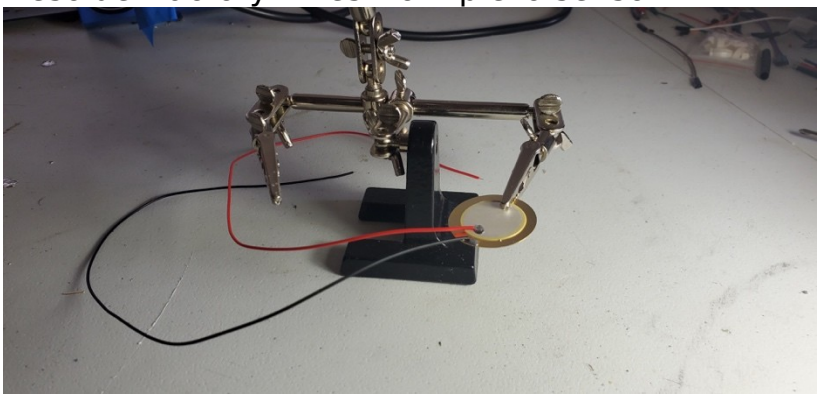
Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

    d. Be sure that one end has a male end and the other has a female end

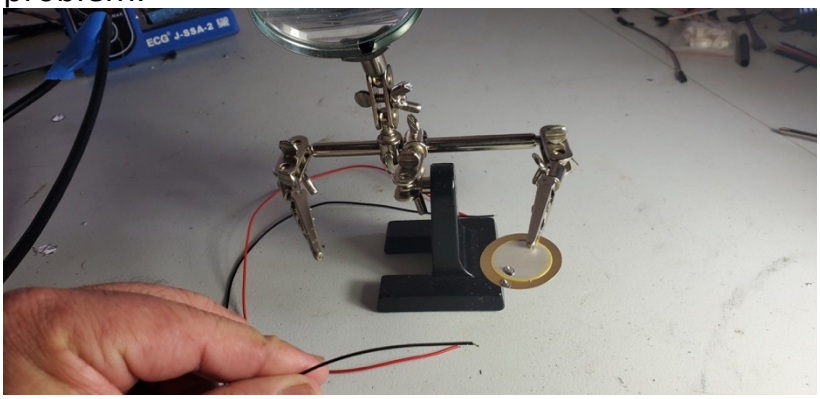
[19] Some drums are wrapped in vinyl or other material. If your drum is like that, you may want to drill a 1/8” pilot hole first. Be sure that you go slow so that you don’t rip the vinyl.



3. Mount LED light strip
    a. Line the inner edge of the drum with double sided tape
    b. Mount the LED strip to the tape
    c. Run the connector ends through the drilled hole
4. Solder piezo sensor
    a. Cut and strip extension wire[20]
    b. Desolder factory wires from piezo sensor

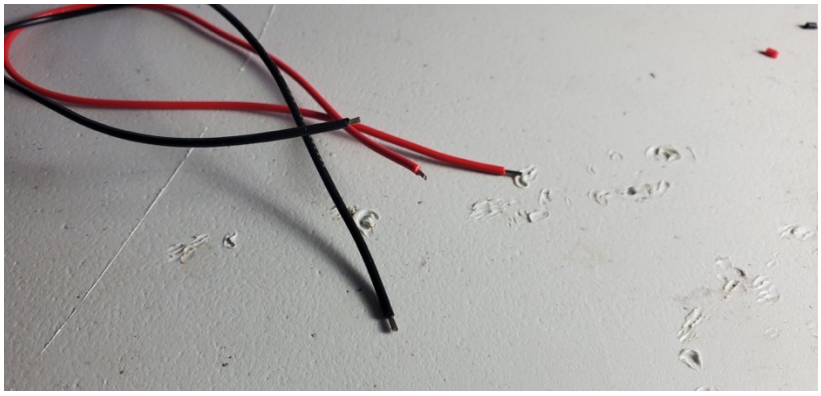


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

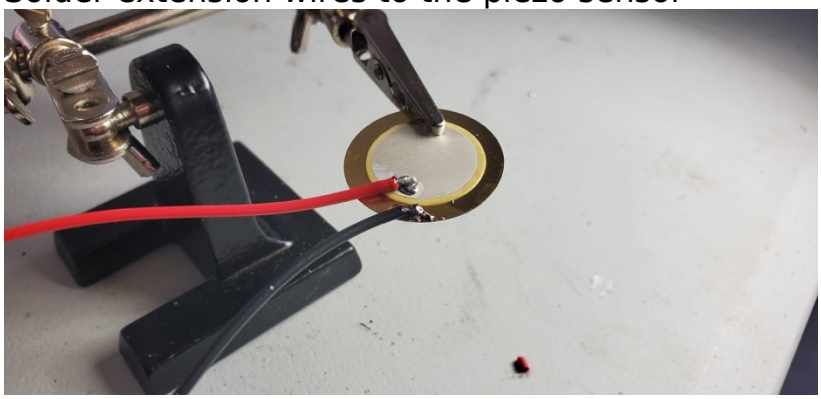


    c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

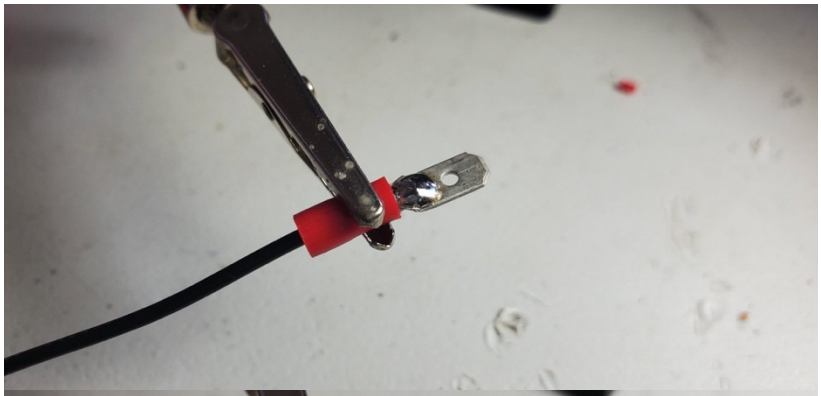
[20] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you’ve been hitting the drum quite a bit.

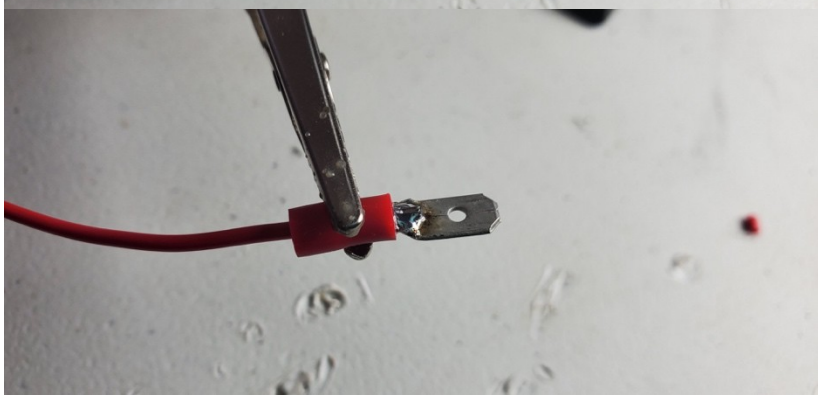


d. Solder extension wires to the piezo sensor



e. Solder a male connector to each of the extension wires.



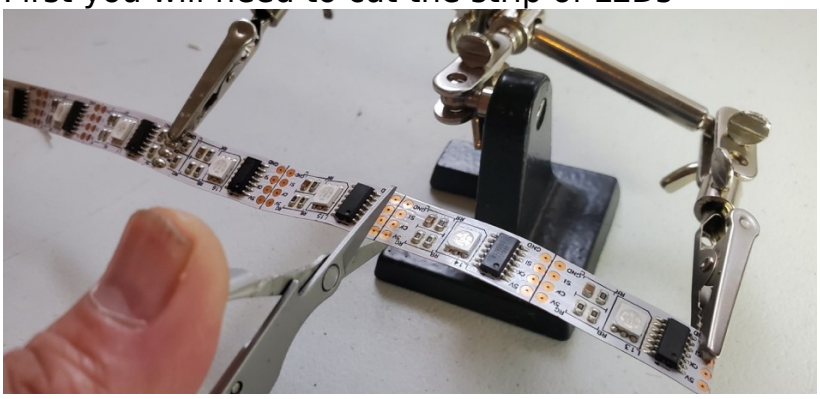


5. Mount piezo sensor

a. Tape the piezo sensor to the inside of the drum head. Make sure the metal side of the sensor touches the drum head
b. Run the piezo sensors through the drilled hole
c. Mount the drum head

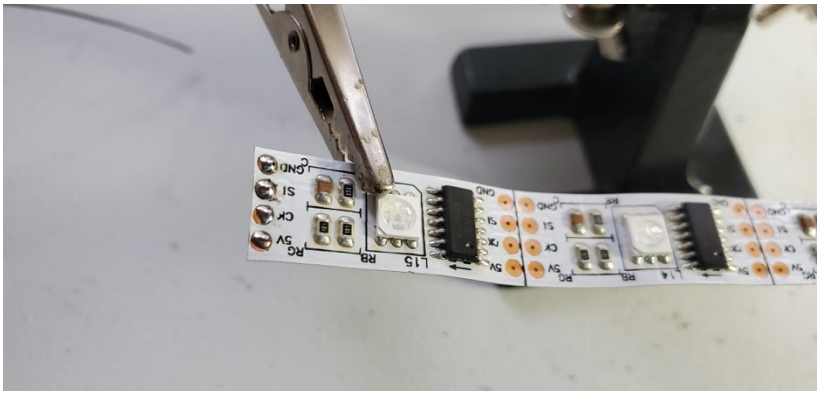
Floor Tom

1. Drill hole for wires
    a. Drill a ½” hole into the side of the drum head. The hole should be centered about 2” from the top of the drum[21]
2. Solder LED light strip
    a. First you will need to cut the strip of LEDs

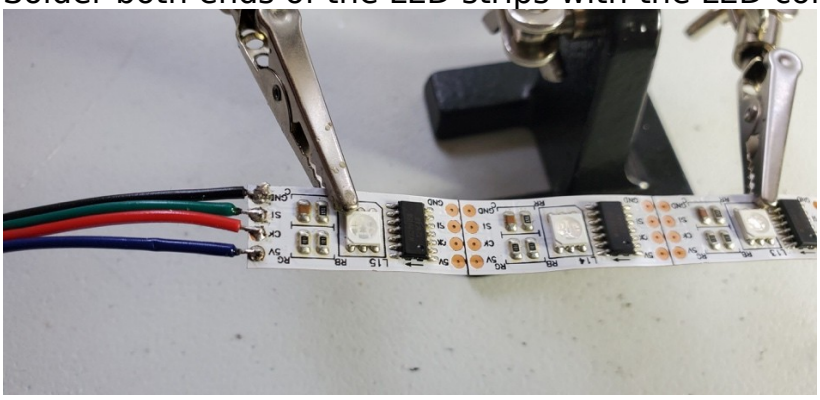


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip



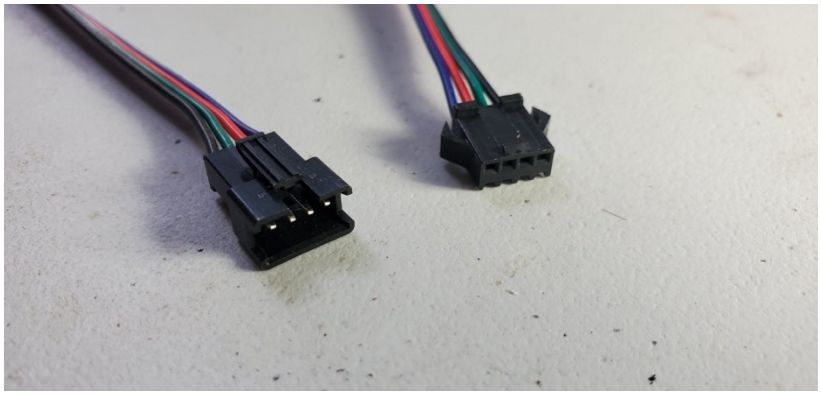
    c. Solder both ends of the LED strips with the LED connectors



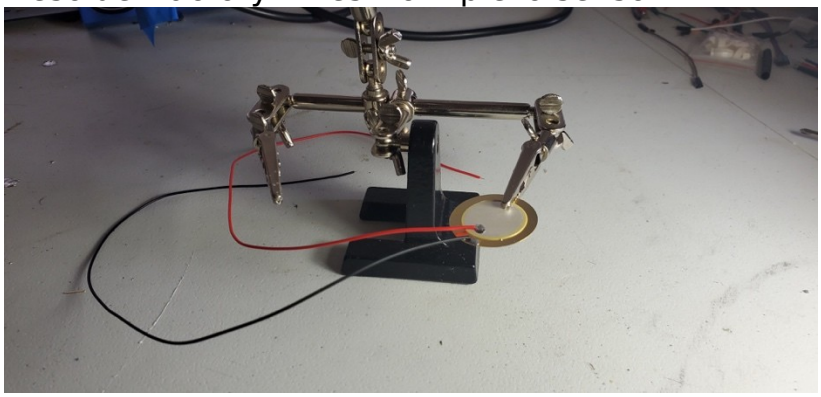
Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire

    d. Be sure that one end has a male end and the other has a female end

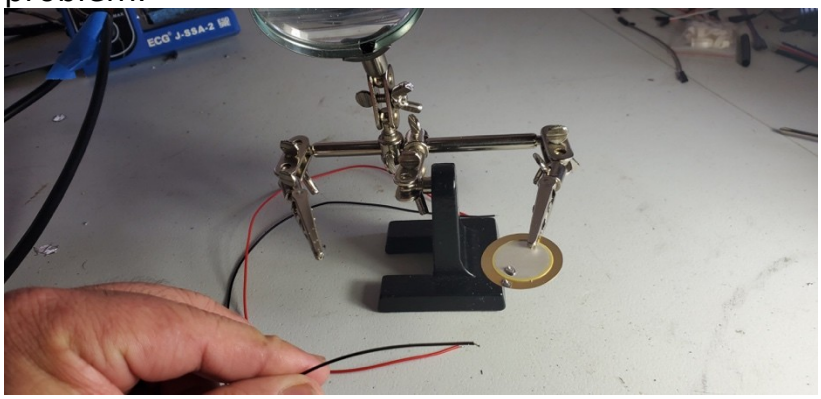
[21] Some drums are wrapped in vinyl or other material. If your drum is like that, you may want to drill a 1/8” pilot hole first. Be sure that you go slow so that you don’t rip the vinyl.



3. Mount LED light strip
    a. Line the inner edge of the drum with double sided tape
    b. Mount the LED strip to the tape
    c. Run the connector ends through the drilled hole
4. Solder piezo sensor
    a. Cut and strip extension wire[22]
    b. Desolder factory wires from piezo sensor

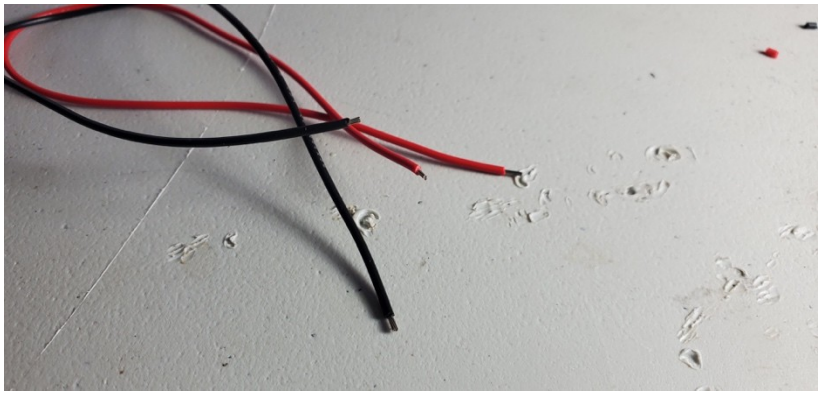


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

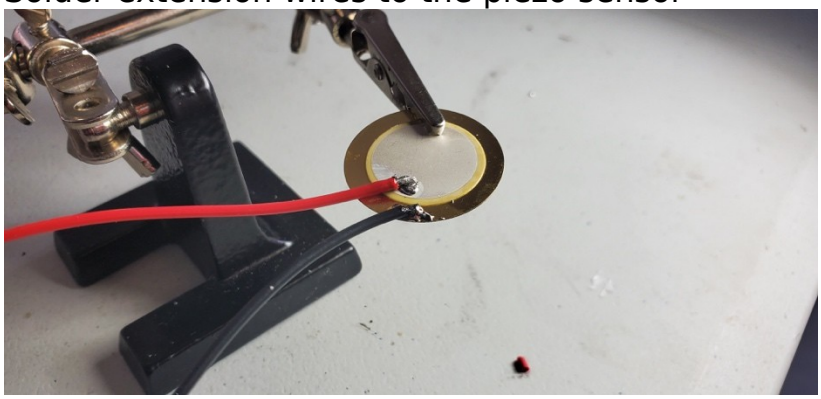


    c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

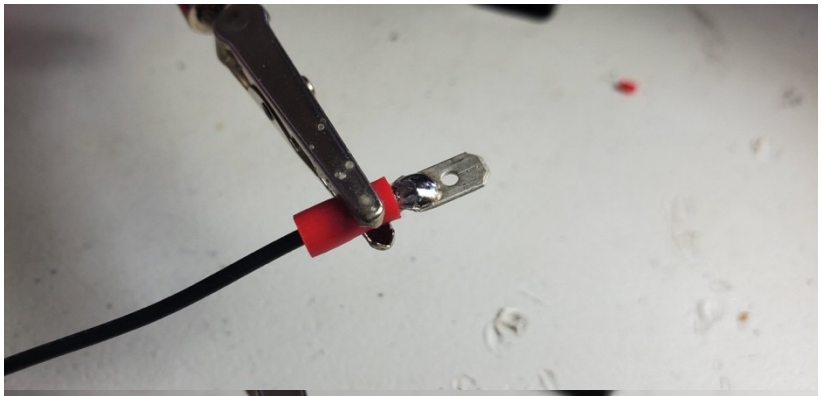
[22] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you’ve been hitting the drum quite a bit.

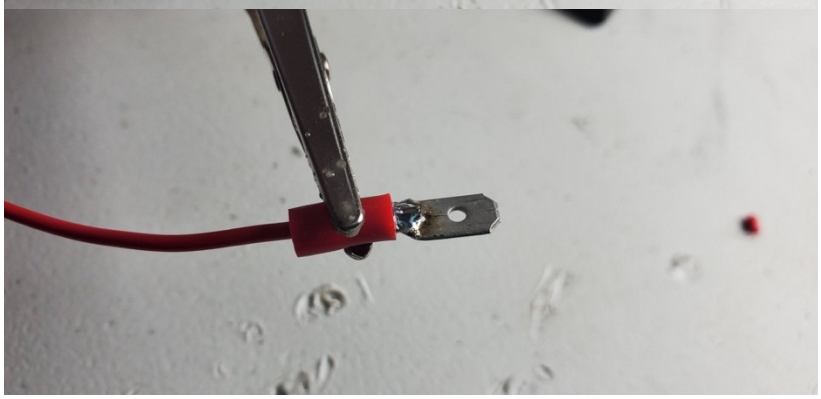


d. Solder extension wires to the piezo sensor



e. Solder a male connector to each of the extension wires.



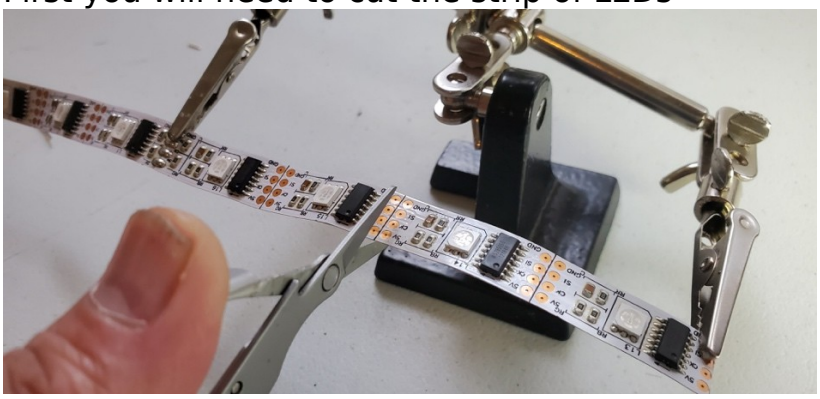


5. Mount piezo sensor

a. Tape the piezo sensor to the inside of the drum head. Make sure the metal side of the sensor touches the drum head
b. Run the piezo sensors through the drilled hole
c. Mount the drum head

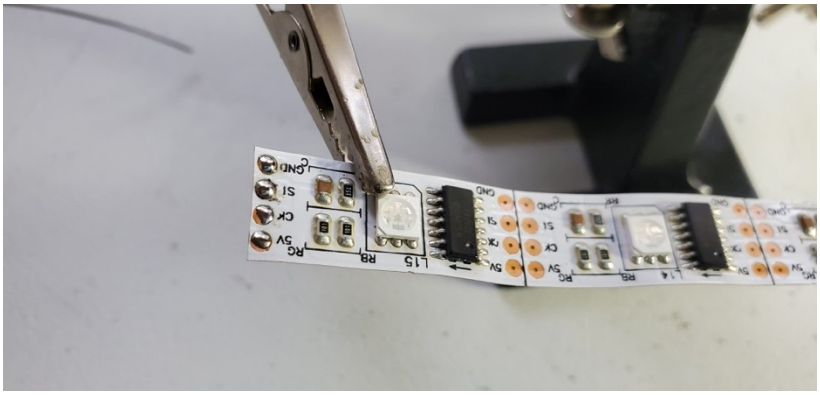
Crash Cymbal

1. Solder LED light strip
    a. First you will need to cut the strip of LEDs

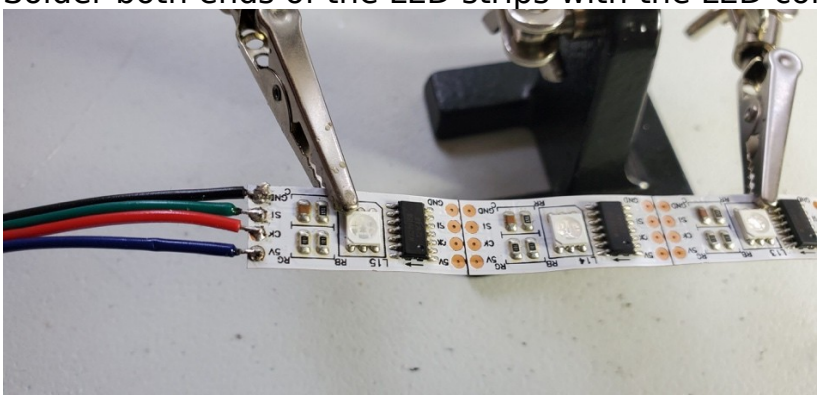


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip

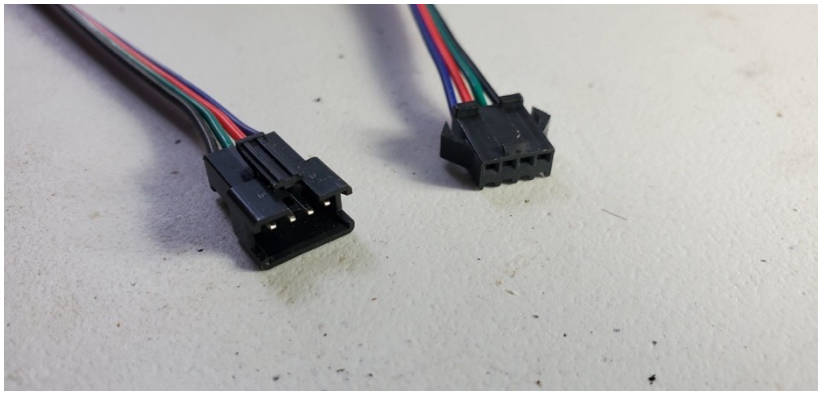


    c. Solder both ends of the LED strips with the LED connectors

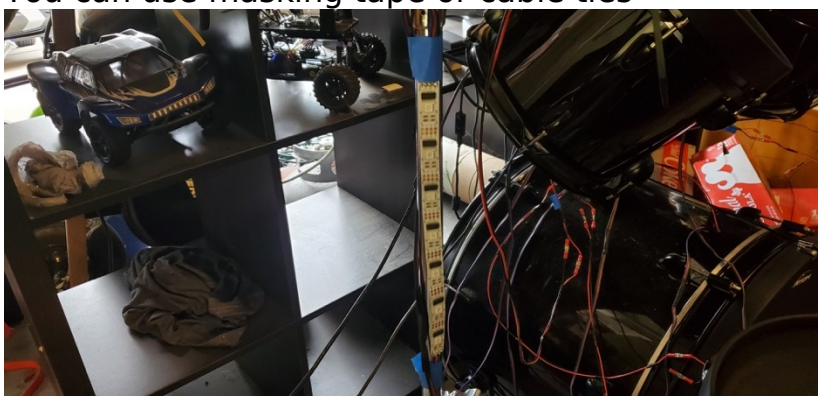


Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

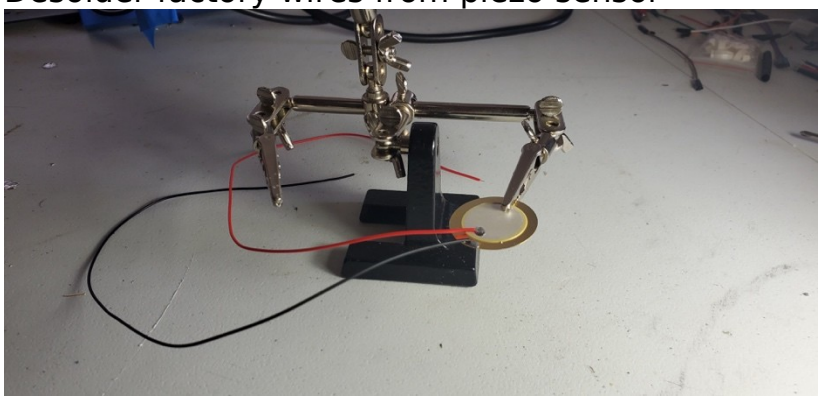
    d. Be sure that one end has a male end and the other has a female end



2. Mount LED light strip
    a. Mount the LED strip to the vertical post of the Crash Cymbal. You can use masking tape or cable ties

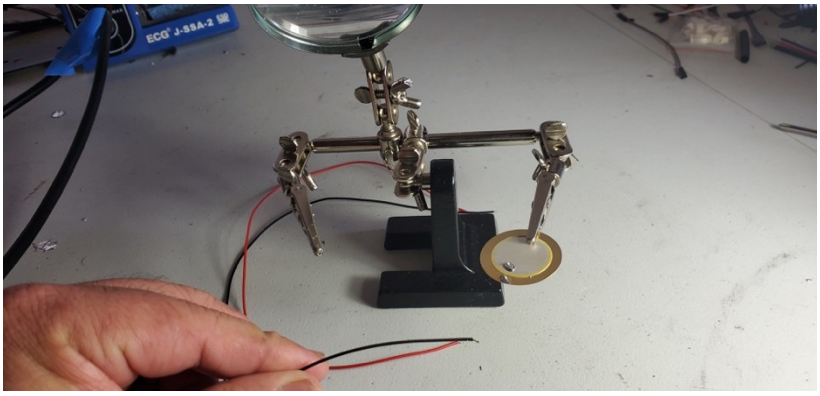


3. Solder piezo sensor
    a. Cut and strip extension wire[23]
    b. Desolder factory wires from piezo sensor

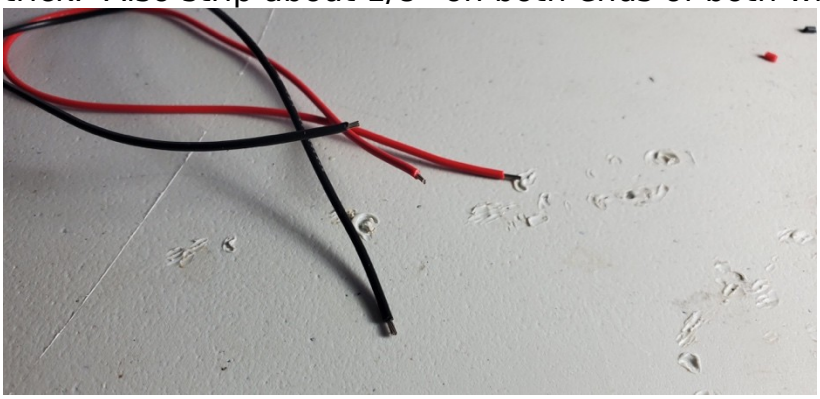


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

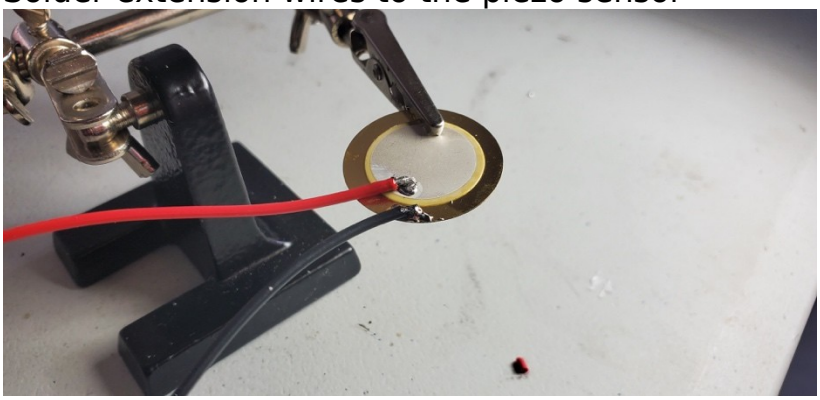
[23] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you've been hitting the drum quite a bit.



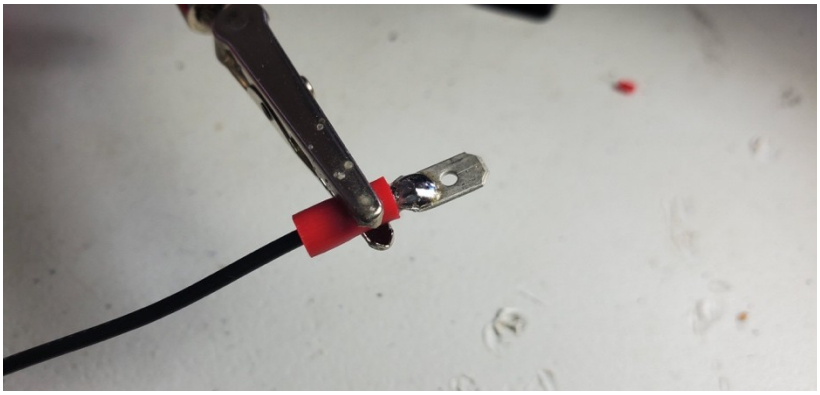
c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

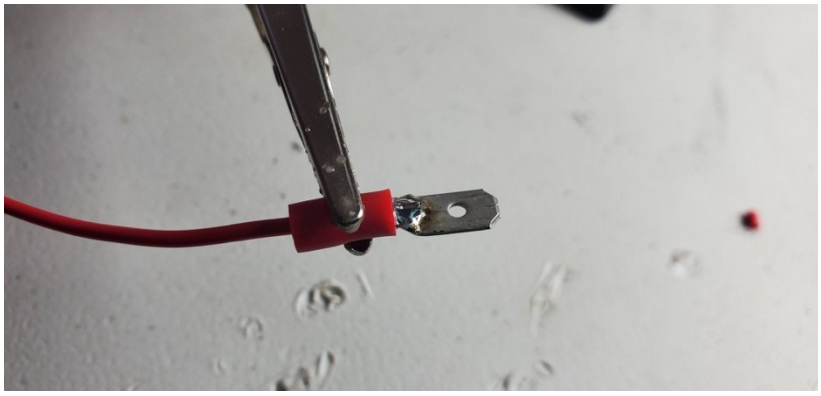


d. Solder extension wires to the piezo sensor

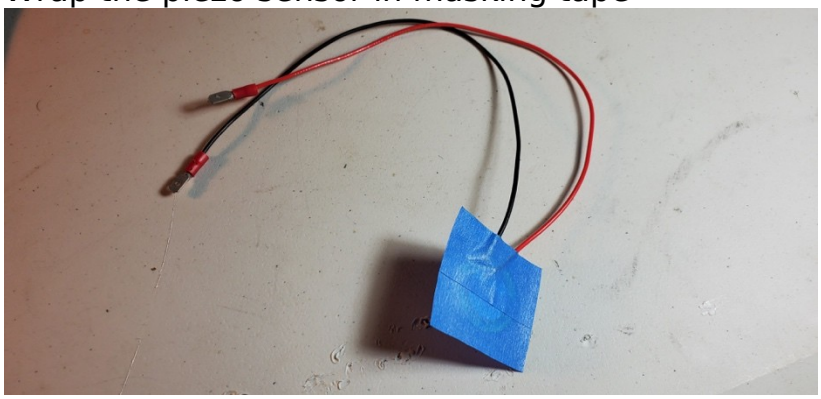


e. Solder a male connector to each of the extension wires.





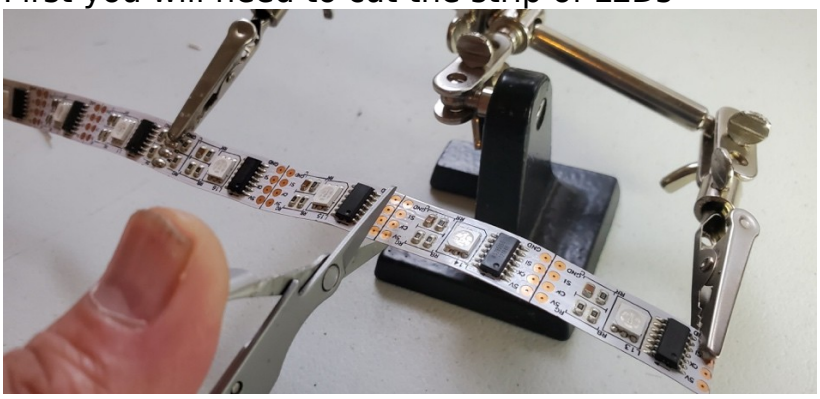
4. Mount piezo sensor
    a. Wrap the piezo sensor in masking tape



    b. Tape the piezo sensor to the underside of the cymbal. Make sure the metal side of the sensor touches the cymbal

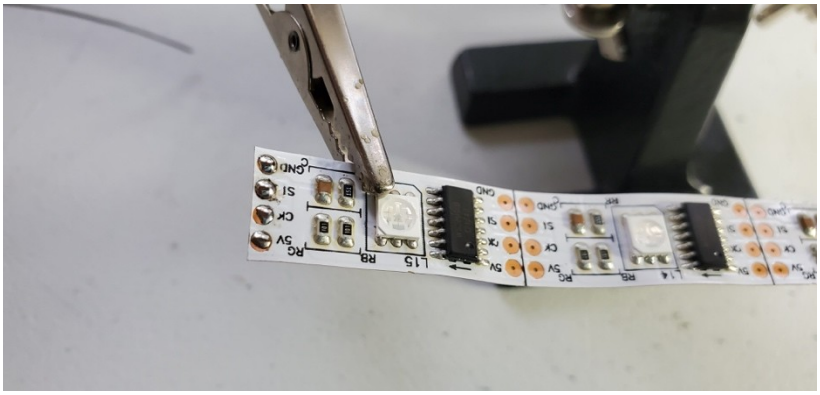
Ride Cymbal

1. Solder LED light strip
    a. First you will need to cut the strip of LEDs

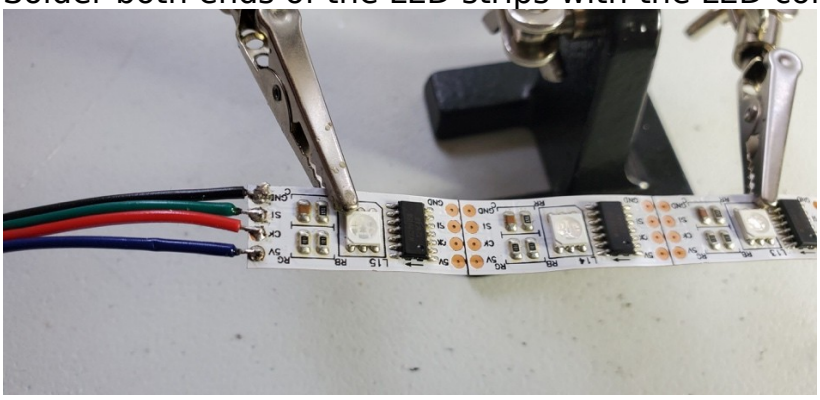


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip

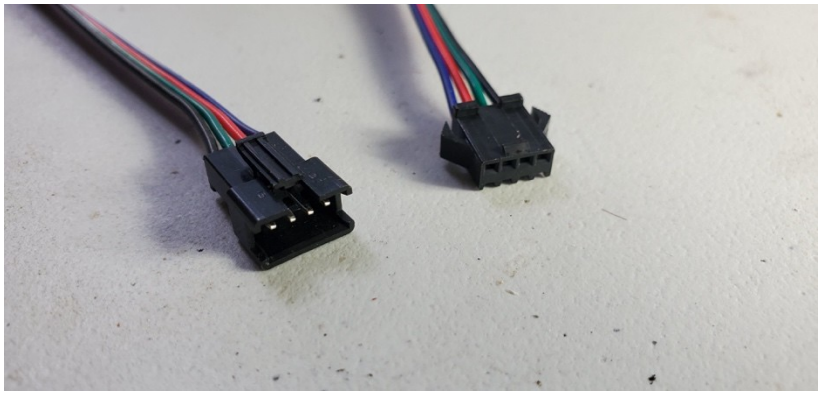


    c. Solder both ends of the LED strips with the LED connectors



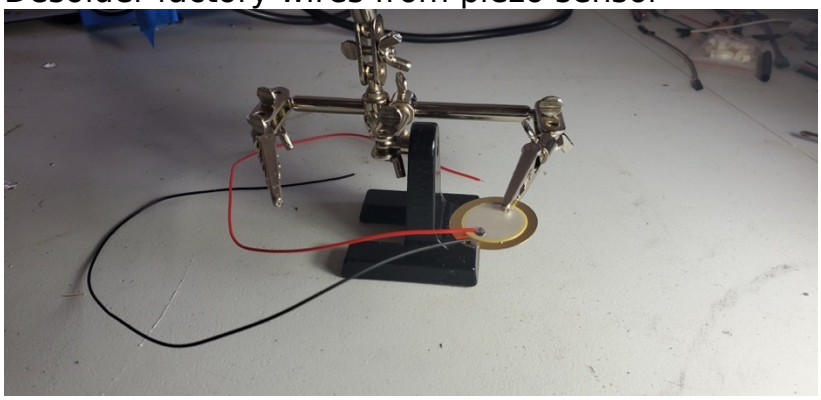
Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

    d. Be sure that one end has a male end and the other has a female end



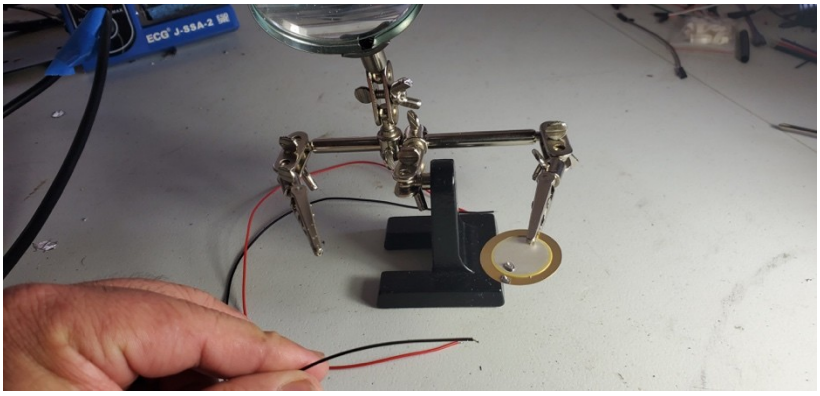
2. Mount LED light strip
    a. Mount the LED strip to the vertical post of the Ride Cymbal. You can use masking tape or cable ties

3. Solder piezo sensor
    a. Cut and strip extension wire[24]
    b. Desolder factory wires from piezo sensor

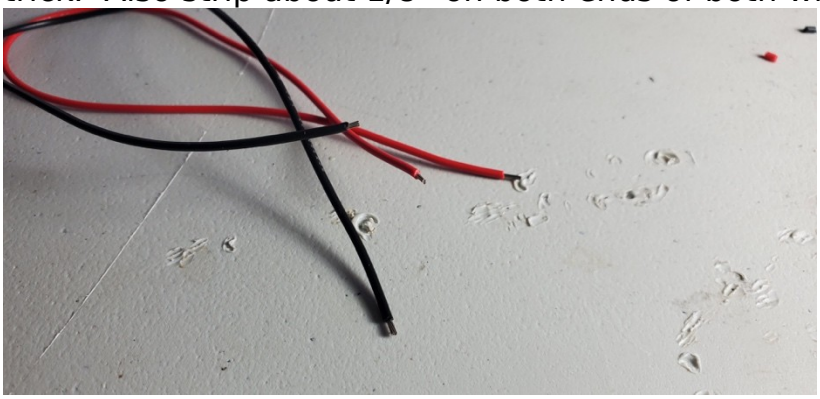


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

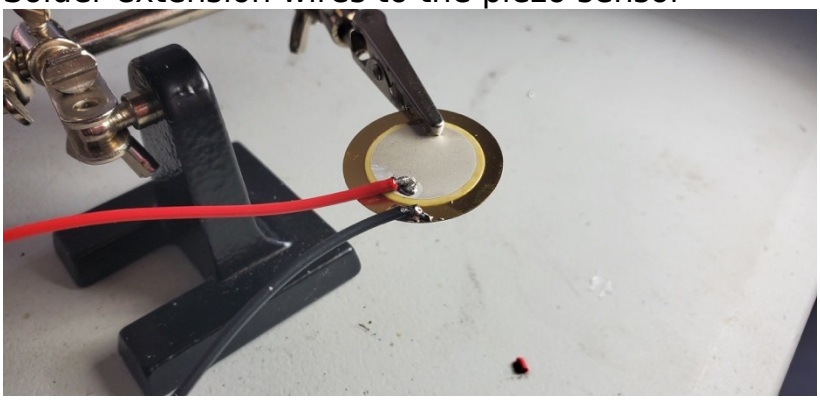
[24] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you've been hitting the drum quite a bit.



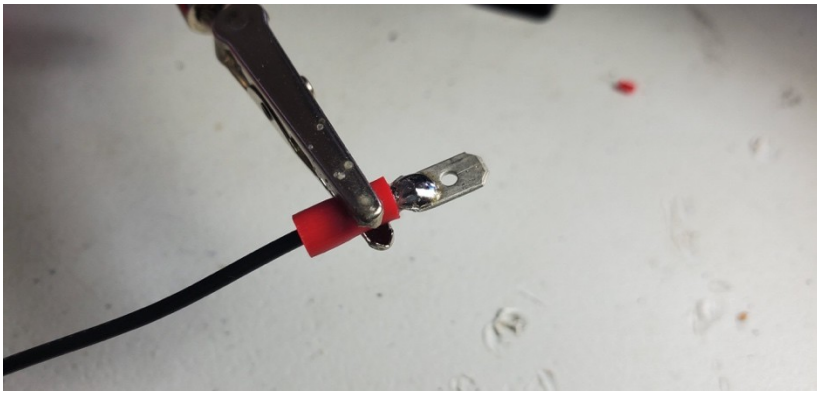
c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

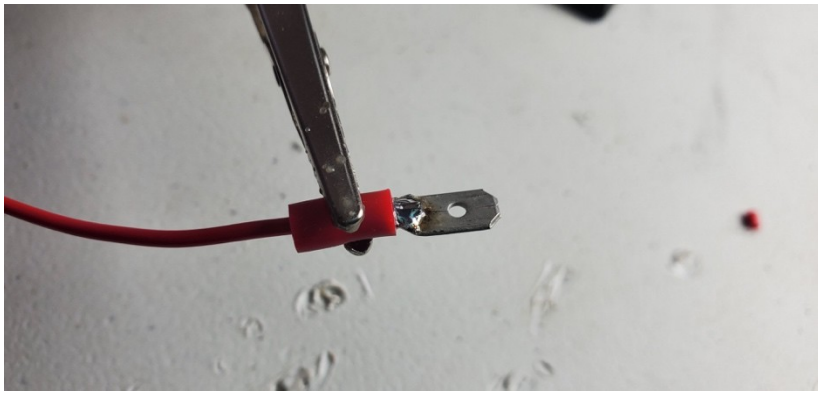


d. Solder extension wires to the piezo sensor

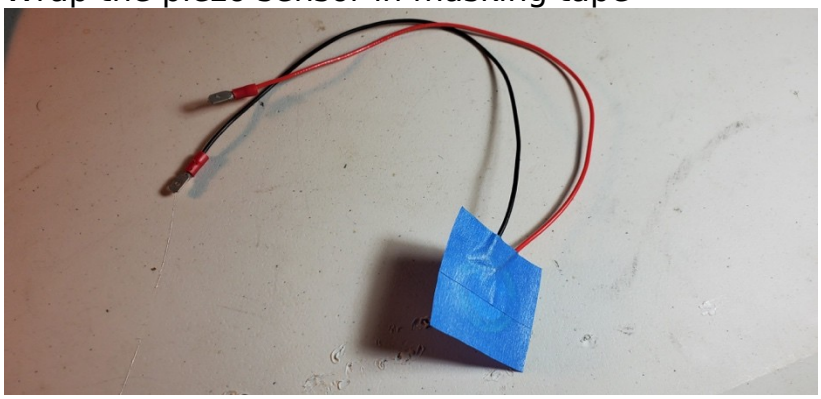


e. Solder a male connector to each of the extension wires.





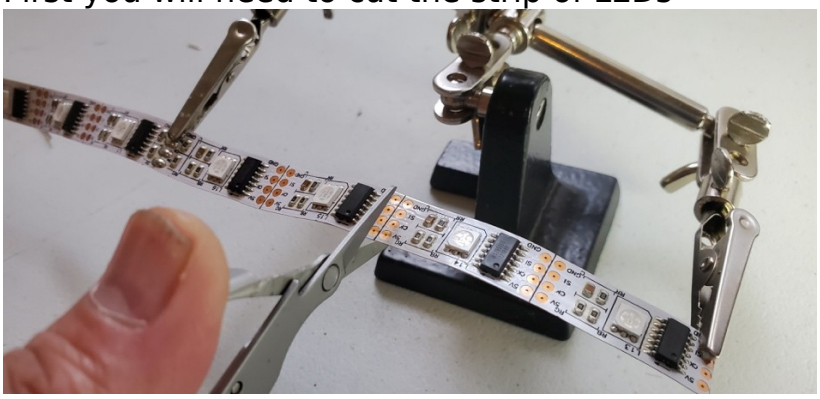
4. Mount piezo sensor
    a. Wrap the piezo sensor in masking tape



    b. Tape the piezo sensor to the underside of the cymbal. Make sure the metal side of the sensor faces the cymbal

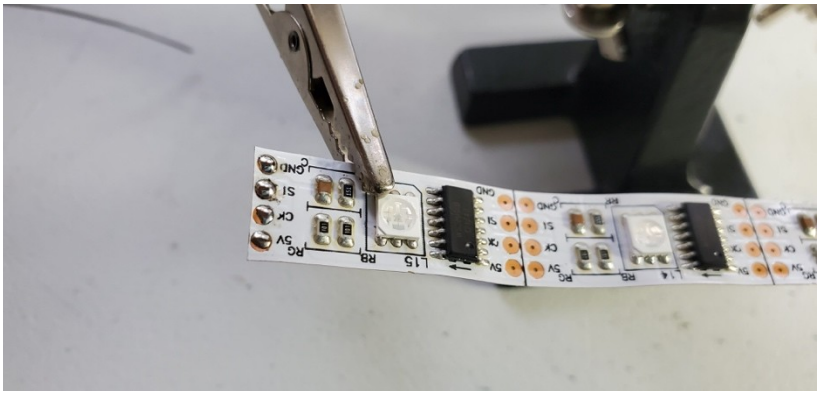
Hihat Cymbal

1. Solder LED light strip
    a. First you will need to cut the strip of LEDs

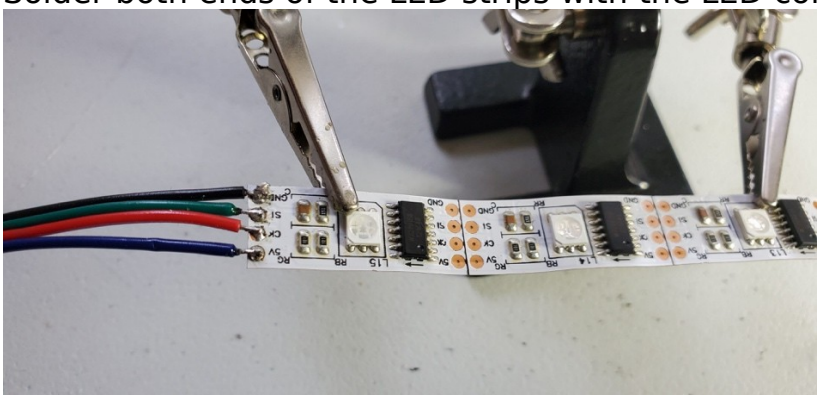


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip

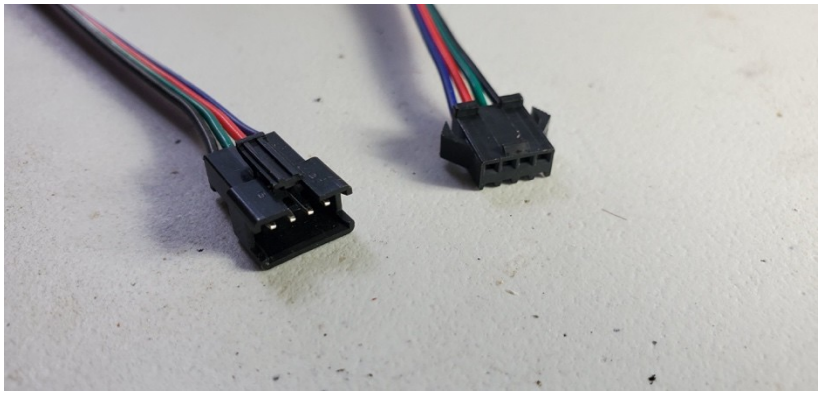


    c. Solder both ends of the LED strips with the LED connectors



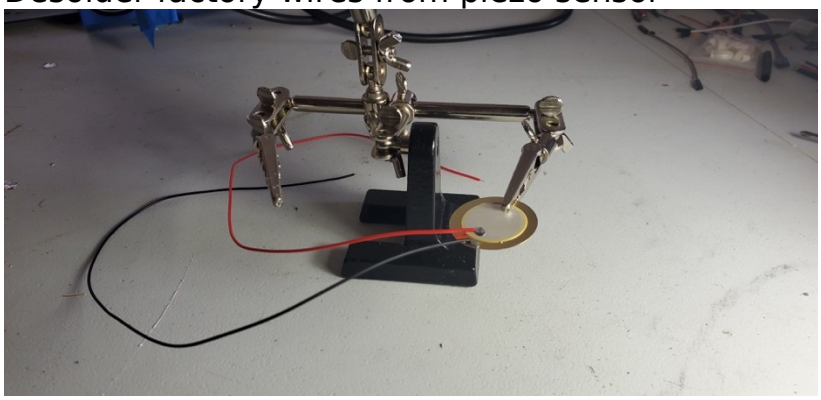
Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

    d. Be sure that one end has a male end and the other has a female end



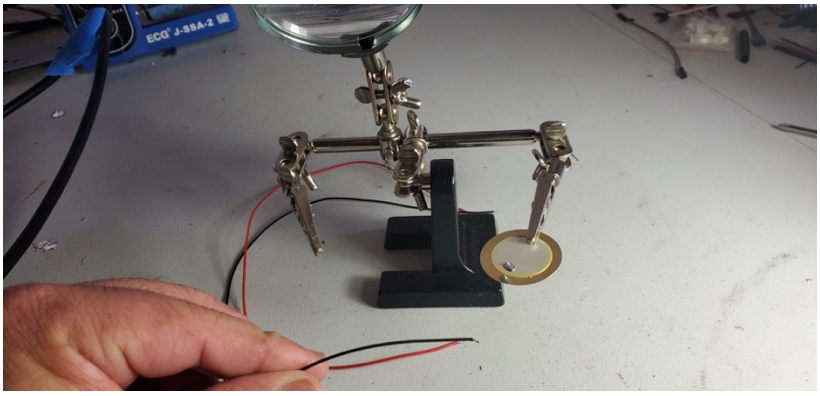
2. Mount LED light strip
    a. Mount the LED strip to the vertical post of the Hihat Cymbal. You can use masking tape or cable ties

3. Solder piezo sensor
    a. Cut and strip extension wire[25]
    b. Desolder factory wires from piezo sensor

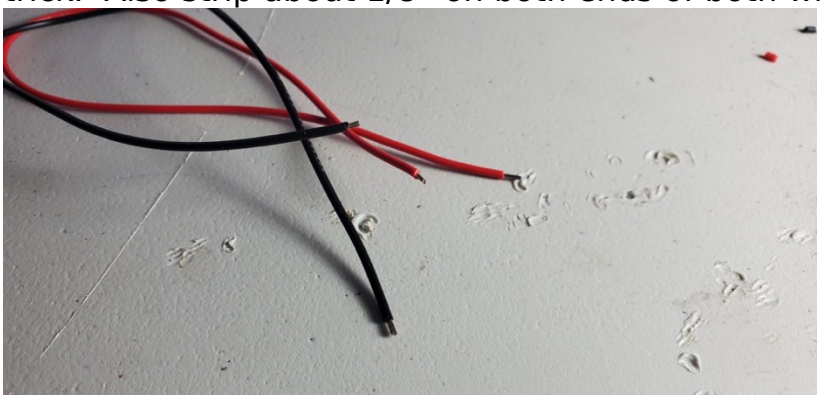


The wires that come with the piezo sensor are quite flimsy. We found that after some moderate use of the drums, the wires fell off the sensors. Resoldering with a heavier gauge wire fixes the problem.

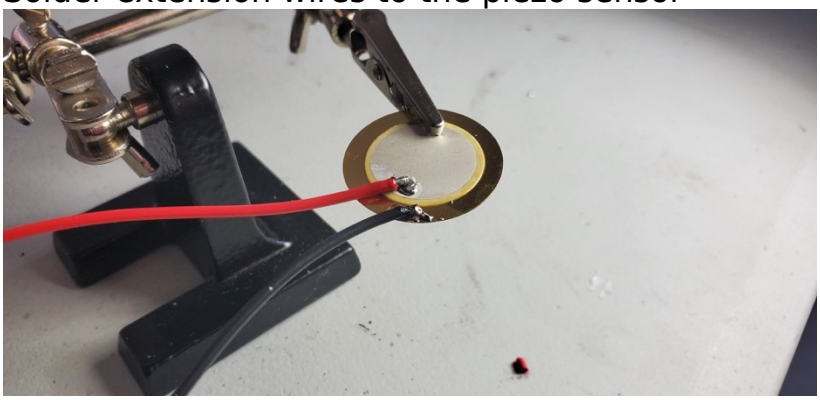
[25] Steps a-c are not strictly required, but strongly suggested. The factory wires tend to be weak and fall off the sensors after you've been hitting the drum quite a bit.



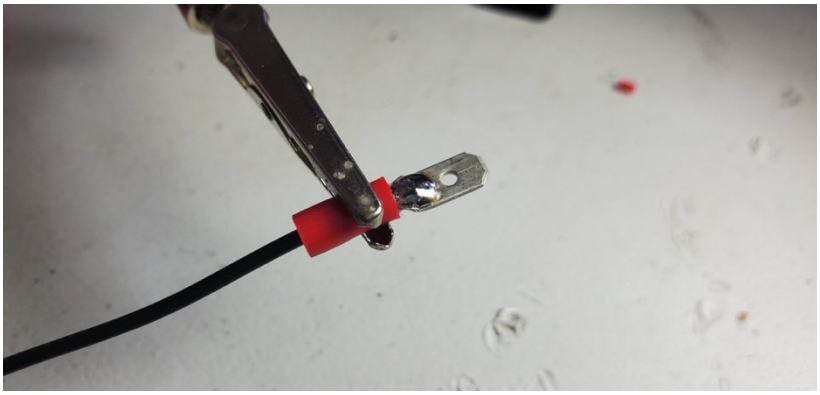
c. Cut a length of the red and blue. 12 inches or so should do the trick. Also strip about 1/8” on both ends of both wires

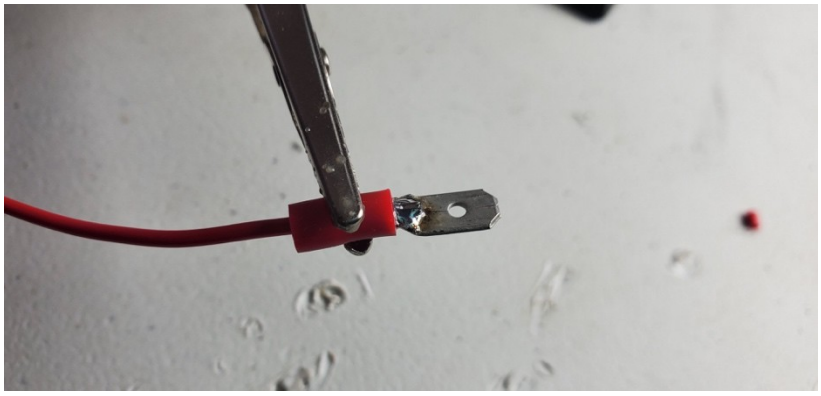


d. Solder extension wires to the piezo sensor

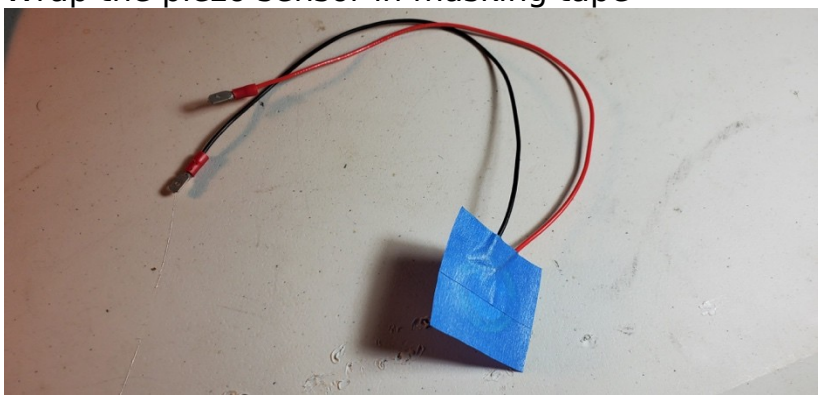


e. Solder a male connector to each of the extension wires.





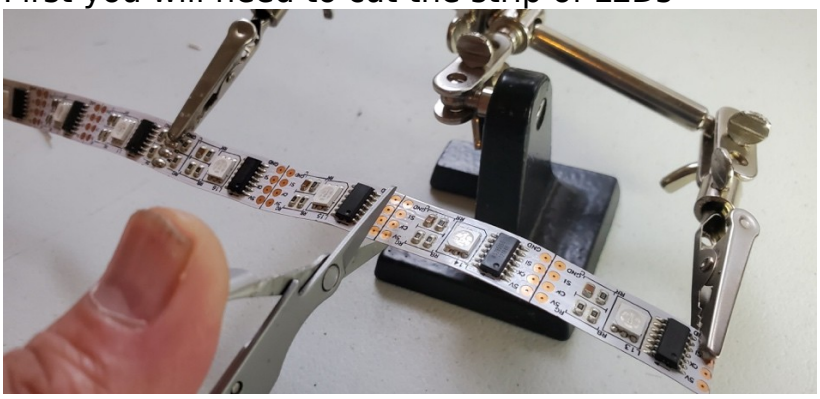
4. Mount piezo sensor
    a. Wrap the piezo sensor in masking tape



    c. Tape the piezo sensor to the underside of the lower cymbal. Make sure the metal side of the sensor faces the cymbal

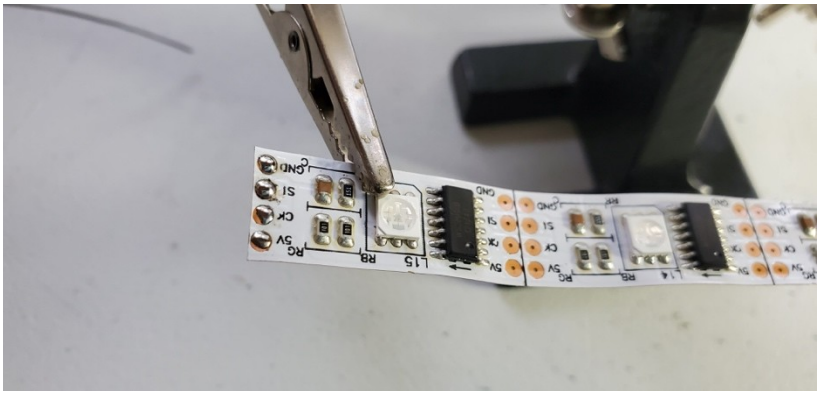
Metronome

1. Solder LED light strip
    a. First you will need to cut the strip of LEDs

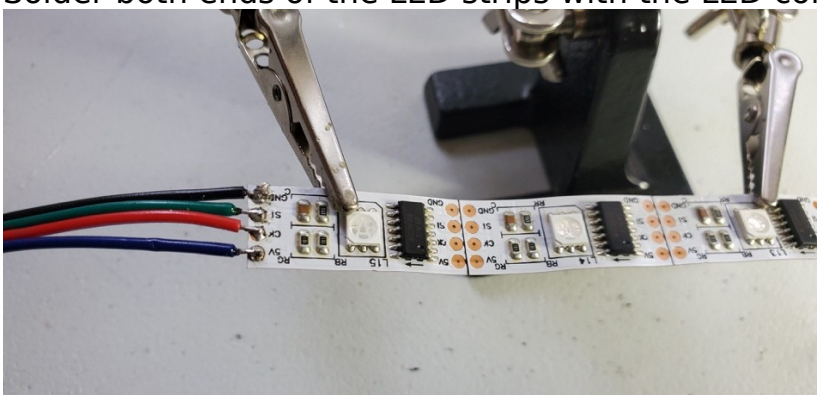


Cut cleanly along the line between the copper leads.

    b. Add solder onto all of the leads on both ends of the LED strip

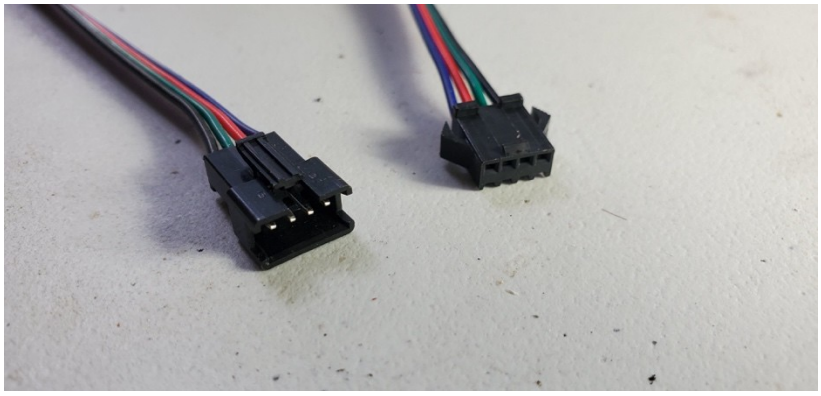


    c. Solder both ends of the LED strips with the LED connectors

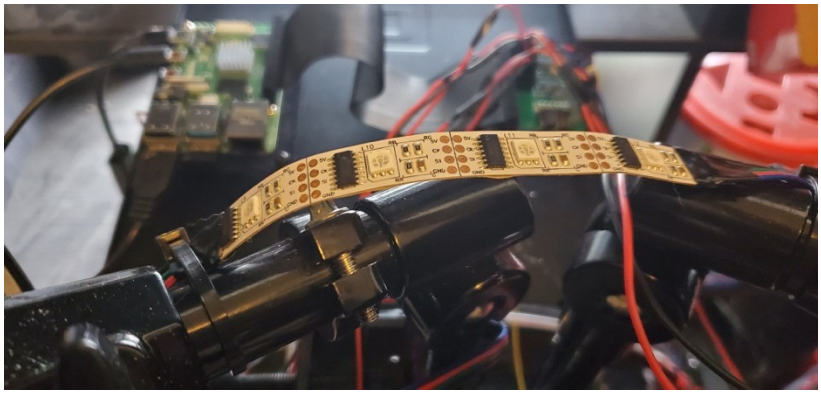


Solder ***GND*** to the black wire and keep the same order of the wires until you end up soldering ***5V*** to the blue wire.

    d. Be sure that one end has a male end and the other has a female end



2. Mount LED light strip
    a. Mount the LED strip someplace easy to see for the drummer. We chose to mount it to the horizontal arms that mount the 10” Tom and 12” Tom drums.



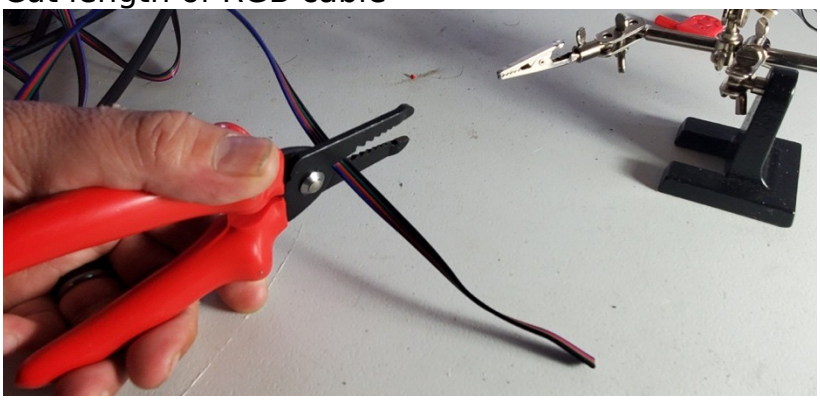
LED Patch Cables

You will need several lengths of these patch cables. The measurements of these cables will vary depending on how you have your drums physically places. Make measurements for the following runs:

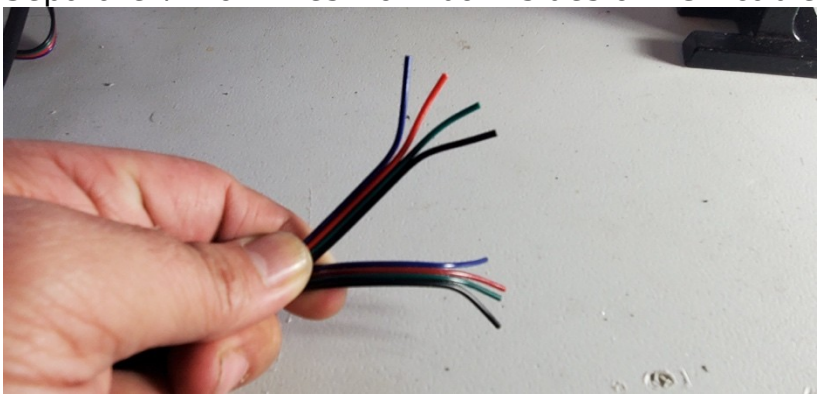
1. Analog to Digital Board to Small Tom
2. Small Tom to Large Tom
3. Large Tom to Snare Drum
4. Snare Drum to Kick Drum
5. Kick Drum to Floor Tom
6. Floor Tom to Ride Cymbal
7. Ride Cymbal to Hihat
8. Hihat to Crash Cymbal
9. Crash Cymbal to Metronome

Now use those measurement for the length of the RGB cable in the following steps:

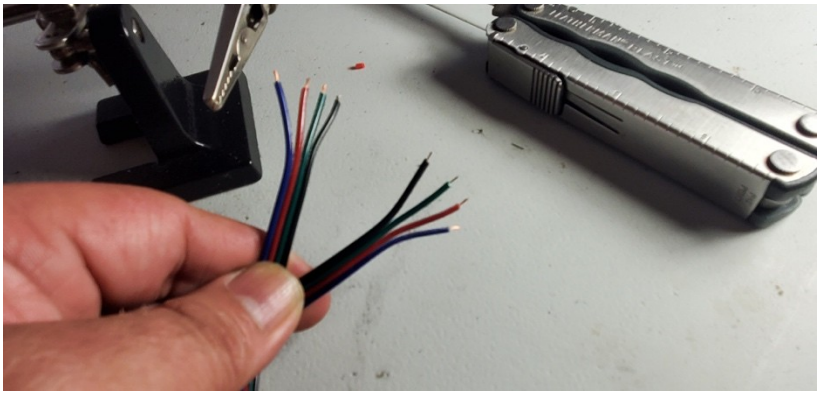
1. Cut length of RGB cable



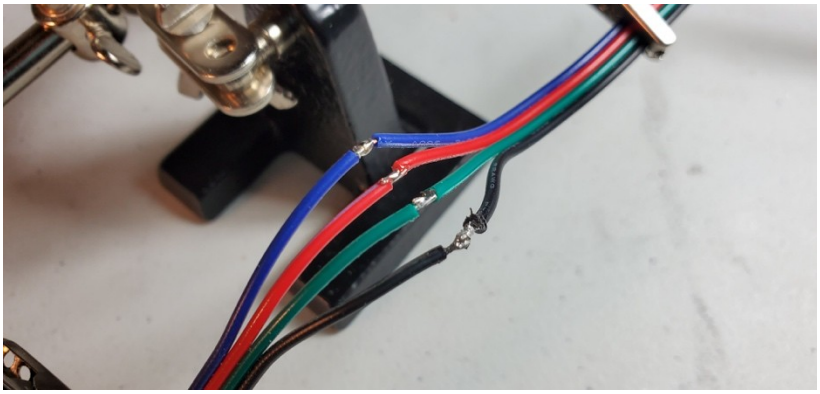
2. Separate ½” of wires from both sides of RGB cable



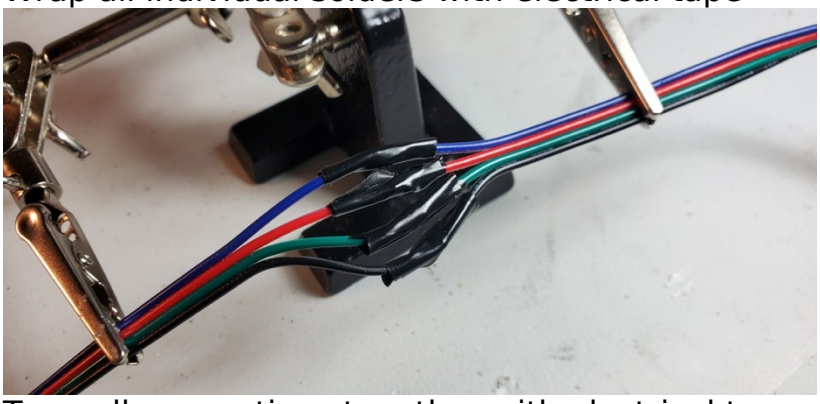
3. Strip 1/8” from end of wires



4. Solder one end to female RGB connector



5. Wrap all individual solders with electrical tape



6. Tape all connections together with electrical tape

7. Repeat Steps 4-6 for the male connector on the other end of the patch cable

Piezo Patch Cables

You will need several lengths of these patch cables. The measurements of these cables will vary depending on how you have your drums physically places. Make measurements for the following runs:

1. Analog to Digital Board to Hihat Cymbal
2. Analog to Digital Board to Crash Cymbal
3. Analog to Digital Board to Ride Cymbal
4. Analog to Digital Board to Small Tom
5. Analog to Digital Board to Large Tom
6. Analog to Digital Board to Snare Drum
7. Analog to Digital Board to Kick Drum
8. Analog to Digital Board to Floor Tom

Now, use those measurements to make the patch cables.

1. Cut length of 20-gauge wire from spools
2. Strip 1/8” from end of wires
3. Solder one end to female ribbon cable connector
4. Solder remaining end to ribbon cable connector
5. Wrap all individual solders with electrical tape
6. Tape all connections together with electrical tape

Software

This section deals with the software installation and configuration to be performed on the Raspberry Pi and anything that needs to be done within the AWS Cloud. Most of the work in the AWS Console will be done via CloudFormation. You should be able to use the HDMI adapter and a USB keyboard and/or mouse to get local console access to the drums.

Raspberry Pi

1. If you do not have your PI setup with current OS, Follow the guide here: https://docs.aws.amazon.com/greengrass/latest/developerguide/setup-filter.rpi.html
2. Set up the Greengrass system on your PI with the guide here: https://docs.aws.amazon.com/greengrass/latest/developerguide/module2.html
3. During this process you will download a .tar.gz file of the Core's security resources, then download the Greengrass installation for your architecture (Armv7l)
4. Start Greegrass on the core device (PI4): https://docs.aws.amazon.com/greengrass/latest/developerguide/gg-device-start.html
5. Set Greengrass to start on boot: https://docs.aws.amazon.com/greengrass/latest/developerguide/gg-core.html#start-on-boot
6. Set Greengrass to run as root on your PI: https://docs.aws.amazon.com/greengrass/latest/developerguide/lambda-group-config.html
7. Check out example source from github: https://github.com/vanderfox/RhythmCloud
8. From the source checkout, copy the contents of the pi/* folder to /home/pi
9. Install the AWS Python IoT SDK follow instructions here: https://docs.aws.amazon.com/greengrass/latest/developerguide/IoT-SDK.html
10. Install the Adafruit GPIO libraries here: https://github.com/adafruit/Adafruit_Python_GPIO Follow instructions
11. Install the ADPi Python library from https://github.com/abelectronicsuk/ABElectronics_Python_Libraries/tree/master/ADCPi and follow the install instuctions
12. Install the libraries for the WS2801 lights here https://github.com/adafruit/Adafruit_Python_WS2801 - there is a newer version that uses Python3, but we have not tested it yet.
13. You will need to install the following pip packages for Python 2 and Python 3.
    a. pip install tzlocal
    b. pip install pid

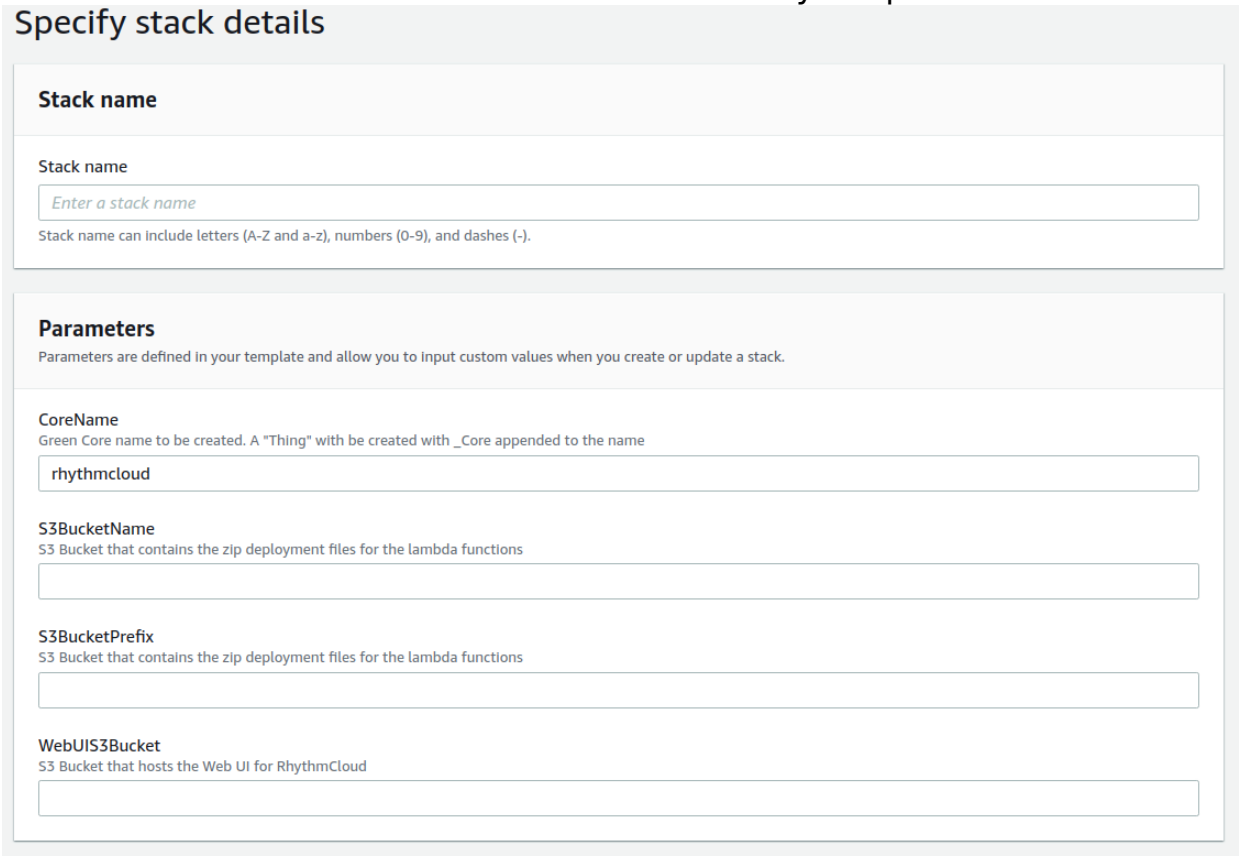
c. pip install supervisor (Thus
d. pip install pytz
e. pip install boto
f. pip install boto3
g. pip install botocore
h. pip install awscli
i. pip install RPi.GPIO
j. pip install PyYAML
k. pip install jsonlib
l. pip install mido

14. Configure supervisor - this will create a daemon for the idleMode.py script. This allows it to keep running between Beat/Song playback runs, and have a cool rainbow pattern going while idle.
    a. Setup initial config file follow instructions at http://supervisord.org/installing.html
    b. Add this block to the configuration to the /etc/supervisor/supervisord.conf:
        i. [program:idlemode]
        ii. command=/usr/bin/python /home/pi/idleMode.py
        iii. stderr_logfile = /var/log/supervisord/tornado-stderr.log
        iv. stdout_logfile = /var/log/supervisord/tornado-stdout.log

AWS Console

1. Copy Lambda function deployments to S3: This will allow the Cloudformation stack to read them and deploy them. In the github directory you checked out earlier, we'll copy the deployment zip for each to a S3 bucket in your account. Then we will run a series of Cloudformation templates to set things up.
    a. Copy the zip file in each directory under 'lambda' to a bucket on S3 that cloudformation can access. For example 'aws s3 cp lambda/GetSongs/GetSongs.zip s3://somebucketinyouraccount. Repeat for each directory 'GetSongs', 'UploadSong', 'GetSongs','UploadSong', 'StartSong', and 'Greengrass_start'
        1. Upload the following files to the bucket
            a. /lambda/Greengrass_startSong/Greengrass_play.zip
            b. /lambda/GetSongs/getSongs.zip
            c. /lambda/StartSong/StartSong-.zip
            d. /lambda/UploadSong/UploadSong.zip
            i. **Note after Cloudformation deployment you will need to edit and re-deploy a new version of 'StartSong' Lambda with your IoT core hostname, private key, and cert file (instructions are below - keep reading).**
    b. Go to Cloudformation service, and click on 'Create stack': Choose 'template is ready' and 'upload a template file'. Choose cloudformation/apigatewaylogroles.yml. This will create some IAM roles needed for the following Cloudformation templates.

c. Go to Cloudformation service, and click on 'Create stack': Choose 'template is ready' and 'upload a template file'. Choose cloudformation/dynamodb.yml. This will create the DynamoDB tables needed for the system.
d. Go to Cloudformation service, and click on 'Create stack': Choose 'template is ready' and 'upload a template file'. Choose cloudformation/greengrass_rhythmcloud.yml. This will create the rest of the infrastructure. Enter the bucket name you uploaded the



Lambda zip files.

e. For the parameters of s3 bucket, enter the name of the bucket you uploaded the lambda zip files to. prefix can be '/' or a enter the name of a directory inside of the bucket you put the zip files into.
f. Upload the html UI files to the WebUIS3Bucket you specified in the last step. The entire contents on the web/ directory should be uploaded. The easiest way to do this is via the 'aws s3' coomand like so:

aws s3 cp . s3://builders2019drumproject/ --recursive

To access the web ui, go to CloudFront service, find the distribution, and get the url for the console.

g. After the stack is complete, verify under IoT-Core -> Greengrass -> Groups that the group is created. Click on 'subscriptions' - verify that is created as well. You should see 2 subscriptions, IoT Cloud ->

Greengrass_HelloWorld, and Local Shadow Service -> GreenGrass_Helloworld.

h. Verify under the Greengrass -> Lambdas you see the Greengrass_HelloWorld lambda function. verify run as is set to 'Another user ID/groupID, UID/GID is 0, no container, timeout 2-5 minutes, on-demand function, input data type is JSON.
i. Go to to your s3 bucket you specified in your cloudformation stack. You should see 2 new files there - rhythmcloud-cert.pem.crt and rhythmcloud-prvt.pem.key copy those to the source directory from github under lambdas/StartSong_greengrass and lambdas/StartSong - these will be needed to communicate messages to the IoT Core. Also copy them to your Raspberry PI, under /home/pi.

2. Redeploy StartSong and Startsong_greengrass with your private and pem keys
   a. Edit start_song.py and change HOST_NAME to the host name of your core. HOST_NAME is found at IoT Core-> Greengrass -> Group -> Cores -> Interact -> HTTPS
   b. Edit PRIVATE_KEY and CERT_FILE to match the key and certificates you copied to the StartSong directory
   c. Rezip StartSong.zip in the StartSong directory with the command *zip -r StartSong.zip*
   d. Update the Lambda in the AWS Console and redeploy
3. Update python files on your PI with your endpoint, certificate, and private key info:
   a. Go to your Pi, in /home/pi/midiplay.py on line 84, change the endpoint to your shadow host name from step 2a. On line 89, change the private key and certificate to the path of your certificate and private key in /home/pi
   b. Go to your Pi, in /home/pi/respondToHitCloud.py on line 68, change the endpoint host name you copied from step 2a. On line 73, make the same change as in the step above to point to your private key and certificate.

Route 53[26]

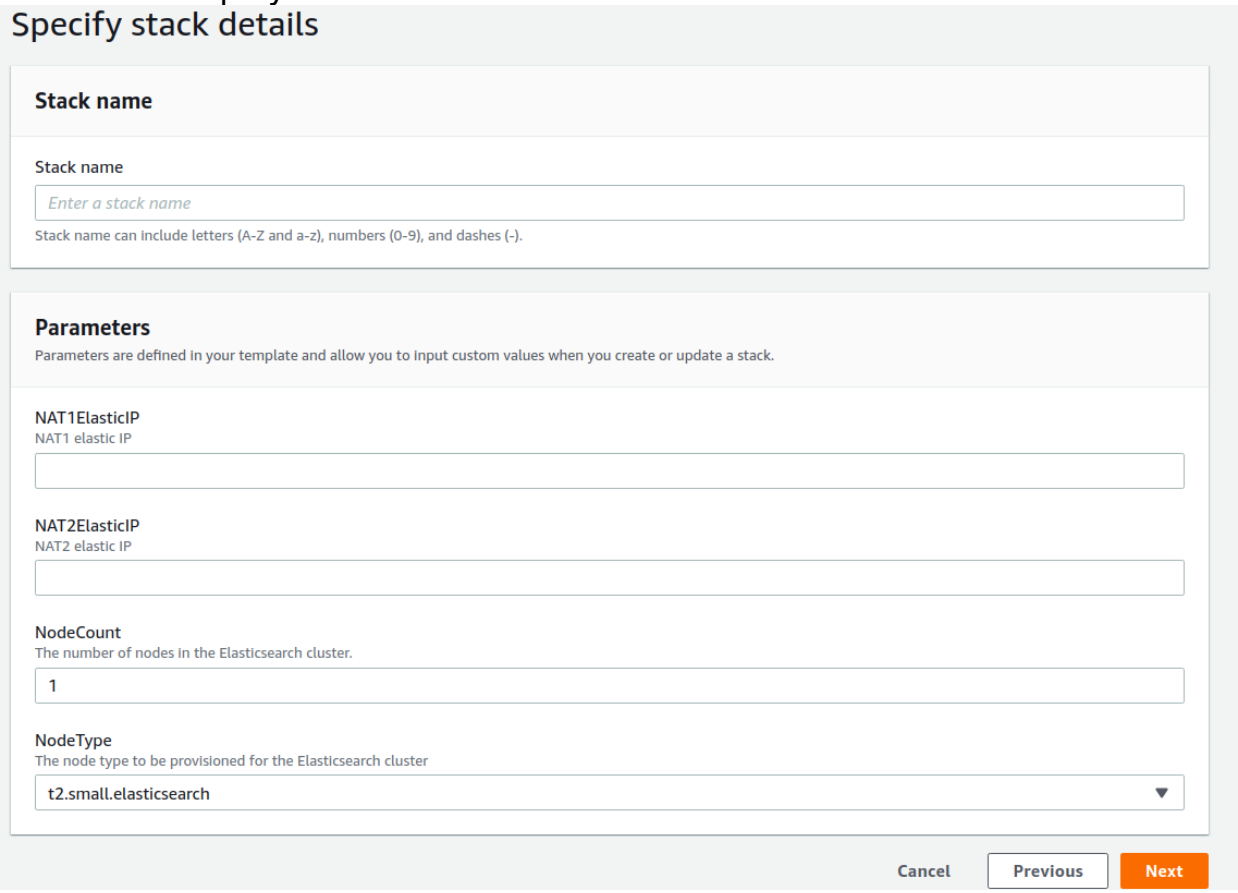
1. Create a Route53 hosted zone

Elasticsearch and Kibana

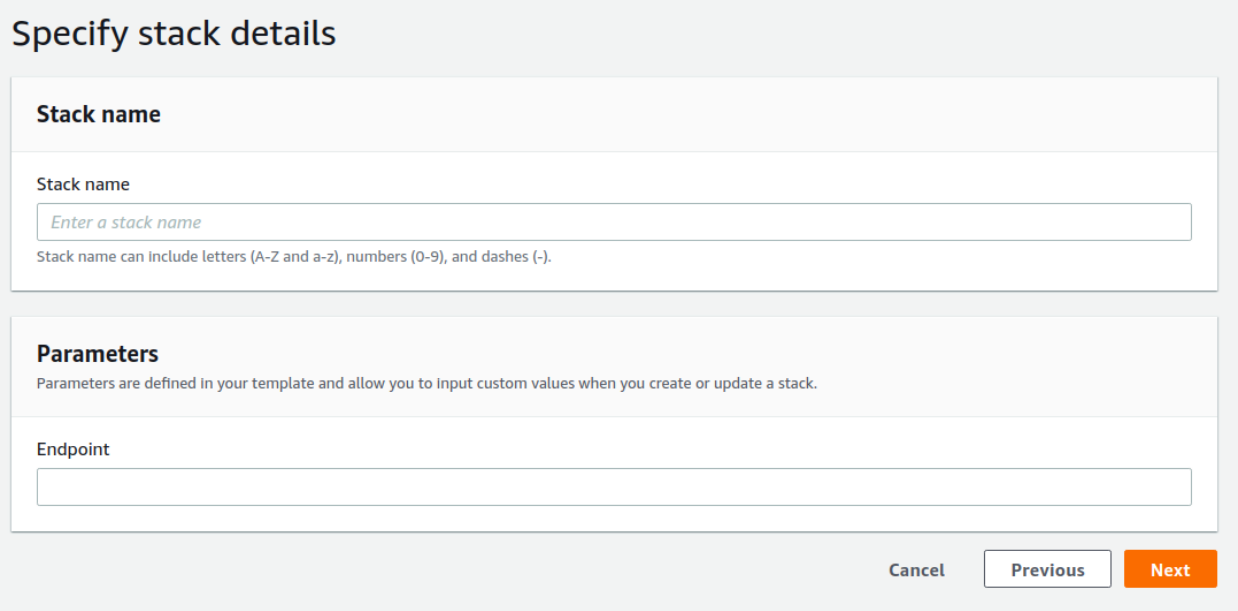
Set up IoT Rules for userHits and referenceHits to push to ElasticSearch

[26] This section is unnecessary if you don't mind working with pre-generated URLs. If you'd rather use a custom domain like rhythmcloud.info, follow the instructions in this section.

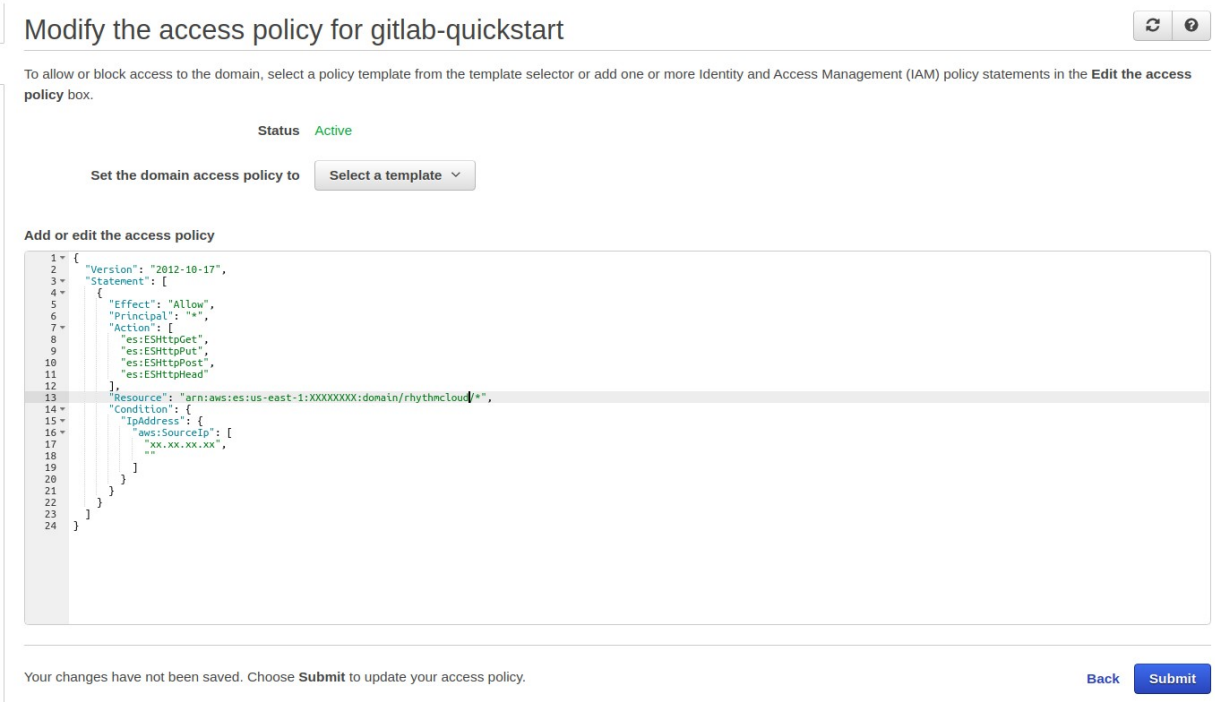
1. Run the Coudformation from the source directory 'template cloudformation/elasticsearch.yml'. Leave the defaults and click next, then deploy.



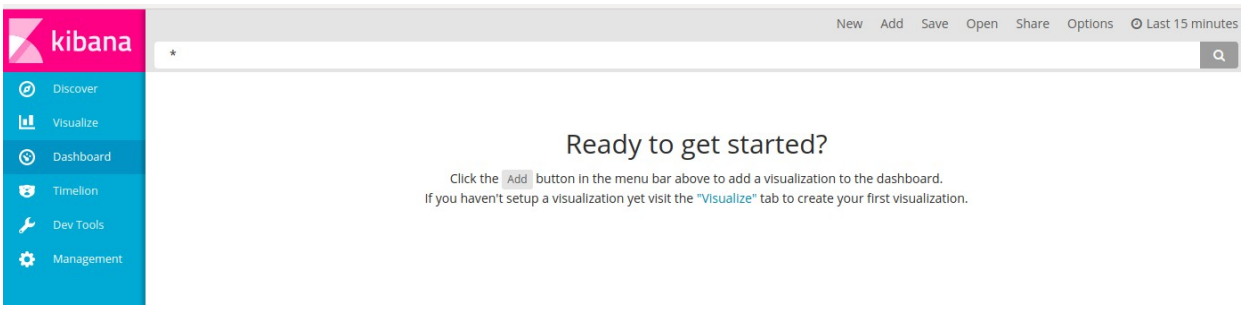
2. After the Elasticsearch service is complete, which takes 30-45 minutes (Check the ElasticSearch console to see if Domain Status = Active. Now you will need to run some curl commands to create the dashboards. In the cloudformation/elasticsearch directory, run 'create_indicies.sh' script. You will need to edit this file to enter your endpoints to yours. This will create 2 indicies that will store the referencehits and userhits. This still store the user hits on the drums and the reference data if what you should be hitting respectively.
3. Run the Cloudformation template cloudformation/elasticsearch/topicrule.yml. You will need to enter your ElasticSearch endpoint in the parameters when you run it.



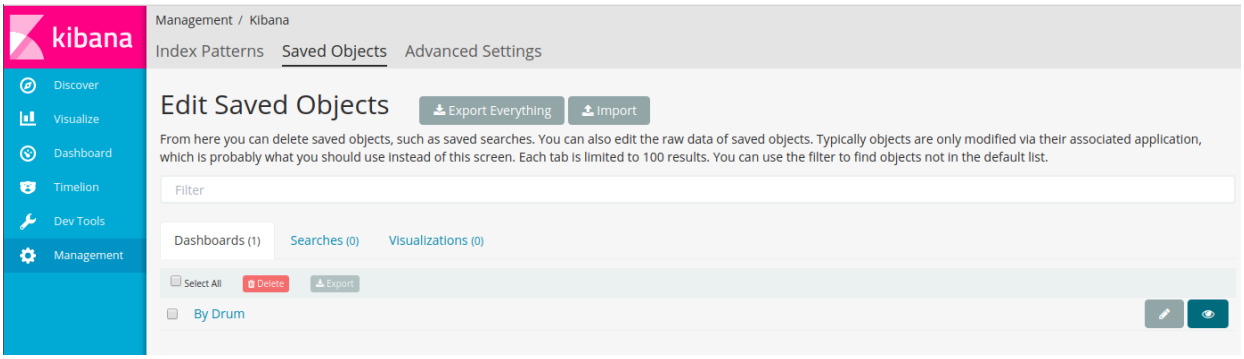
4. Afterwards, go to your ElasticSearch console, and go to the Kibana URL. You may need to modify the access control like so:



4. Import the dashboards. Go to the Kibana endpoint, if you entered your IP address into the modify access section, you should see the console.



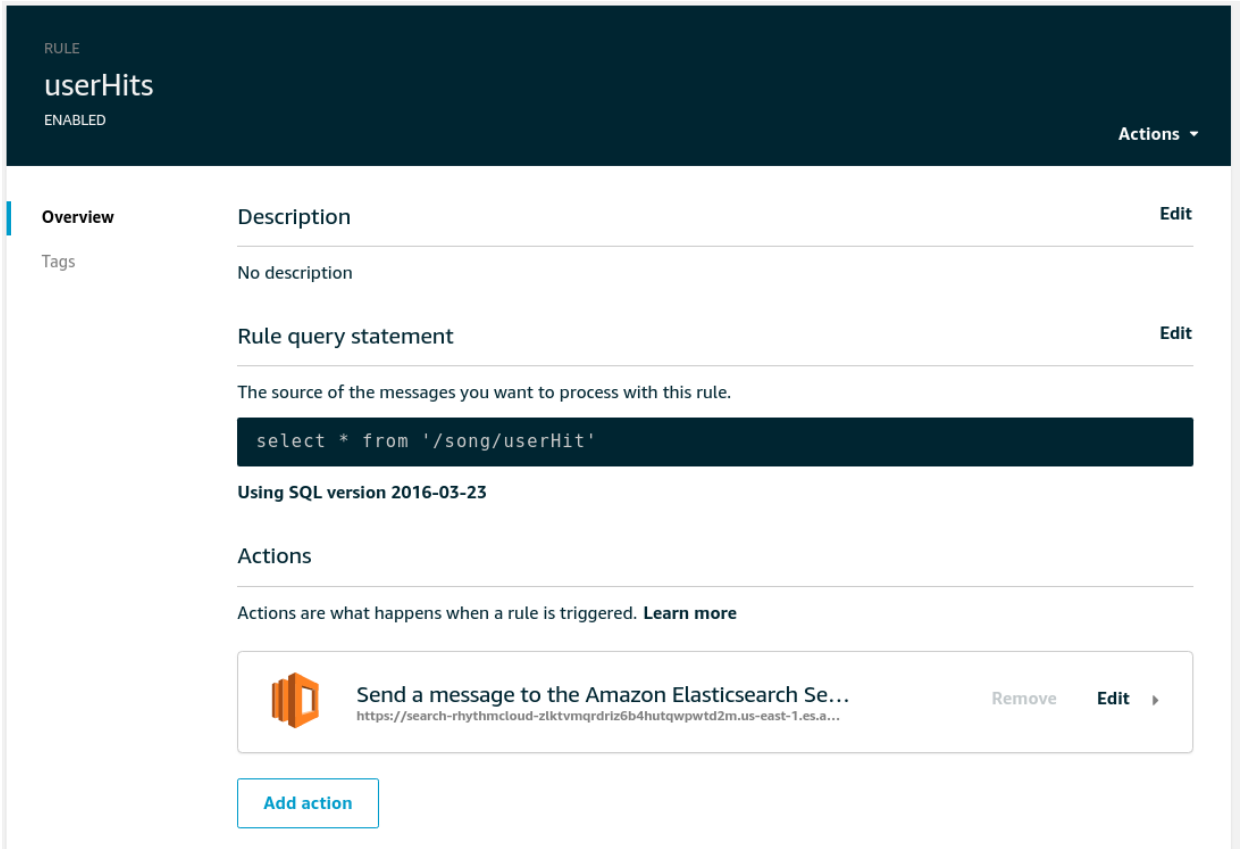
5. Go to Management -> Saved Objects -> Import
   Select the file 'kibana_dashboards.json'. It should look like so:



Once everything is started, and you play a song, data should appear in this dashboard!

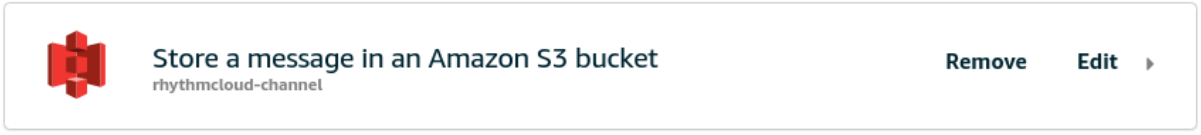
Configure Iot Rules

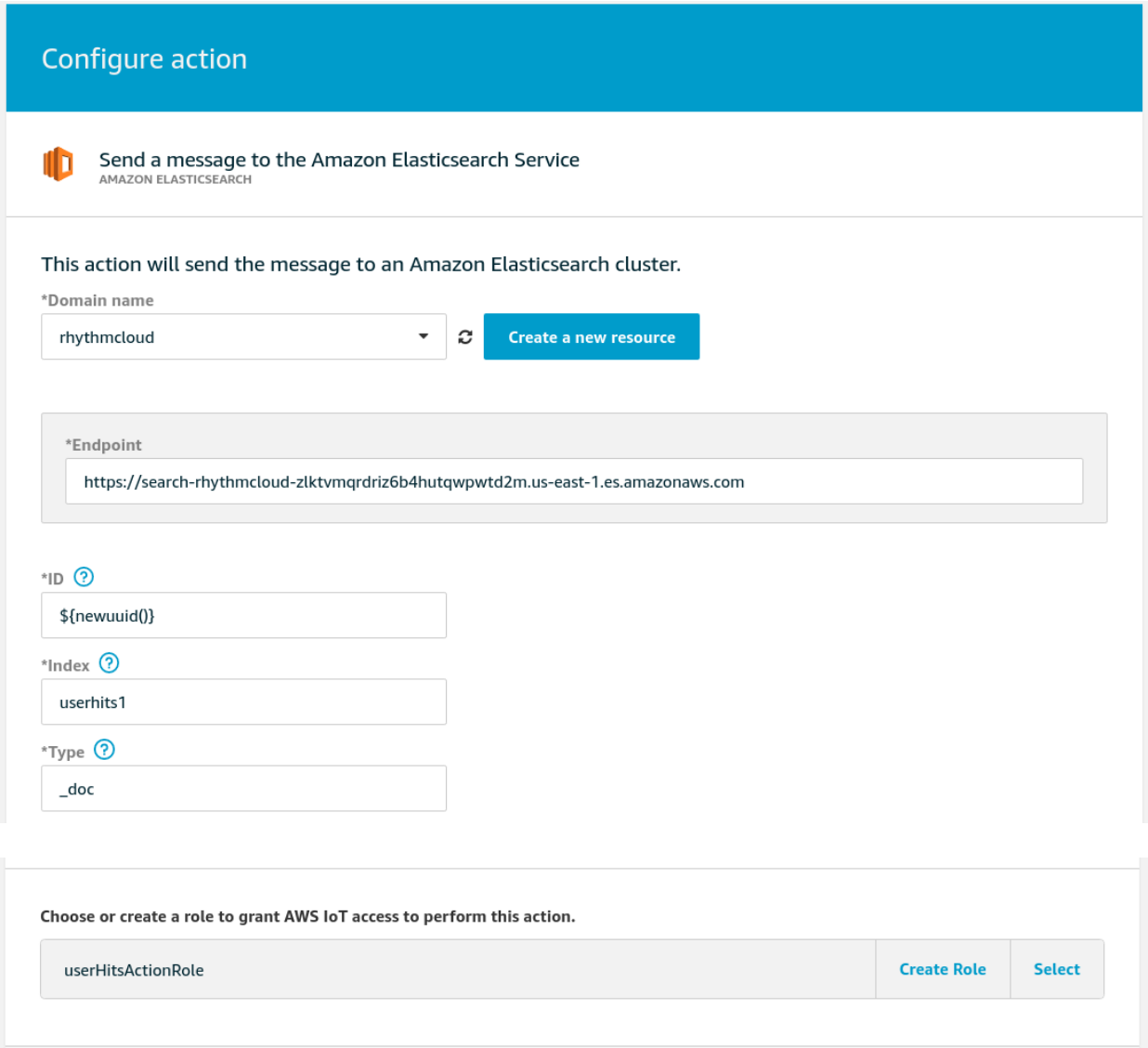
If you can't run cloudformation/elasticsearch/topicrule.yml for some reason the manual instructions are below. If you ran that Cloudformation template, you can skip the manual creation steps.



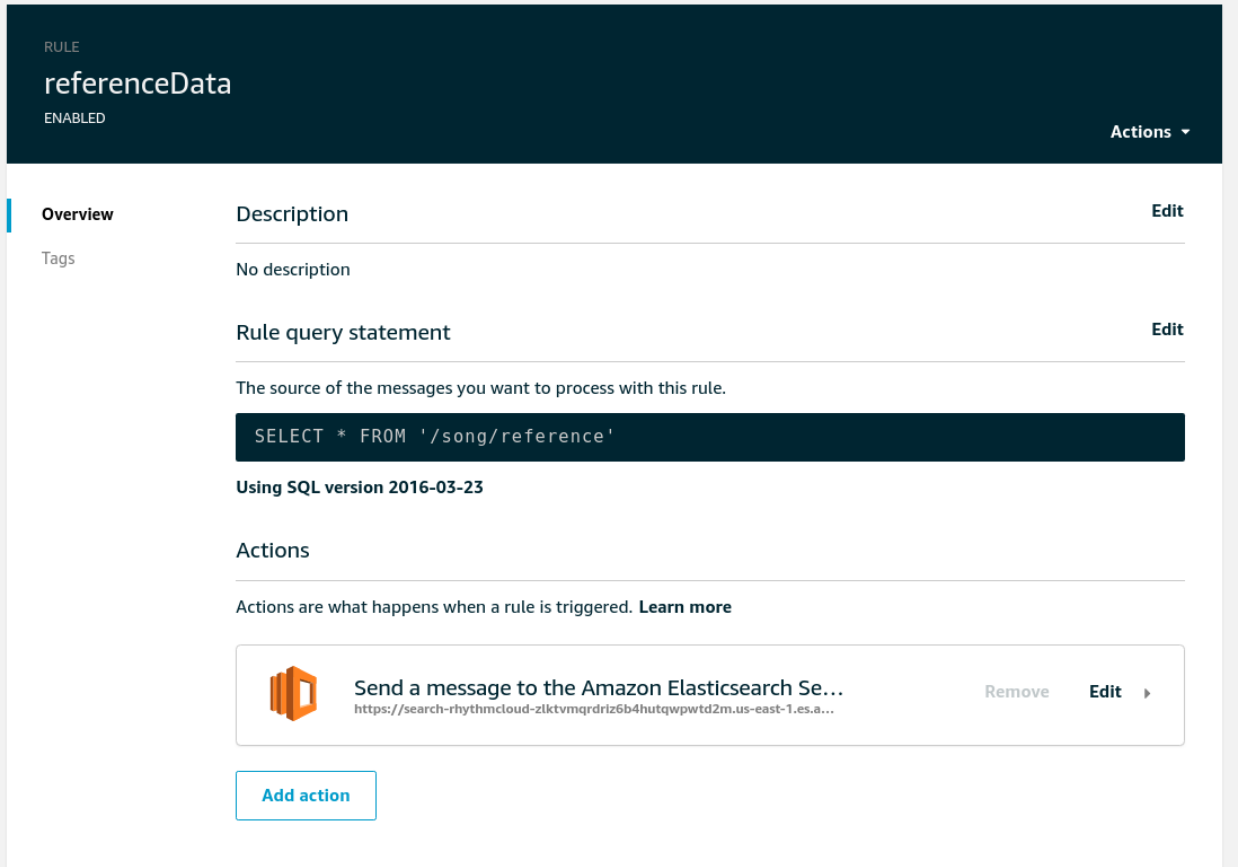
Error action

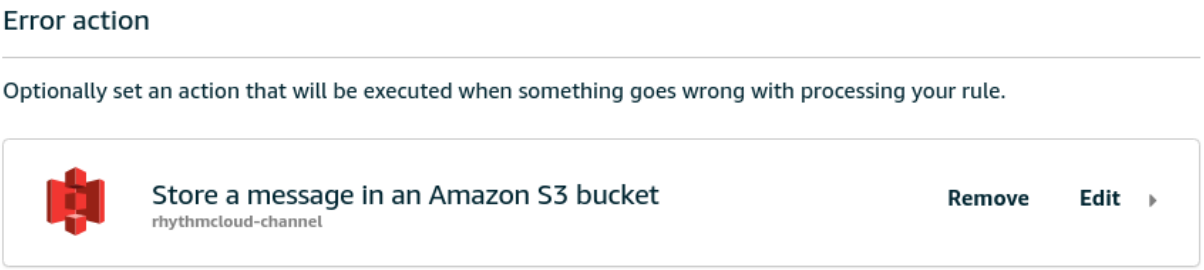
Optionally set an action that will be executed when something goes wrong with processing your rule.

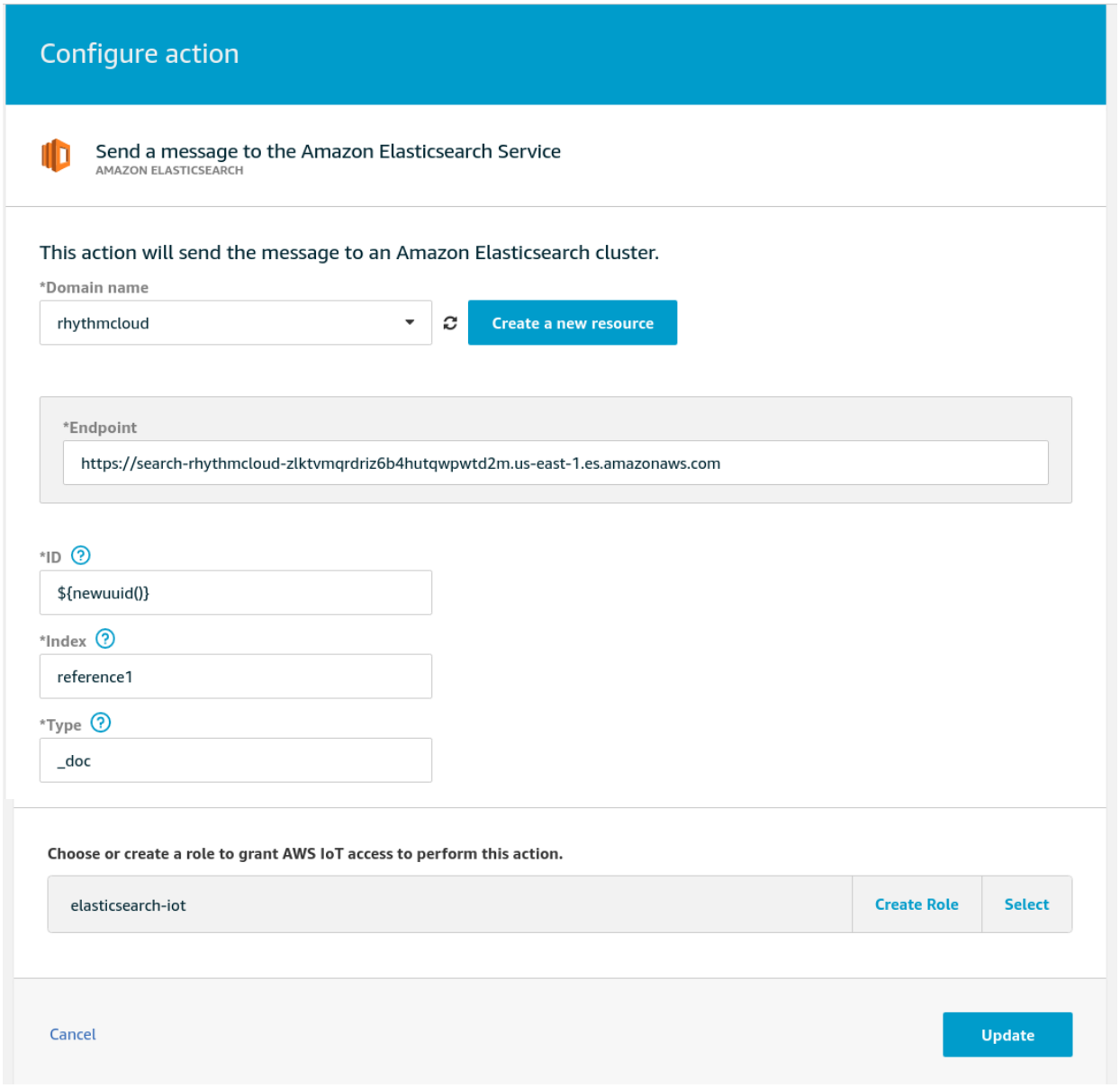




You'll also need a referenceData rule to send what the user should be doing sent to another ElasticSearch index.


RULE
referenceData
ENABLED
Actions
Overview
Tags
Description
Edit
No description
Rule query statement
Edit
The source of the messages you want to process with this rule.
SELECT * FROM '/song/reference'
Using SQL version 2016-03-23
Actions
Actions are what happens when a rule is triggered. Learn more
Send a message to the Amazon Elasticsearch Se…
https://search-rhythmcloud-zlktvmqrdriz6b4hutqwpwtd2m.us-east-1.es.a…
Remove
Edit
Add action


Error action
Optionally set an action that will be executed when something goes wrong with processing your rule.
Store a message in an Amazon S3 bucket
rhythmcloud-channel
Remove
Edit



Make sure the index name on both rules matches the index name you created with the curl scripts to create the indicies in ElasticSearch.

Assembly

1. Reassemble the drum set mounting all of the drums back on stands
2. Attach the mic shelf with the Raspberry Pi to the Drum Set
3. Connect power to the LED lights
4. Connect power to the Raspberry Pi
5. Use a patch cable to attach the LEDs together. Make the following connections:
    a. Analog to Digital Board to Small Tom
    b. Small Tom to Large Tom
    c. Large Tom to Snare Drum
    d. Snare Drum to Kick Drum
    e. Kick Drum to Floor Tom
    f. Floor Tom to Ride Cymbal
    g. Ride Cymbal to Hihat
    h. Hihat to Crash Cymbal
    i. Crash Cymbal to Metronome
6. Use the piezo patch cables to attach the drum sensors to the Analogue to Digital board on the following channels:

Drum/Cymbal	**Channel**
HiHat Cymbal	1
Crash Cymbal	2
Ride Cymbal	3
Small Tom	4
Large Tom	5
Snare Drum	6
Kick Drum	7
Floor Tom	8

7. Attach the Fire Tablet mount to the drum set
8. Load Fire Fire Tablet into the mount
9. Attack the drum stick holder to the Hihat

AWS Sizing and Pricing

Sizing

- ElasticSearch – t2.small

Pricing

The cost of using RhythmCloud is expensive given the single set of drums that this build it targeted for. Usage of all services are low. The following is a summary of the price estimates for operating a single set of RhythmCloud Drums.

- ElasticSearch - t2.small $0.036 per Hour
- IoT Core/Greengrass - Free Tier
- AWS Lambda - Free Tier
- DynamoDB - Free Tier
- CloudFront - Free Tier
- S3- Free Tier

AWS Services Used

The following services are used by AWS and recommended for drum builders to be familiar with:

- IoT Greengrass
- IoT Core
- API Gateway
- Lambda
- ElasticSearch Service
- DynamoDB
- S3
- CloudFormation (For building)

Testing and Validation

Test Hardware and System on PI

There are 3 python scripts you can run manually to test the Python packages and hardware connections.

idleMode.py

Run Command*:* *python idleMode.py*
Validation: The LEDs will start to cycle through a rainbow of colors.

midiplay.py

Run Command*:* */usr/bin/python /home/pi/midiplay.py <duration in sec> <file> <session id> <tempo in BPM>*
Validation: The drums will light up in time to the beat or song specified by **file**.

respondToHitCloud.py

Run Command*:* */usr/bin/python /home/pi/respondToHitCloud.py <duration in sec> <file> <session id>*
Validation: The drums will light up in time to a beat or song specified by **file**. Strike the drums. You should see data appear in the Kibana dashboards.

Usage

When the Raspberry Pi powers up, all services will automatically start.

Navigate to <INSERT URL> to bring up the user interface.

Uploading Songs and Beats

Playing Songs and Beats

Viewing Accuracy

Troubleshooting

In a complex system such as this, many things can go wrong. Let's go over how to troubleshoot each seaction to see how to throubleshoot when things are not working. If nothing is triggering, work backwards from the device then towards the IoT cloud, then towards API Gateway/Lambda then UI. Specifically, there are a few common issues that might come up.

No Lights/Not All Lights Illuminations

1. Check all connections for wires and make sure everything is securely connected.
2. Look at the three major Python files on the Pi: idleMode.py, midiplay.py, and respondToHitCloud.py
    a. Validate that the PIXEL_COUNT variable matches the total number of LEDs you have in the system.
3. Check drum mappings. They are below PIXEL_COUNT and are smallTom, largeTom, snareDum, kickDrum, floorTom, rideCymbal, highHat, crashCymbal, metronome.

    For the Drum object, the first two parameters are the starting and ending LED number. Carefully count your LEDs in the strip and the order they are wired, and make sure those numbers are correct for your setup. If not, you will get partial drums light up, overlap between drums, or crashing with array index errors.

No Data Appearing in Dashboards

Try running this script manually, if it's not throwing errors it's sending to the IoT system. You see confirmations of lighted feedback if you change the following code in blink_drums function to look like so:

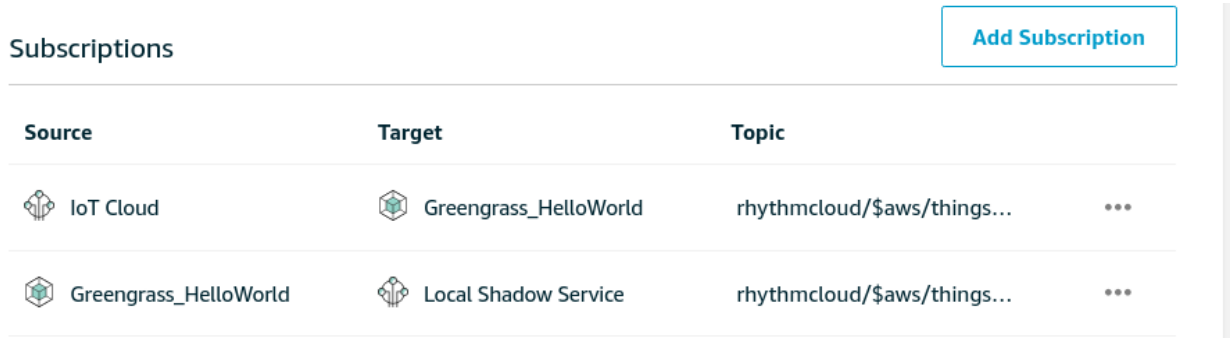
```
def blink_drum(pixels, drumList, color=(255, 255, 255)):

    pixels.clear()
    for drum in drumList:
        for k in range(drum[0], drum[1]):
            pixels.set_pixel(k,
Adafruit_WS2801.RGB_to_color( color[0], color[1], color[2] ))
            pixels.show()
            pixels.clear()
            pixels.show()
```

If you see no data in Kibana, check with the above code to see if the drum lights up when you hit it. If neither light up, check the PIXEL_COUNT variable in the script, as well the the Drum objects like above and make sure the LED ranges for each drum match up. Check the wiring as well. If all of those are

working, check the following items are set up correctly in the AWS IoT Console:

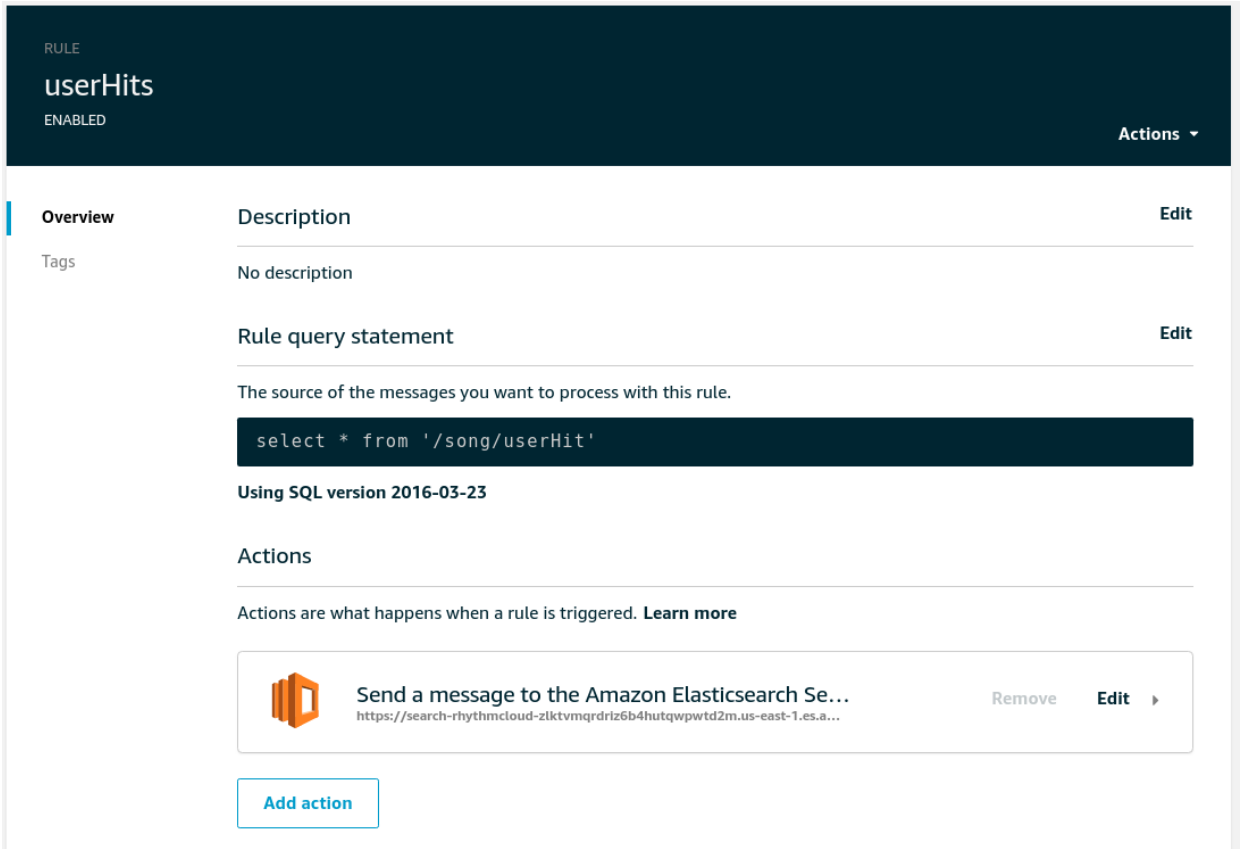
Subscriptions - (Iot Core -> Greengrass-> Groups -> rhythmcloud -> Subscriptions ->
Make sure you have the following (They should have been created by Cloudformation):



Next check the Rules (created from 'Act') in IoT Core -> Rules.

You need 2 rules to send to ElasticSearch - userHits and referenceData

Here is what userHits should look like:



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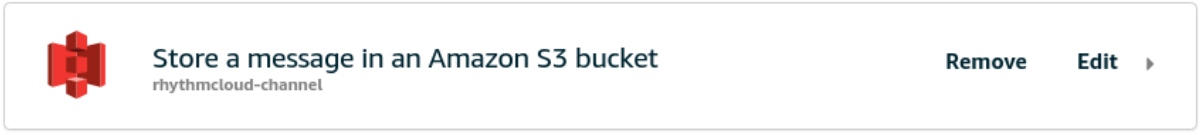

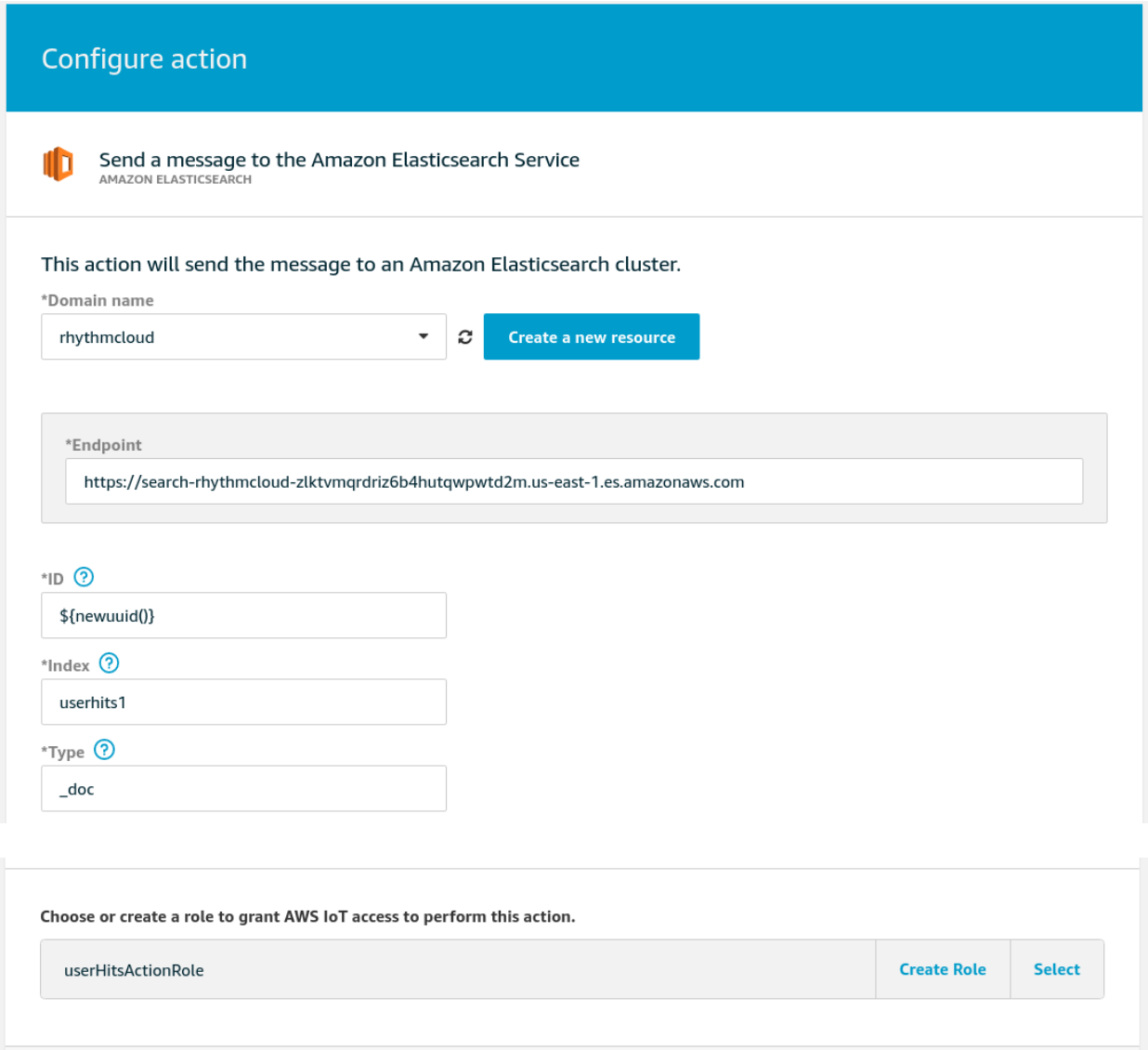

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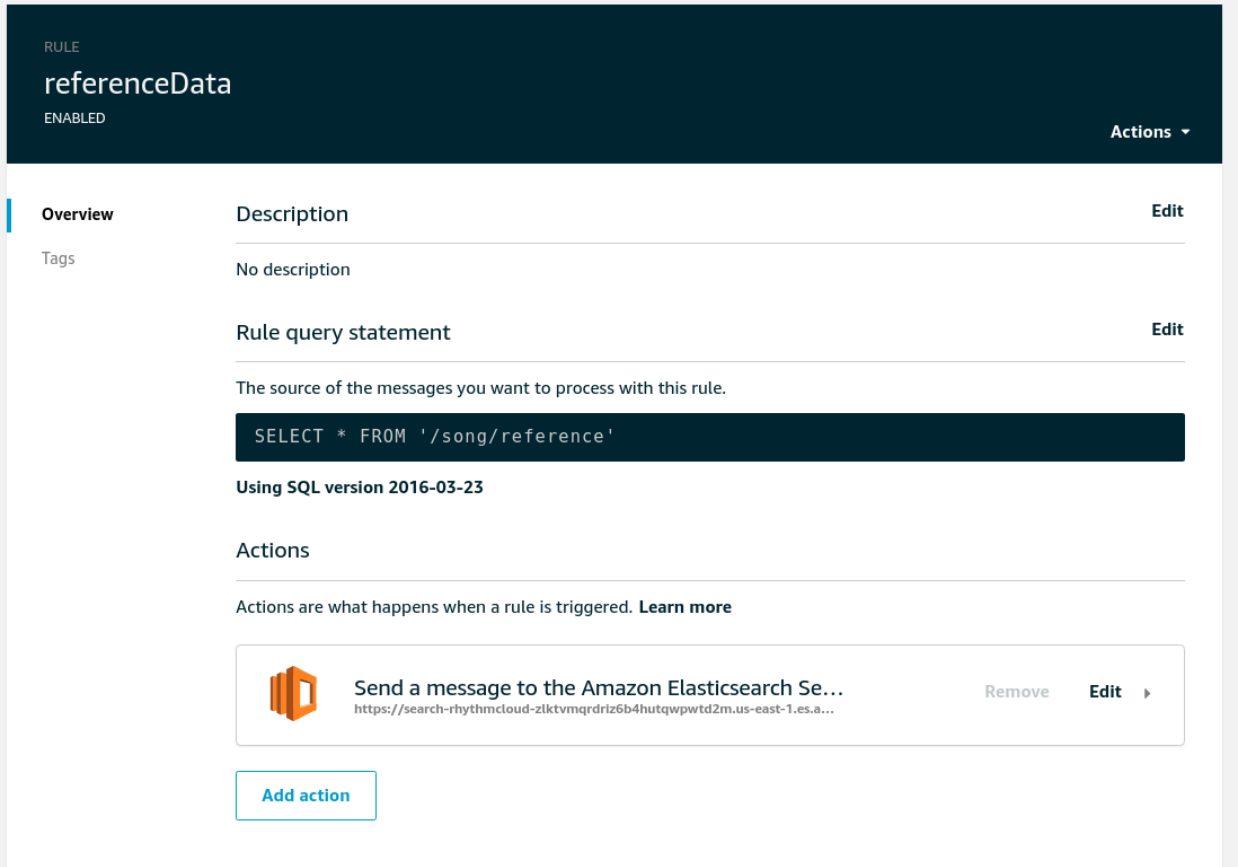

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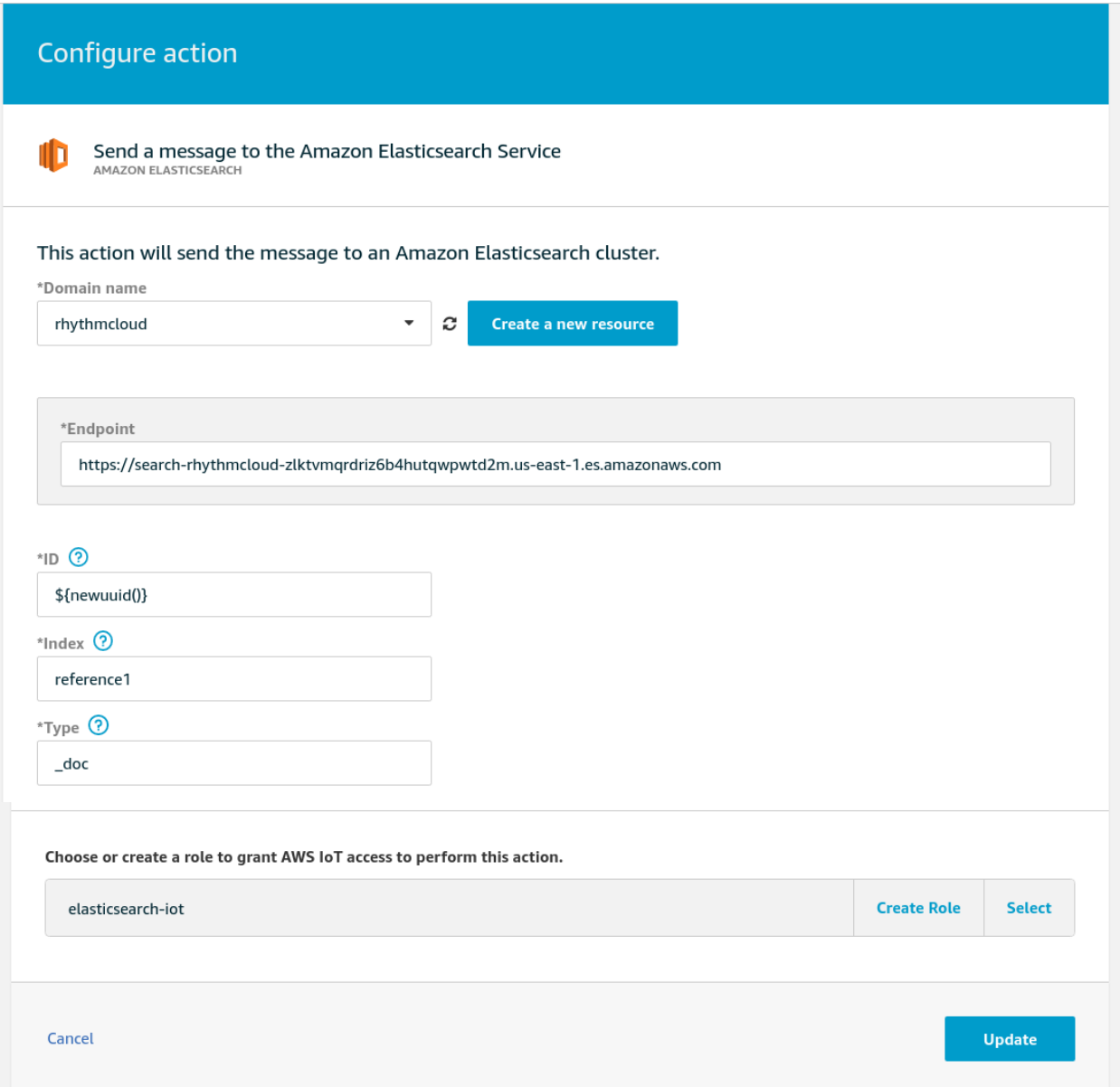

Make sure the index name on both rules matchces the index name you created with the curl scripts to create the indicies in ElasticSearch.

If the rules are in place, and you still don't see data transmitted into Kibana, configure a S3 bucket error logging - under "Error Action". If there are configuration errors between ElasticSearch and IoT Core, the errors will be logged there.

Lights Not Triggering

Check logs:

The logs for the Greengrass Lambda are store in /greengrass/ggc/var/log/user/<region>/<some numbers>/

Watch the log files after you make a request from the UI. Do they trigger? If not try:

a. Run sudo greengrass restart and try again

b. Make sure the IoT Greengrass Core is deployed. Go to Iot Core -> Greengrass -> Group -> deploy after its finished try again

Check deployments of code - you can find the code Greengrass deploys in /greengrass/ggc/deployment/lambda

Verify the code matches what you intented to deploy. If it's not there, the deploy did not work. Retrace the group deployment and make sure it completes without error.

Beats File Format

Beats files a simple way to author a beat to play or practice with. Here is an example file:

```
tempo: 128
song:
- loop:
- repeat: 5
bar:
- combo:
- hit: highhat
- hit: kickdrum
- hit: highhat
- combo:
- hit: highhat
- hit: snaredrum
- hit: highhat
- hit: highhat
- combo:
- hit: highhat
- hit: kickdrum
- combo:
- hit: highhat
- hit: snaredrum
- hit: highhat
```

Properties:

- tempo: BPM of the beats
- song: marker to begin the song
- loop: builds a loop, which can be run multiple times with the 'repeat' property.
- hit: play a drum hit with the specified drum
- combo: group a series of hits to happen at once
- Specify them one after another in series for playback. The tempo determines how long it will
- play. The playback UI can override the tempo value.

FAQs

1. **What is RhythmCloud's purpose?**
   RhythmCloud's sole purpose is to use the marriage of a musical instrument and technology to teach a drummer padawan how to play the drums as quickly as possible.

2. **How do I get started?**
   Simply sit down at the RhythmCloud drum set and select the beat to learn off the accompanying Fire Tablet and you'll start off on the road to rock star fame. RhythmCloud will then start you off on your first beat to play. When you've played the exercise, your accuracy results will be displayed on the Fire Tablet.

3. **Do I need drum sticks?**
   Yes. The RhythmCloud drum set is an actual drum set and will require drum sticks. If you catch RhythmCloud set up on one of our official demos, we will have plenty of drumsticks for you.

4. **Do I need to know how to play the drums already?**
   No. Just follow the flashing lights and hit the drum as the do as best as you can. If a drum lights up, hit it with the drum stick.

   However, if you do already know how to play the drums, RhythmCloud provides a great way for you to test your accuracy. RhythmCloud can record you and test you against your own beats or pre-made MIDI files.

5. **How can I get my own set of RhythmCloud drums?**
   The RhythmCloud project comes complete with DIY instructions for building your very own set. Check out the project's GitHub page for more information.

6. **Do I need internet access?**
   Yes. Internet access is required for the drums to connect to the Amazon Web Services cloud so that performance data can be visualized.