



## Acoustic Levitator

By UpnaLab (/member/UpnaLab/) in Workshop (/workshop/) &gt; Science (/workshop/science/projects/)

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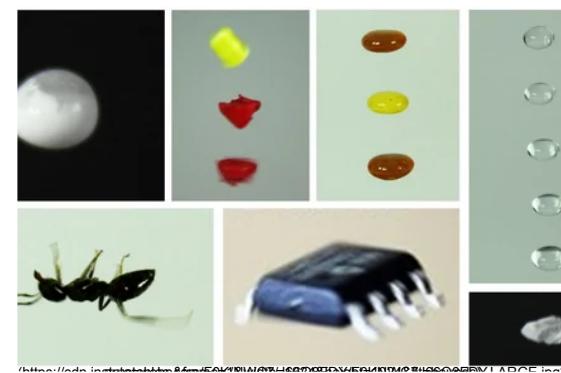
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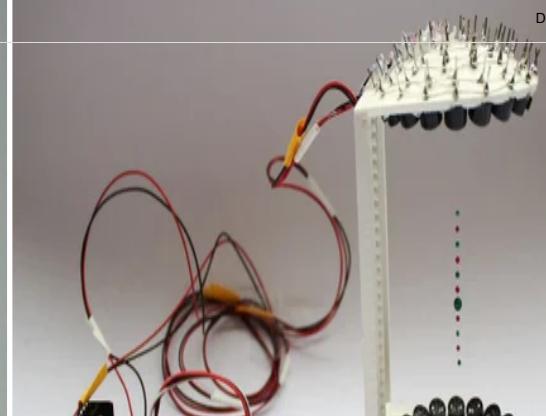
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Acoustic Levitator DIY - TinyLev - lev...



I built an acoustic LEVITATOR! Maki...





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By **UpnaLab**

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About: Build your own cutting-edge devices coming directly from UpnaLab. UpnaLab is the future interactive devices lab working with Ultrasonics, electromagnetism, lasers and more. More About UpnaLab » (/member/UpnaLab/)

Use acoustic waves to hold in mid-air samples such as water, ants or tiny electric components. This technology has been previously restricted to a couple of research labs but now you can make it at your home.

If you want more background and details you can check our **Open Access papers**:

- [More details and supplementary information about this levitator](http://scitation.aip.org/content/aip/journal/rsi/88/8/10.1063/1.4989995)
- [How Acoustic Tractor Beams Work](http://www.nature.com/articles/ncomms9661)
- [Acoustic Delay Lines for Compact Tractor beams](http://ajp.scitation.org/doi/full/10.1063/1.4972407)

**Do not forget to watch the attached video. The first video is the instructions whereas the second one is a fantastic video by Physics Girl**  
[\(.https://www.youtube.com/user/physicswoman\)](https://www.youtube.com/user/physicswoman) **explaining the physics behind it.**

**If you want to build other devices coming directly from the research lab subscribe or get in touch:** Youtube: <https://www.youtube.com/user/asiermarzo>  
[\(.https://www.youtube.com/user/asiermarzo\)](https://www.youtube.com/user/asiermarzo).

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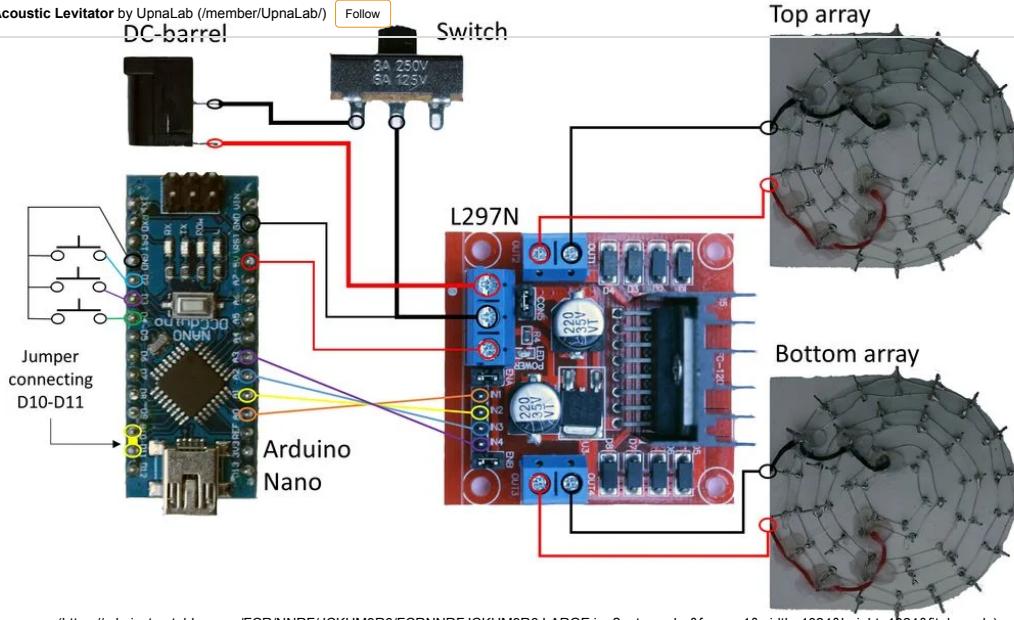
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## Step 1: Gather the Components



## Kit

Now you can get all the components in this kit:

[https://www.makerfabs.com/index.php?route=product/product&product\\_id=508](https://www.makerfabs.com/index.php?route=product/product&product_id=508)

([https://www.makerfabs.com/index.php?route=product/product&product\\_id=508](https://www.makerfabs.com/index.php?route=product/product&product_id=508)).

<https://www.tindie.com/products/Makerfabs/acoustic-levitator-kit/>

(<https://www.tindie.com/products/Makerfabs/acoustic-levitator-kit/>).

<https://www.robotshop.com/de/de/acoustic-levitator-kit.html>

(<https://www.robotshop.com/de/de/acoustic-levitator-kit.html>).

## Individual components

We present a list of the necessary components. I have tried to place links for different countries.

However, the same parts can be found all around the world, some useful websites are

<http://www.findchips.com/> (<http://www.findchips.com/>) <http://www.dx.com/>

(<http://www.dx.com/>) <http://www.findchips.com/> (<http://www.miniinthebox.com/>).

<http://www.lightinthebox.com/> (<http://www.lightinthebox.com/>) <http://www.findchips.com/>

(<http://www.banggood.com/>).

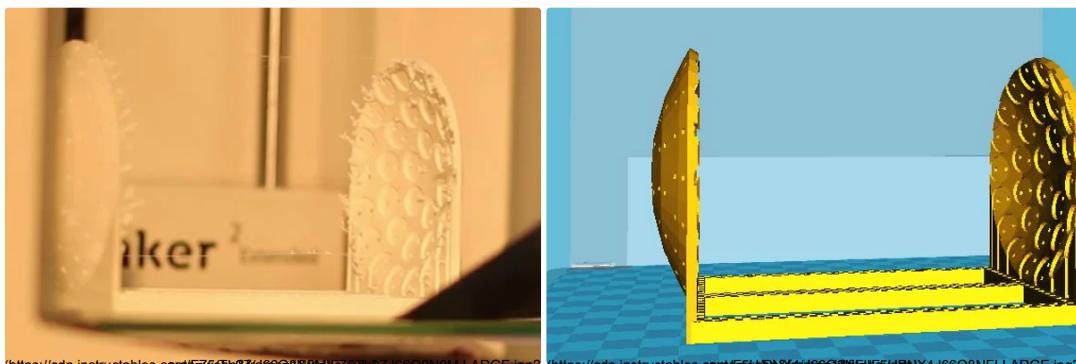
- 72x 10mm 40kHz transducers. Manorshi provides [MSO-P1040H07T](https://manorshi.en.alibaba.com/product/60248714908-801018150/10mm_40khz_piezo_ultrasonic_Transmitter_Receiver_sensor.html?spm=a2700.8304367.rect38f22d.1.2a14feeWWhcRg) ([https://manorshi.en.alibaba.com/product/60248714908-801018150/10mm\\_40khz\\_piezo\\_ultrasonic\\_Transmitter\\_Receiver\\_sensor.html?spm=a2700.8304367.rect38f22d.1.2a14feeWWhcRg](https://manorshi.en.alibaba.com/product/60248714908-801018150/10mm_40khz_piezo_ultrasonic_Transmitter_Receiver_sensor.html?spm=a2700.8304367.rect38f22d.1.2a14feeWWhcRg)) at a very good price, minimum order is 500 but they will ship with less at a higher price. Also Ningbo has good ones [FBULS1007P-T](https://bestgroup.en.alibaba.com/product/987365133-800848321/dog_repeller_ultrasonic_transducer_40khz_black_plastic_ultrasonic_sensor_ultrasonic_depth_sensor.html?spm=a2700.7803228.1998738836.187.TSqSLZ) ([https://bestgroup.en.alibaba.com/product/987365133-800848321/dog\\_repeller\\_ultrasonic\\_transducer\\_40khz\\_black\\_plastic\\_ultrasonic\\_sensor\\_ultrasonic\\_depth\\_sensor.html?spm=a2700.7803228.1998738836.187.TSqSLZ](https://bestgroup.en.alibaba.com/product/987365133-800848321/dog_repeller_ultrasonic_transducer_40khz_black_plastic_ultrasonic_sensor_ultrasonic_depth_sensor.html?spm=a2700.7803228.1998738836.187.TSqSLZ)).
- 1x 3D-printed TinyLev support. (STL file provided in Step 2)
- 1x Arduino Nano ([US](http://a.co/3jrSAEw) (<http://a.co/3jrSAEw>)) [UK](http://www.amazon.co.uk/dp/B015MGHH6Q) (<http://www.amazon.co.uk/dp/B015MGHH6Q>)
- 1x L298N Dual Motor Drive Board ([US](http://a.co/fm78YUh) (<http://a.co/fm78YUh>)) [UK](http://www.amazon.co.uk/dp/B00GKF60Z8) (<http://www.amazon.co.uk/dp/B00GKF60Z8>)
- 1x 130x90mm sheet (wood or acrylic) for the base of the driver board.
- [1x power switch](http://amzn.eu/a5CdIyi) (<http://amzn.eu/a5CdIyi>).
- [DC adaptor variable between 7V and 12V](http://amzn.eu/agfrvCS) (<http://amzn.eu/agfrvCS>).
- [DC female connector](http://amzn.eu/eMWF5UE) (<http://amzn.eu/eMWF5UE>).
- Jumper wires
- 12AWG black and red wire
- 24AWG black and red wire
- 24AWG exposed wire ([UK](http://uk.rs-online.com/web/p hookup-equipment-wire/0390555) (<http://uk.rs-online.com/web/p hookup-equipment-wire/0390555>)) [USA](http://www.alliedelec.com/rs-pro-390555/70825826/) ([https://www.alliedelec.com/rs-pro-390555/70825826/](http://www.alliedelec.com/rs-pro-390555/70825826/))
- Some Expanded Polystyrene beads to levitate (between 1mm and 3mm diameter)
- An acoustically transparent material: A metallic grid, very thin fabric or teabag paper.

### Necessary Tools

- 3D printer -> you can use an online service
- Soldering Iron, Tin and Flux.
- Hot-glue gun
- Multimeter
- Cable Peeler
- Screwdriver and Pliers.
- Drill
- Oscilloscope with two probes (optional) -> you can get one for less than 50£ <http://amzn.eu/5ey6ty2> (<http://amzn.eu/5ey6ty2>)

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### Step 2: 3D Print the Base



3D print the base for the levitator. We used a 0.4mm nozzle and brim but no support. It should be possible to print it in one piece. A 0.6mm nozzle also provides good results.

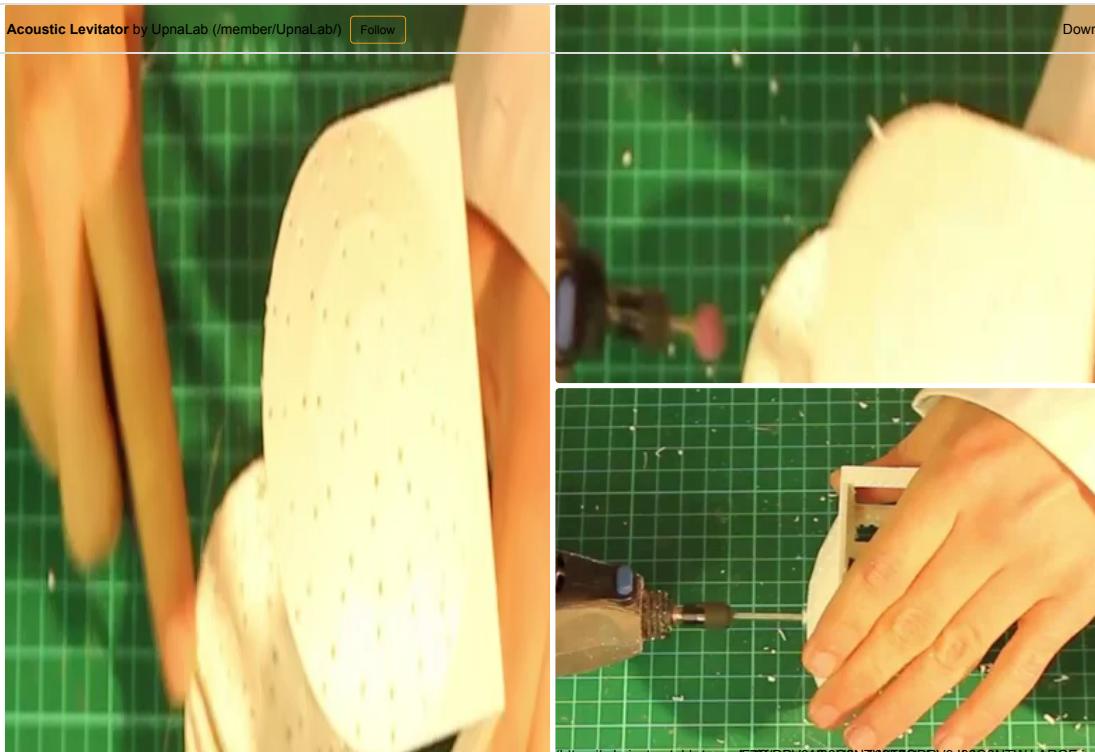
Included in this step, you have the first version (v0 14 x 7.86 x 8.31cm). Or you can use the next version with some reinforcement in the joints (v1 15.6 x 7.86 x 8.54cm).

- You may also want to print [the fantastic stand](https://www.thingiverse.com/thing:2766680) (<https://www.thingiverse.com/thing:2766680>) from Jeff Bearer
- Or you can also use a full case to make more robust and look awesome. by [Jakub Nagy](https://www.instructables.com/id/Acoustic-Levitator-Case/) (<https://www.instructables.com/id/Acoustic-Levitator-Case/>)

 <a href="#">TinyLev_v0.stl</a>	Download ( <a href="https://cdn.instructables.com/ORIG/F78/ZW23/JKN8P8JS/F78ZW23JKN8P8JS.stl">https://cdn.instructables.com/ORIG/F78/ZW23/JKN8P8JS/F78ZW23JKN8P8JS.stl</a> ) ( <a href="https://cdn.instructables.com/ORIG/F78/ZW23/JKN8P8JS/F78ZW23JKN8P8JS.stl">https://cdn.instructables.com/ORIG/F78/ZW23/JKN8P8JS/F78ZW23JKN8P8JS.stl</a> )
 <a href="#">TinyLev_v1.stl</a>	Download ( <a href="https://cdn.instructables.com/ORIG/F9J/3WN6/JKN8P8KG/F9J3WN6/JKN8P8KG.stl">https://cdn.instructables.com/ORIG/F9J/3WN6/JKN8P8KG/F9J3WN6/JKN8P8KG.stl</a> ) ( <a href="https://cdn.instructables.com/ORIG/F9J/3WN6/JKN8P8KG/F9J3WN6/JKN8P8KG.stl">https://cdn.instructables.com/ORIG/F9J/3WN6/JKN8P8KG/F9J3WN6/JKN8P8KG.stl</a> )
 <a href="#">TinyLev_v1_leg.stl</a>	Download ( <a href="https://cdn.instructables.com/ORIG/FDA/5SBH/JKN8P8KE/FDA5SBHJKN8P8KE.stl">https://cdn.instructables.com/ORIG/FDA/5SBH/JKN8P8KE/FDA5SBHJKN8P8KE.stl</a> ) ( <a href="https://cdn.instructables.com/ORIG/FDA/5SBH/JKN8P8KE/FDA5SBHJKN8P8KE.stl">https://cdn.instructables.com/ORIG/FDA/5SBH/JKN8P8KE/FDA5SBHJKN8P8KE.stl</a> )

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### Step 3: Clean the Base



You may need to use a file to clean the edges around the levitator and clean the sockets. A Dremel will do the job faster. You may also want to drill a hole in the centre of each side, this will allow to insert a camera, a needle or evacuate liquids.

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#### Step 4: Mark Polarity (using a Multimeter)

Tutorial: Marking the Polarity of Ultr...

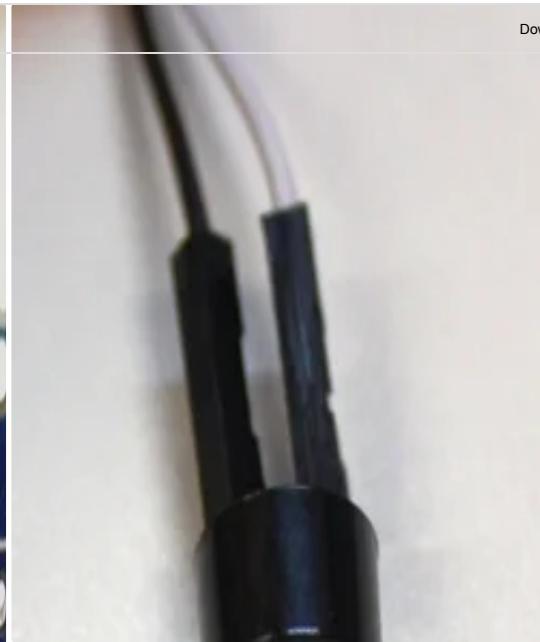
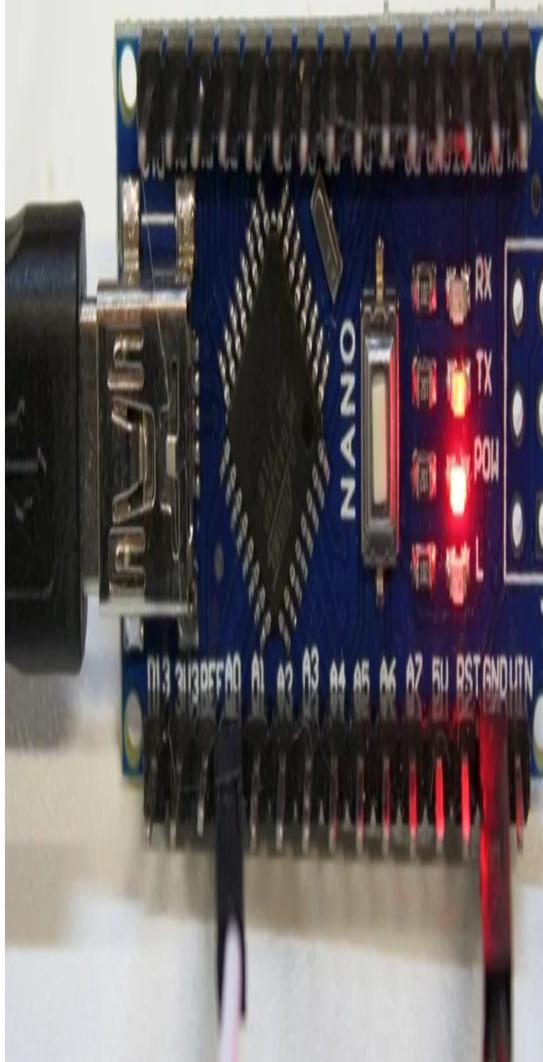


If you have a multimeter and some copper tape, this method is quite simple to perform.

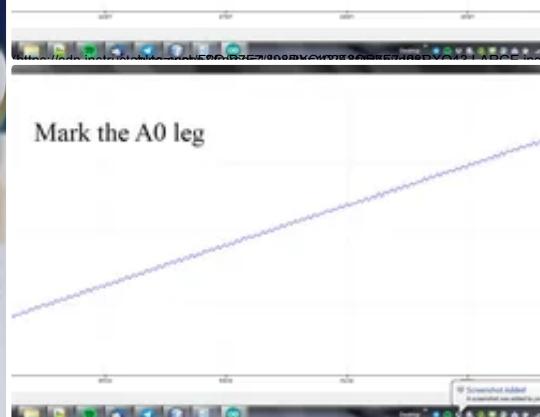
DO NOT TRUST THE POLARITY MARKINGS FROM THE MANUFACTURER!!!

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#### Step 5: Mark Polarity (Using an Arduino)



Mark the GND leg



Mark the A0 leg

The easiest way to mark the polarity is to use the Arduino itself. This method does not require an oscilloscope or to poke the transducers inside.

Install the code from this section into the Arduino. Connect one wire to A0 and another wire to GND.

While the Arduino is connected to the PC, run the Serial Plotter (Tools->Serial Plotter) and be sure that the speed is set to 115200.

When a transducer is connected between A0 and GND the signal will do one of the following things:

- Signal goes down or remains at 0. Then, mark the leg connected to GND.
- Signal goes up or remains at 1023. Then, Mark the leg connected to A0.
- It is important to not touch the transducers leg or the wires while doing that or the values will reset.

If it is still not possible to detect the polarity, poke the inside of the transducer with a thin wire and check if the spike goes up or down (like in the obsolete method). Spike up -> mark A0 leg, spike down -> mark GND.



[nanoScope.ino](#)

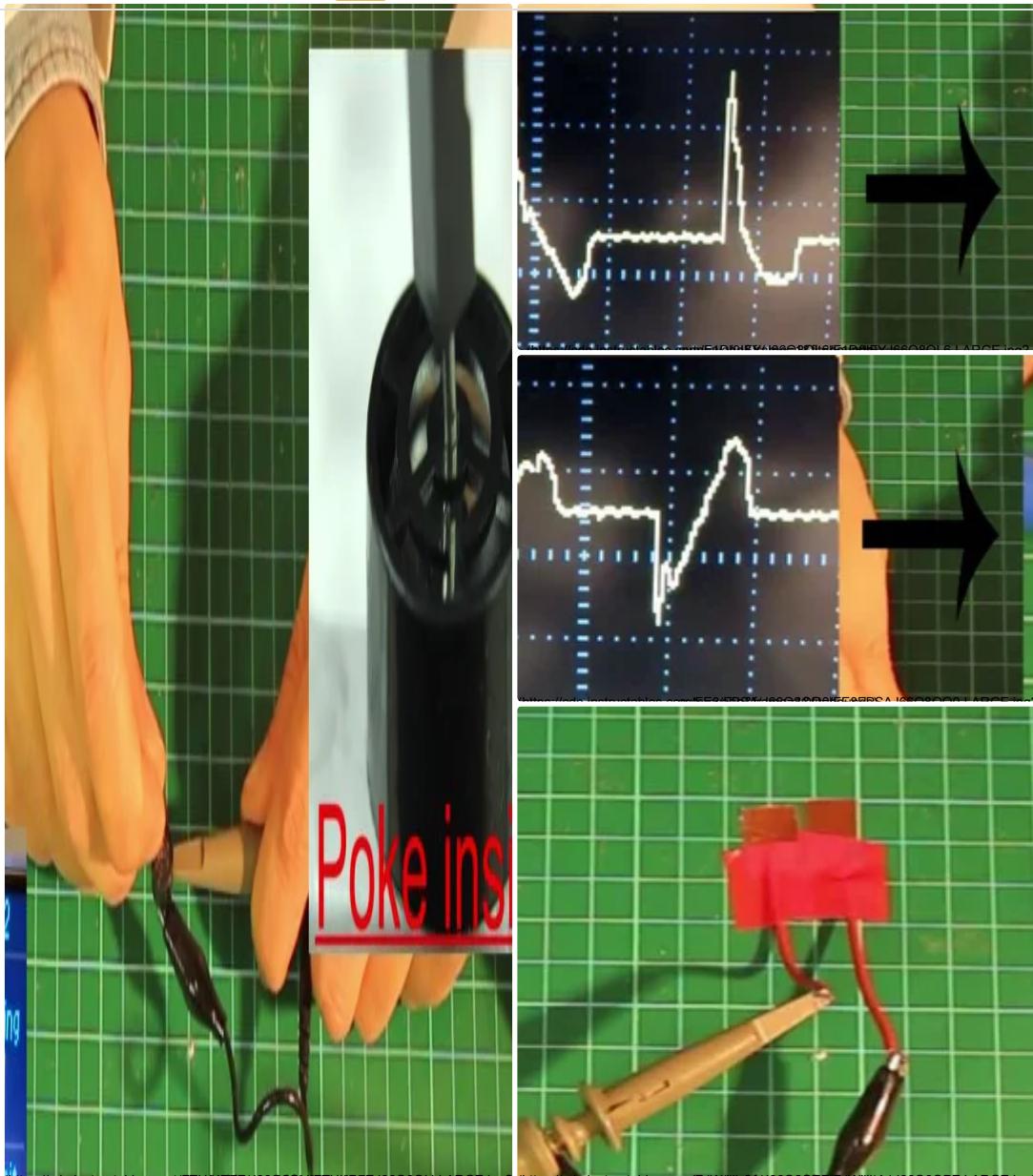
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(<https://cdn.instructables.com/ORIG/FFW/IH82/J98RXO3E/FFWIH82J98RXO3E.ino>)

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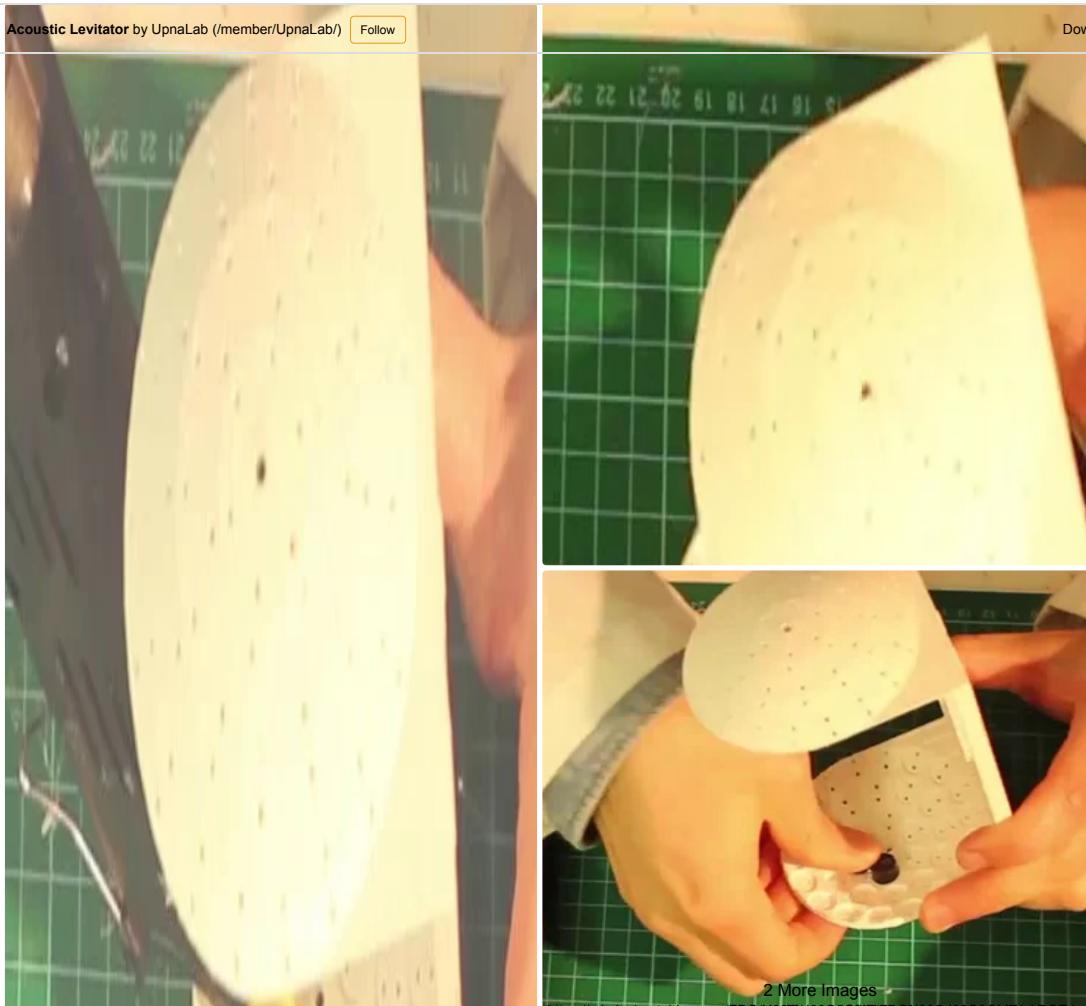
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The transducers have polarity and it is important to glue them in the base oriented with the same polarity. Do not trust the marks made by the manufacturer, they are not reliable at all. The easiest way is to connect a transducer to an oscilloscope and poke the inside with a thin wire. If the spike goes up, mark the leg connected to the positive part of the probe. If the spike goes down, mark the leg connected to ground. You can use two stripes of copper to make this process faster. After all, you will need to mark 72 transducers.

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### Step 7: Glue the Transducers

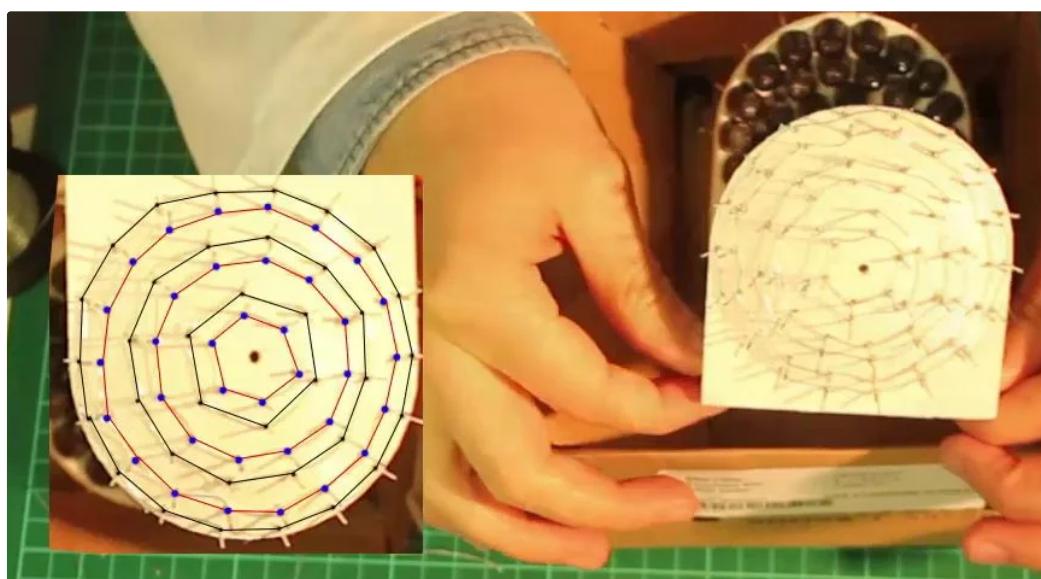
[2 More Images](#)

Apply a little bit of hot glue on the side of the socket (if you apply glue near the holes for the legs, the legs will be covered in glue when you push the transducers through), push the transducer in and apply some pressure with your fingers to make it lay as flat as possible in the socket.

**It is very important that all the marked legs are pointing towards the centre of the device (where the hole is).**

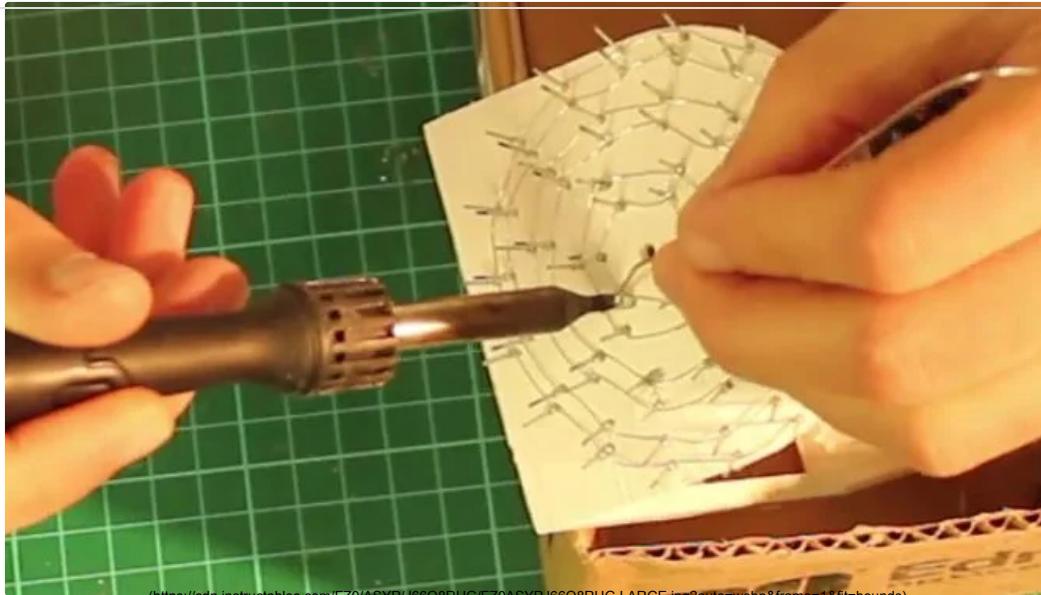
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### Step 8: Wire the Transducers



Wrap the exposed wire in six concentric rings around the legs of the transducers.

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Solder the pins to the wires.

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### Step 10: Prepare 4 Long Wires



Now, we need to make the wires that connect the transducers to the driver board.

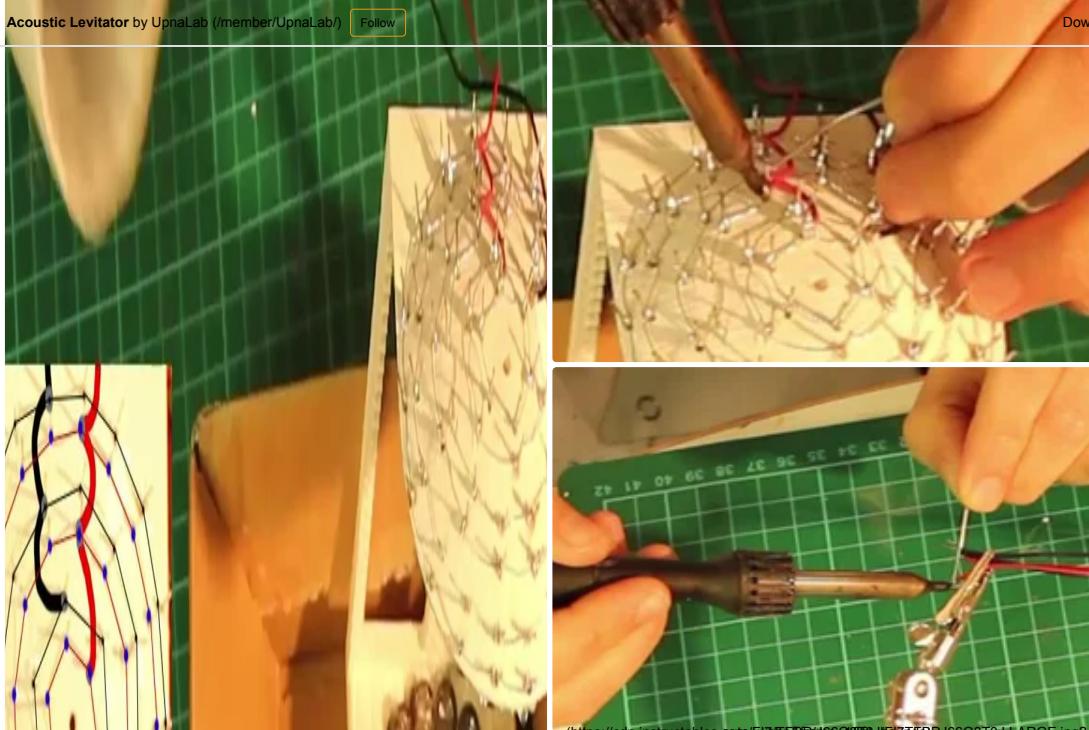
2 red wires and 2 black wires. They need to be around 1 meter. In one side there is only the tip exposed. On the other side there are 3 segments exposed, in the video it is shown how this can be done.

The side with 3 segments will go into the transducers rings and the side with only the tip will go into the driver board.

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### Step 11: Solder Long Wires





Solder the long wires to the transducers. The side with the 3 segments exposed goes into the transducers, one segment for each ring. Each side of the levitator has a black and a red wire. You can use flux and tweezers to facilitate the soldering. Tin the other sides of the wires (the side that only has the tip exposed)

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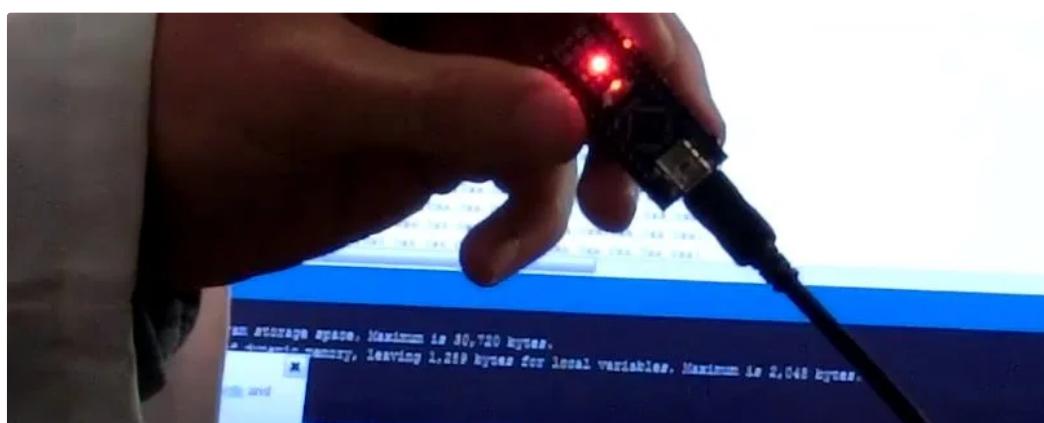
### Step 12: Solder Arduino Headers



Solder the headers of the Arduino, backwards if possible.

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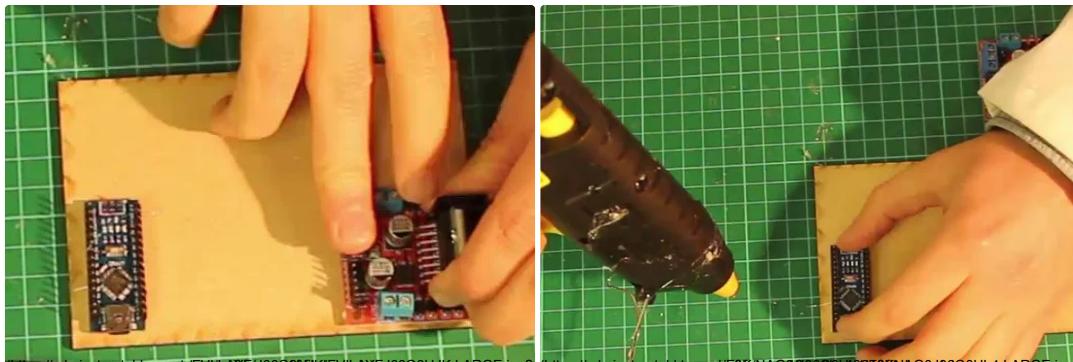
### Step 13: Program the Arduino



Upload the code provided in this step into the Arduino Nano.

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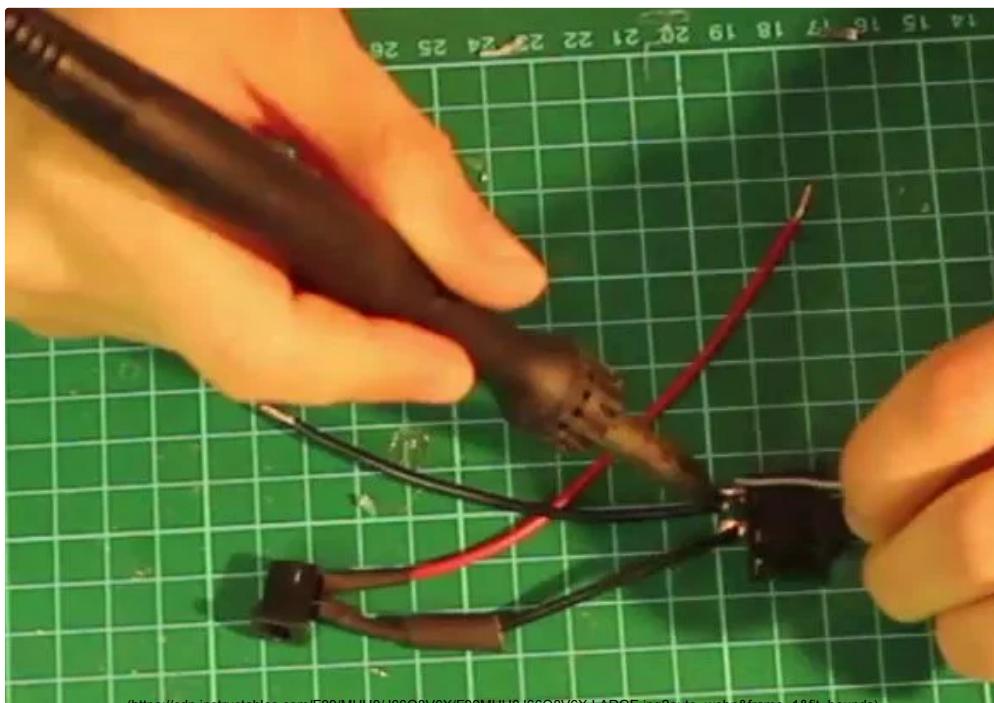
### Step 14: Glue Arduino and Driver



Glue the Arduino Nano and the Driver into the base. It is important to use the positions and orientations of the figures.

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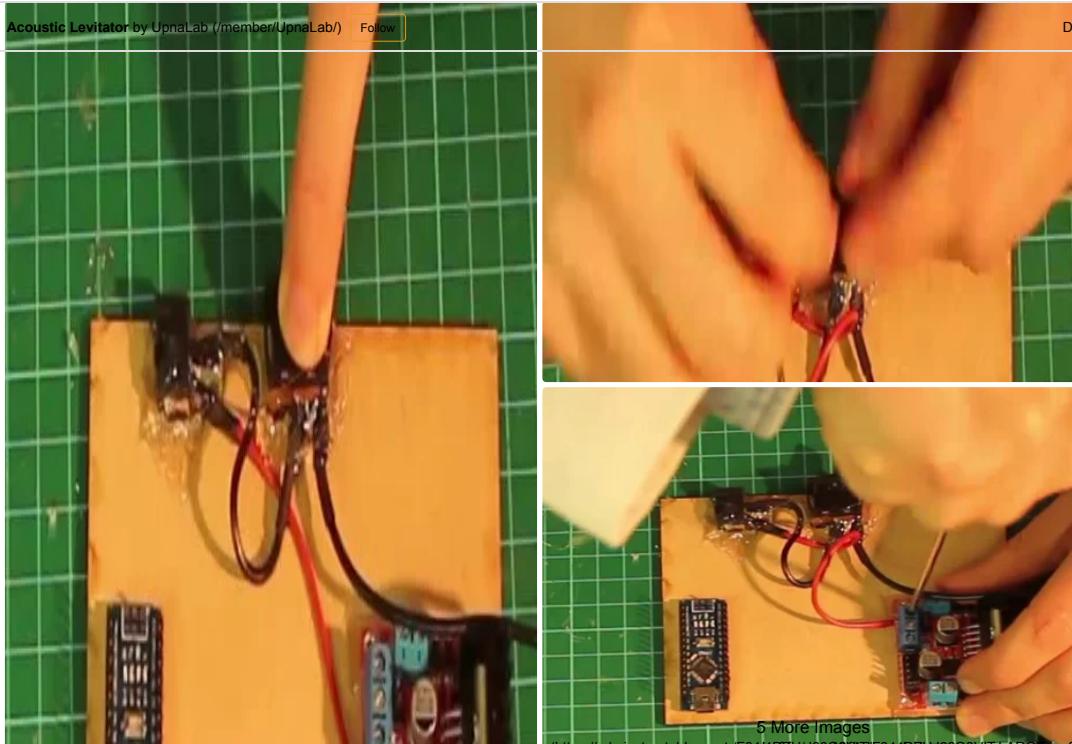
### Step 15: Create the DC Supply



You will need to solder the DC female connector to the Switch and leave two wires prepared to supply power to the driver board.

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### Step 16: Glue DC and Wiring



5 More Images

Glue the DC connector and the switch.

Connect the red wire from the supply into the 12V input of the driver.

Connect the ground from the supply into the middle connector of the driver, also insert a male-female jumper there.

Insert a male-female jumper into the 5V input of the Driver.

Connect the male-female jumpers that we connected to the driver into ground and 5V of the Arduino.

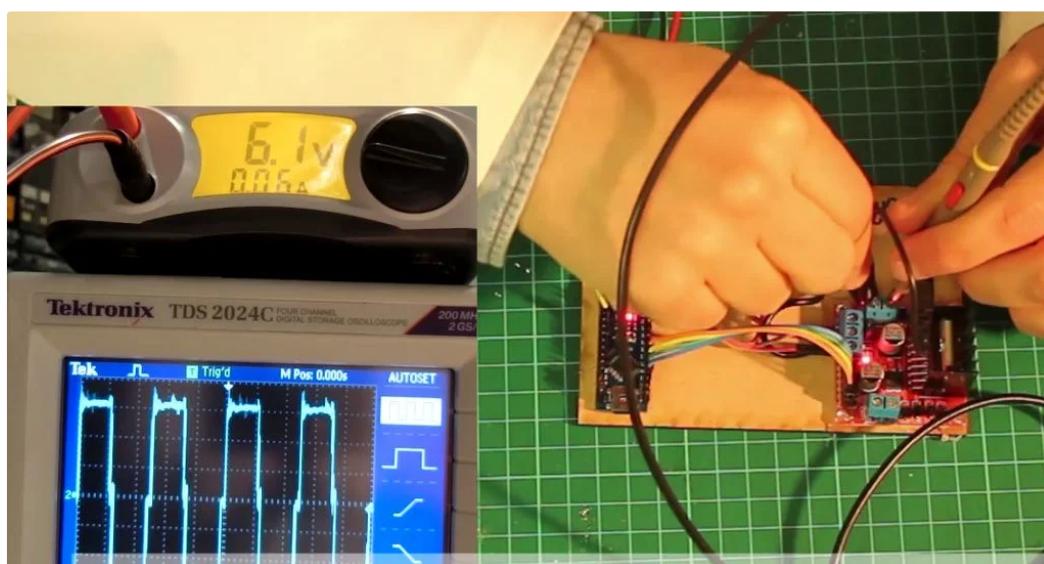
Connect 4 female jumpers from the Arduino (A0,A1,A2,A3) into the inputs of the driver (IN1,IN2,IN3,IN4).

Connect a female-male jumper into ground of the Arduino, this jumper can be connected to D2, D3 or D4 to move the particles up, down or reset them to their original position.

**Connect D10 to D11 with a jumper.** This is vital for the synchronised emission of the signals.

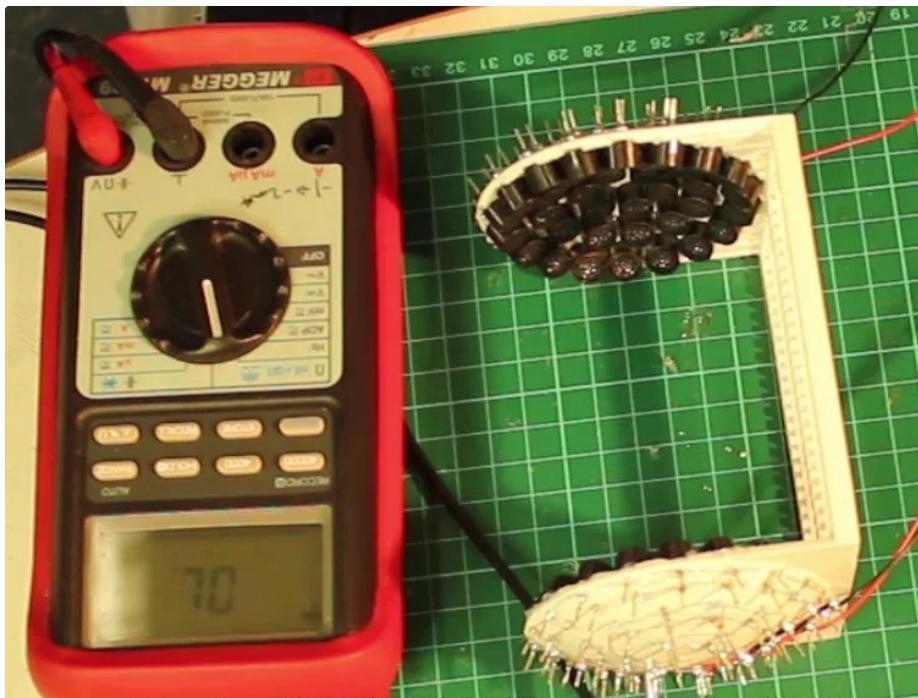
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### Step 17: Test the Driver



When powered (always between 6V and 12V) the output signals of the driver (IN1&IN2 or IN3&IN4) should output a 40kHz square wave of twice the voltage provided to the circuit.

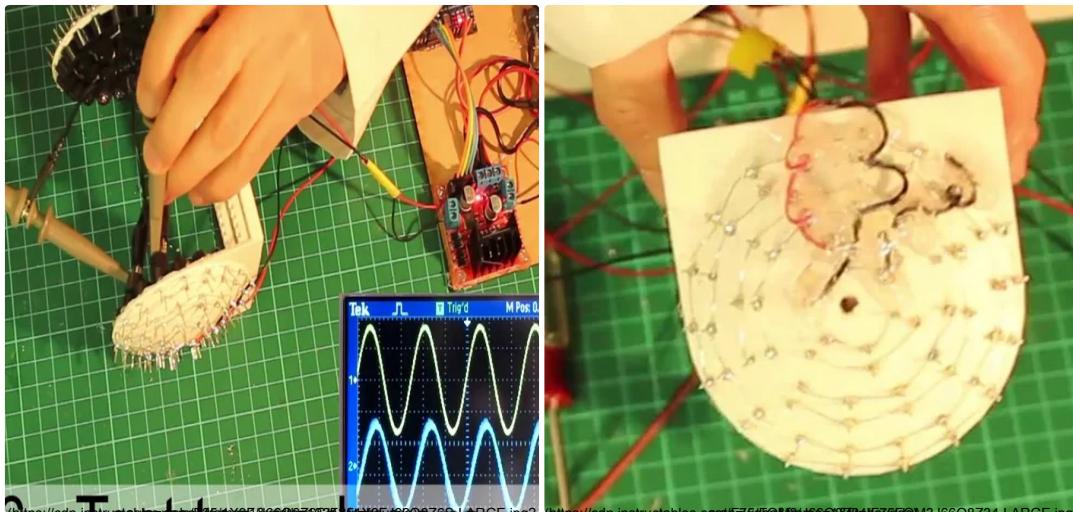
### Step 18: Test for Shortcuts



Test that there are no shortcuts between the red and black wires of the levitator.

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### Step 19: Test the Transducers



Connect the levitator to the driver board and switch it on (always provide between 6V and 12V).

For testing, 6V will be enough.

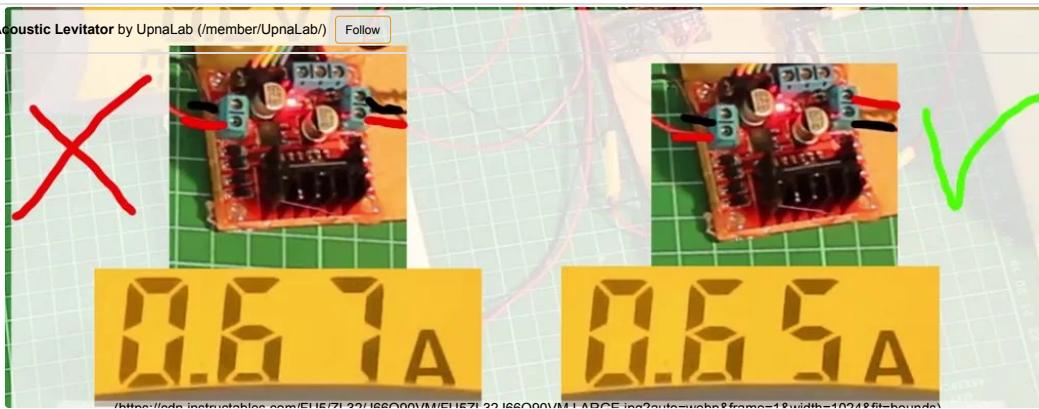
You will need two probes with transducers connected (pay attention to connect the marked leg into the positive part of the probe).

Transducers of the same array (side) should be in phase.

You can correct mistakes by cutting the exposed wire and bridging with wires.

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### Step 20: Test Optimum Resonance



Connecting the wires as shown in the right should provide optimum performance and minimum power consumption. Otherwise, swap the red and black wire.

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### Step 21: Secure the Wires and Glue the Legs

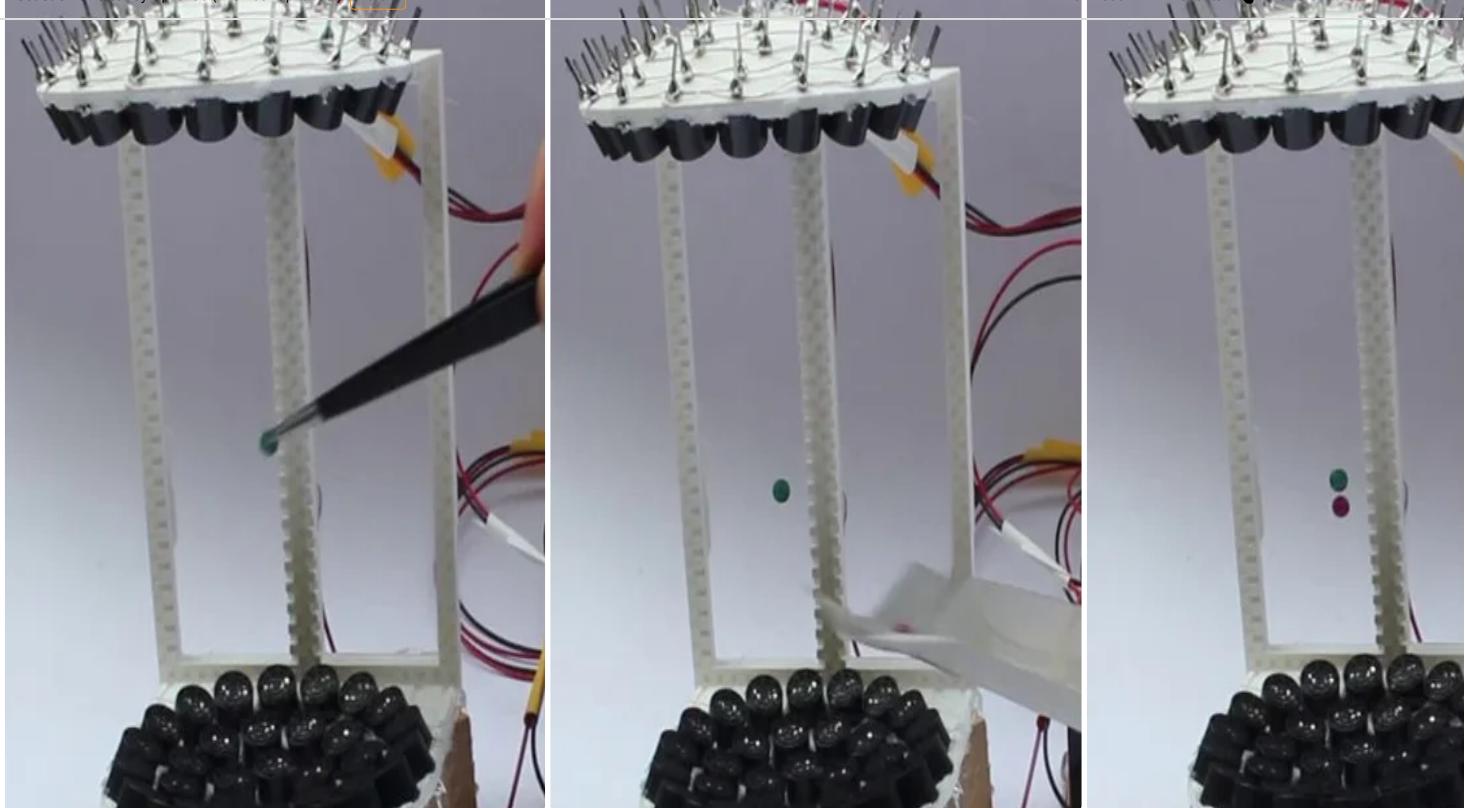


Apply some hot-glue to glue the wires to the levitator for mechanical support.

You can now glue the legs.

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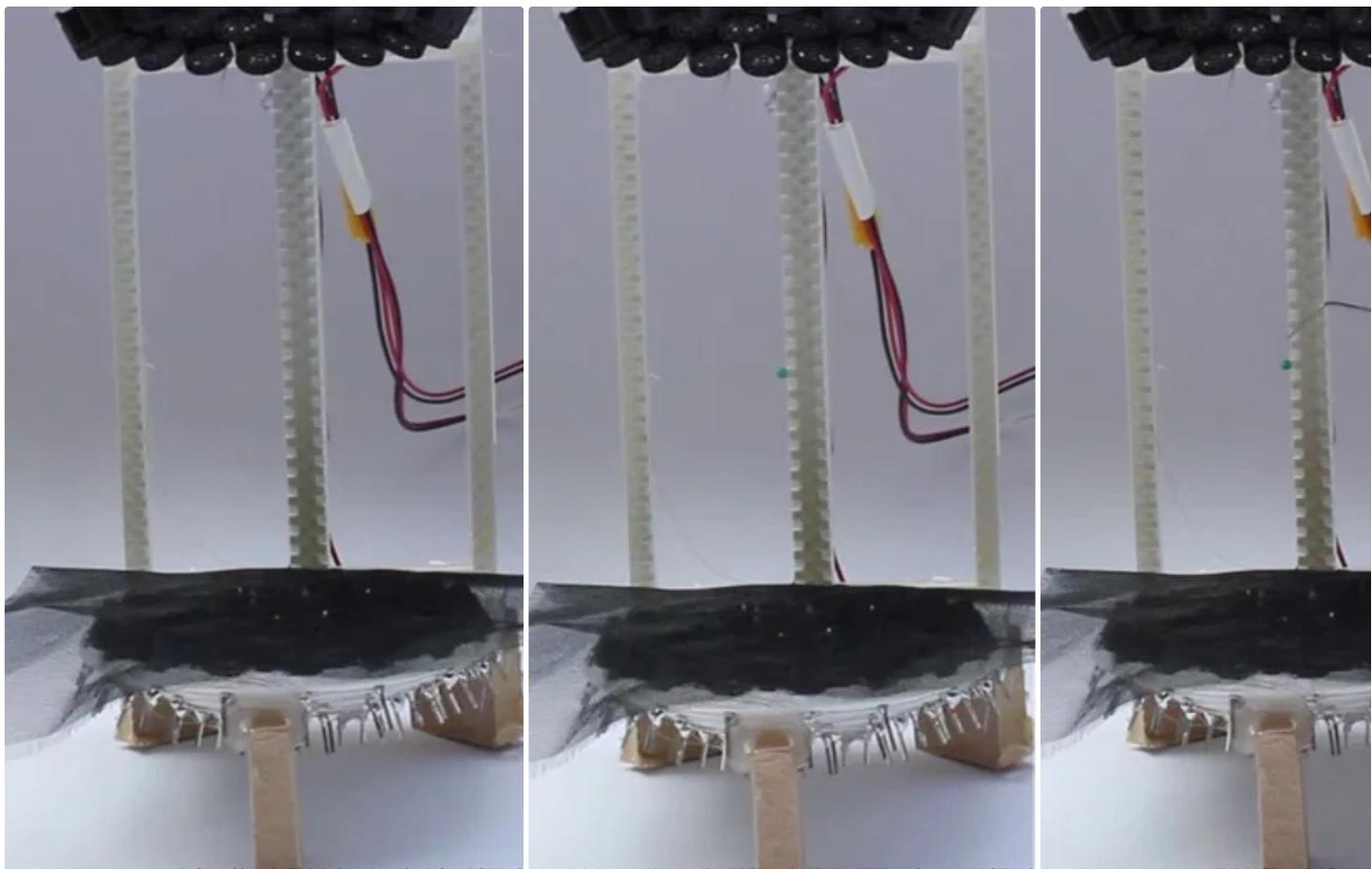
### Step 22: Levitating Solids



Provide up to 10V. You can use a tweezer to place the particles. Also a metallic grid or thin fabric (acoustically transparent) will be useful since the particles can be placed there and then introduced into the levitator.

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### Step 23: Levitating Liquids



It is necessary to adjust the voltage to the type of liquid. Too high and the droplets will pop, too low and they will fall. For water around 9V is enough and for alcohol around 8V.

Place a particle to have a guidance of where to inject the droplets.

A syringe with a bent needle and the tip removed is the best option.

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### Step 24: BIGLev (optional Device)



If you want a more powerful levitator you can use the 16mm transducers. The process is exactly the same but you will need to 3d-print the levitator base in 2 part and glue them together (one half is attached in this step). This levitator can take up to 20V in the driver board (40Vpp) and levitate solids of up to 6g/cm<sup>3</sup> but it is not as easy to use for liquids.

- 72x 16mm 40kHz transducers. Manorshi provides [MSO-A1640H10](#) ([https://manorshi.en.alibaba.com/product/60175991283-800165597/Long\\_Range\\_15Meter\\_Aluminum\\_Plastic\\_Ultrasonic\\_Sensor\\_Detector\\_110dB\\_Sensor.html?spm=a2700.7803228.1998738836.186.LYgvHK](https://manorshi.en.alibaba.com/product/60175991283-800165597/Long_Range_15Meter_Aluminum_Plastic_Ultrasonic_Sensor_Detector_110dB_Sensor.html?spm=a2700.7803228.1998738836.186.LYgvHK)),

You can use instead 25kHz transducers, they are weaker but would allow to levitate larger objects. For that use the simplified code attached, and modify it to match your frequency.

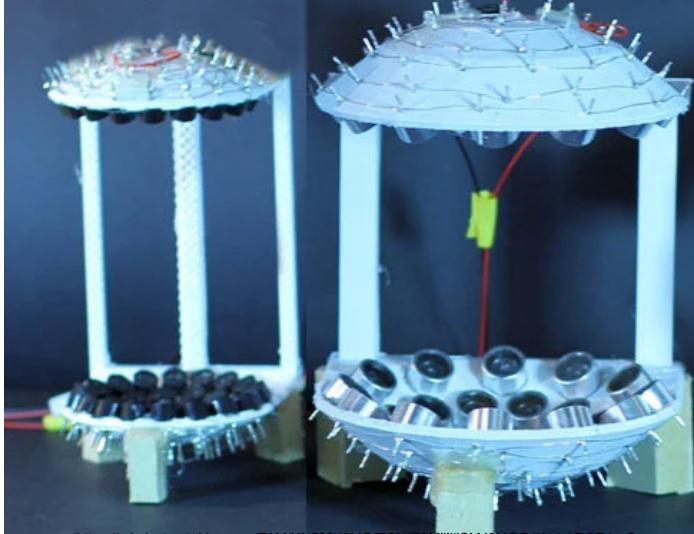
 [BigLev\\_half.stl](#) [Download](#) (<https://cdn.instructables.com/ORIG/F33/JHPQ/J66Q97EF/F33JHPQJ66Q97EF.stl>) [View in 3D](#)  
(<https://cdn.instructables.com/ORIG/F33/JHPQ/J66Q97EF/F33JHPQJ66Q97EF.stl>)

 [Signal40Khz.ino](#) [Download](#) (<https://cdn.instructables.com/ORIG/FW8/AD7J/JEIV6OGA/FW8AD7JJEIV6OGA.ino>)  
(<https://cdn.instructables.com/ORIG/FW8/AD7J/JEIV6OGA/FW8AD7JJEIV6OGA.ino>)

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### Step 25: Mid-Lev (Optional Device)

# TinyLev MidLev



If you want to use 16mm diameter transducers but BiGLev is too big, you can use MidLev. It uses 16mm diameter transducers but it will fit most of the printers.

**midLev16**  [Download](#) (<https://cdn.instructables.com/0RIG/F8H/G7VV/J6MGGHMI/F8HG7VVJ6MGGHMI.stl>) 

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## Step 26: MiniLev (Optional Ultra Low-budget Device)

<https://www.instructables.com/PROJECT-AUDIO-ACOUSTIC-LEVITATION/>

This solution only requieres an Arduino Nano and two transducers. You can desolder the transducers from a cheap Range Finder HC-SR04.

Install the provided Arduino Code from Step 12. Connect pin D10 to D11. Connect one transducer to A0 and A1; and another transducer to A2 and A3.

Put the transducers opposite to each other to levitate a particle between them, it is easier to place the particle with a metallic grid.

You can use [this](https://www.tinkercad.com/things/2yDkXuRhWhw) (<https://www.tinkercad.com/things/2yDkXuRhWhw>) 3D-printed case designed by [lB-as](https://www.instructables.com/member/lB-as/) (<https://www.instructables.com/member/lB-as/>).

You can also use the [simplified code](https://github.com/gbararov/NanoLey) (<https://github.com/gbararov/NanoLey>) by [morlok](https://www.instructables.com/member/morlok/) (<https://www.instructables.com/member/morlok/>).

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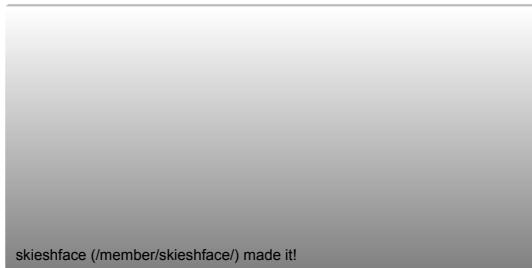
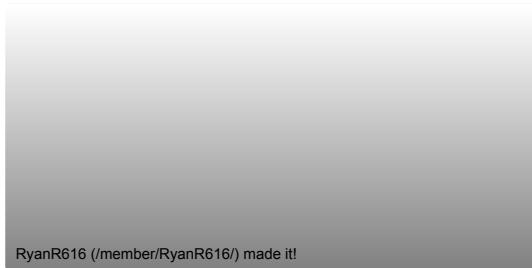
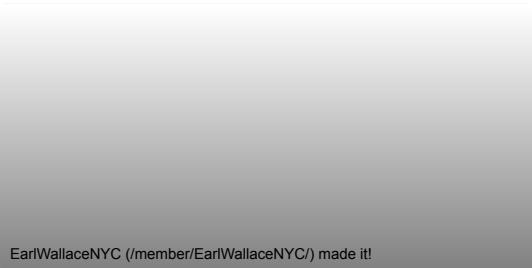
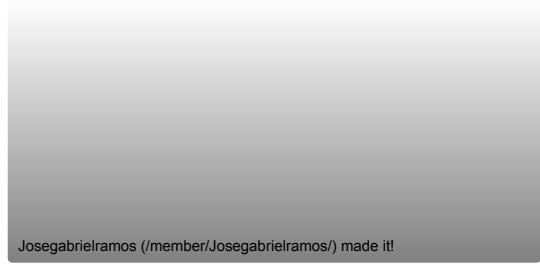
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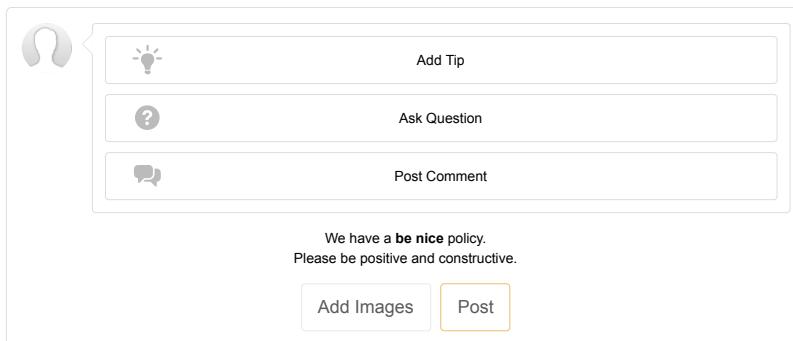
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## Recommendations



(/contest/fta2020/) (/contest/space2020/)



## 688 Discussions

(/member/chin\_chun/) chin\_chun (/member/chin\_chun/) Question 4 weeks ago on Step 2

Answer Upvote

Hello,

I have successfully suspended the water droplets. I want to calculate the surface tension of the liquid through the sound pressure but I don't know the position of the transducer. What is the location of each transducer?

Thank you!!

1 answer ▾

(/member/origamicreeper/) origamicreeper (/member/origamicreeper/) 3 months ago

Reply Upvote

Please help, I am working on the biglev and cant find any good 16mm transducers to use, the only one I can find has a minimum requirement of 500 orders, are there any other ones that I can use?

1 reply ▾

(/member/HeribertoL2/) HeribertoL2 (/member/HeribertoL2/) Question 3 months ago on Step 17

Answer Upvote

Greetings, I am doing this project with my son and the frequency at the driver is 39khz but the voltage is .285v can some one help? the power supply that came with the kit the measured output is 9v. Do we need to change the power supply? frequency seems to be right but the voltage is not 6V.

(<https://content.instructables.com/FOY/6ZMB/K6E2IORD/FOY6ZMBK6E2IORDstartlarge.jpg?fit=bounds&height=1024&width=1024>)

2 answers ▾

(/member/Dray23/) Dray23 (/member/Dray23/) Question 2 months ago

Answer Upvote

Hello,

I have built the levitator, but it doesn't seem to work properly. I managed to levitate a ball of styrofoam which was tossed away once I tried to move it up/down with the arduino. Also, I'm barely managing getting the ball to levitate at all.

\*I've checked the transducers, the frequency is correct on all of them (40kHz), the output voltage is the same as the input for most (expect a few, which out only halve of the input). Is this perhaps the reason for the

I look forward to your reply.

Thank you!

(<https://content.instructables.com/FD9/13DJ/K7KSC5IR/FD913DJK7KSC5IRlarge.jpg?fit=bounds&height=1024&width=1024>)

1 answer ▾

(/member/Vizis/) Vizis (/member/Vizis/) Question 2 months ago

[Answer](#)

[Upvote](#)

How much current whole construstion draws?

1 answer ▾

(/member/vicustoperico/) vicustoperico (/member/vicustoperico/) Tip 25 days ago

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How can I change the voltage to levitate liquids? Help me please, I'm doing my DFD with this kit. Thank you!

孙硕斐  
(/member/%25E5%25AD%2599%25E7%25A1%2595%25E6%2596%2590/) (/member/%25E5%25AD%2599%25E7%25A1%2595%25E6%2596%2590/)  
Question 2 months ago on Step 14

[Answer](#)

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Hello, I am trying to build a device that can levitate water droplets with 6mm in diameter. Since this requires the usage of 25kHz transducers, I am wondering how exactly the simplified code should be altered to accommodate for 25kHz transducers (I am new to Arduino and do not understand the code too much).

Also, does altering the distance between the plates also require some modification to the code?

Thanks!

(/member/galiuxd/) galiuxd (/member/galiuxd/) 3 months ago on Step 13

[Reply](#)

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can you tell me which program i have to download for this step please?

(/member/Kickbox369/) Kickbox369 (/member/Kickbox369/) Question 3 months ago

[Answer](#)

[Upvote](#)

what would be the code if u were to use a pic as a microcontroller on ccs compiler, ik that arduino has its own type of code but it's also a form of C coding and im curious to build this with a pickit 3 pic16f690 microcontroller

(/member/djlacs32/) djlacs32 (/member/djlacs32/) Question 3 months ago on Step 13

[Answer](#)

[Upvote](#)

hi I cant open the code please help

(/member/nkim452/) nkim452 (/member/nkim452/) Question 3 months ago

[Answer](#)

[Upvote](#)

Hello, I am building an acoustic levitator for a school science fair. So far I've only been able to levitate foam beads. I plan on getting some pure ibuprofen and dissolving it in warm/hot ethanol, then levitating droplets of this. When the ethanol dissolves, the pharmaceutical is supposed to be in amorphous form, so it will dissolve faster. I have not been able to levitate liquids yet, though... (I have tried using a syringe with a needle to levitate droplets of water.) They just fall down. I am wondering if this has to do with the voltage, and if so, how do I change the voltage? Are there any other things I can try in order to levitate drops of liquids? (Also, I'm currently in seventh grade and I don't have much experience with circuits, can you use simplistic vocabulary? Sorry/thank you ☺)

(/member/bluedog201/) bluedog201 (/member/bluedog201/) Question 4 months ago on Step 26

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2 answers ▾

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