Introduction

Congratulations on purchasing the Spengler Link Kit that allows the Hasbro Ghostbusters Plasma Series Spengler's Neutrona Wand to control your Pack!

The Spengler Link Kit is designed to be permanently installed inside the wand and then provide a 3.5mm stereo audio jack that will output sound and control signals and optionally a separate 4 wire long cable that can provide power to the wand from a GhostLab42 Spengler Sound board or the Spengler Decoder board so that you do not have to have separate batteries in the wand and all of your electronics can be powered by a single 12V rechargeable battery located in your pack.

The Spengler Sound board can control either a GBFans powercell and cyclotron lights board for your full-sized pack or a GhostLab42 Spirit Pack Lights for the Halloween Spirit Pack. With either of these Pack Lights kits, your pack can show many different sequences: Power up, Power down, Overheating, Venting, and even speeding up the sequences if you fire the Spengler wand with high intensity.

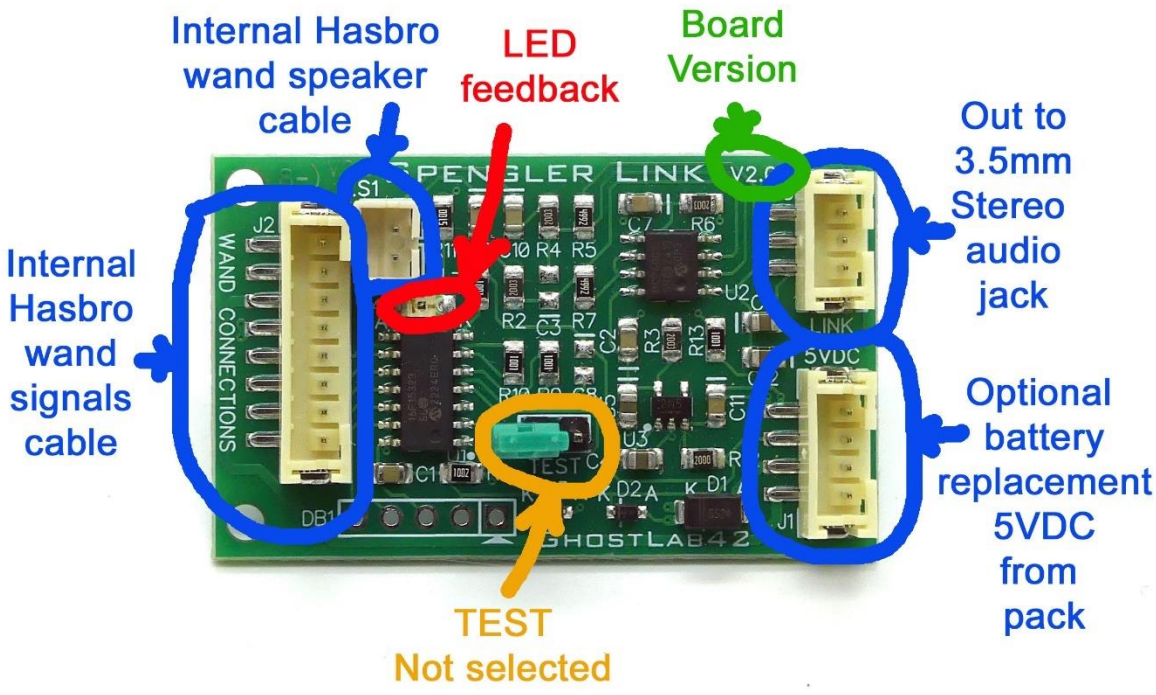


Front



Back

Connections and Settings for V2.0:



There are four separate cable connections:

1) WAND CONNECTIONS, J2, 8 pin connector (PH style, 2.0mm pitch)
   An 8-wire connector that provides the actual connections to Spengler Wand's electronics.
2) WAND SPEAKER, LS1, 2-pin connector (PH style, 2.0mm pitch)
   A 2-wire connector that will also go to the Spengler Wand's electronics.
3) SOUND LINK, J3, 3 pin connector (PH style, 2.0mm pitch)
   A 3-wire connector that will go out to the 3.5mm stereo audio jack
4) SOUND 5VDC, J1, 4 pin connector (PH style, 2.0mm pitch)
   A 4-wire connector that can be used to replace the Spengler wand's need for a set of batteries that normally go in the handle.
   This is an optional connection. If you want only a single connection between the Spengler Wand and your pack that is an Audio cable that can be easily connected and disconnected, then you will need batteries in the wand and you will not need anything plugged into this connector.

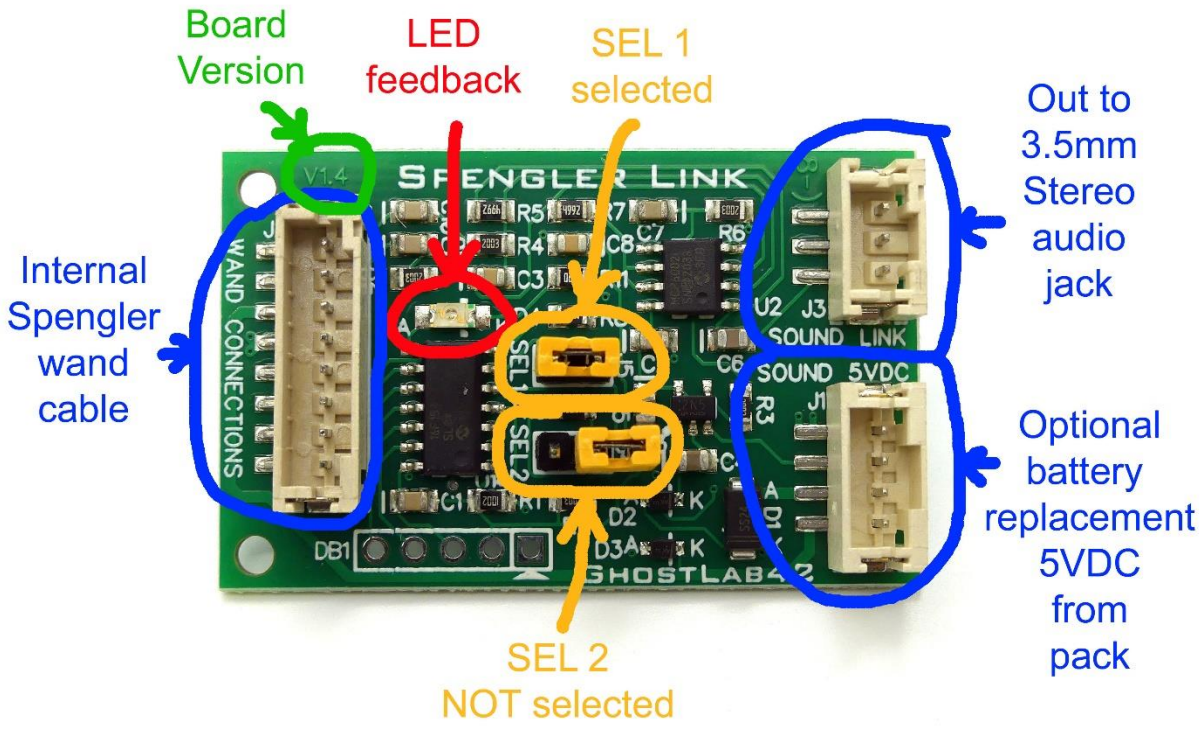
Feature Selection.

There is a single jumper only used for running the self-test:

TEST	Description
Off	Standard wand operation
ON	Test mode – not for normal operational use

The above image shows the "Standard wand operation" mode is selected.

Connections and Settings for V1.4:



There are three separate cable connections:

1) WAND CONNECTIONS, 8 pin connector (PH style, 2.0mm pitch)
   An 8-wire connector that provides the actual connections to Spengler Wand's electronics.

2) SOUND LINK, 3 pin connector (PH style, 2.0mm pitch)
   A 3 wire connector that will go out to the 3.5mm stereo audio jack

3) SOUND 5VDC, 4 pin connector (PH style, 2.0mm pitch)
   A 4-wire connector that can be used to replace the Spengler wand's need for a set of batteries that normally go in the handle.
   This is an optional connection. If you want only a single connection between the Spengler Wand and your pack that is an Audio cable that can be easily connected and disconnected, then you will need batteries in the wand and you will not need anything plugged into this connector.

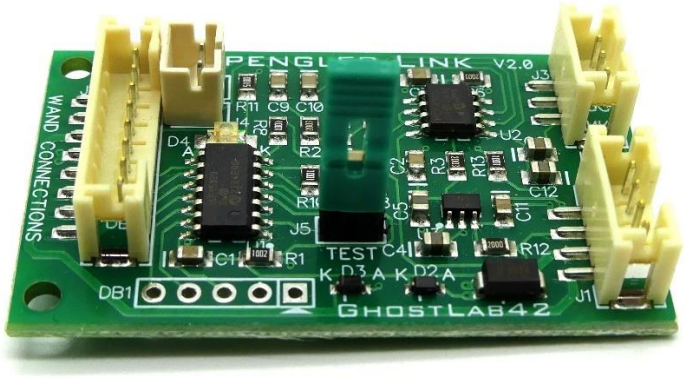
Feature Selection.

There are two jumpers that can be used to select one of several features:

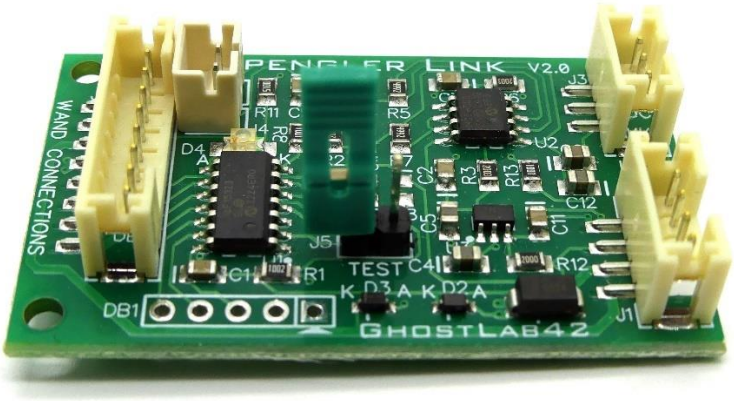
SEL1	SEL2	Description
off	Off	Standard wand operation
off	ON	N/A
ON	off	Keep Alive, do not power down when idle for long periods
ON	ON	Test mode

The above image shows the "Keep Alive" feature is selected.

A jumper is considered “ON” when the small shorting part is connected to both pins:



A jumper is considered “off” when it is not connected to both pins.



Yes, you could just remove the shorting part completely, but since it is easy to misplace, I like to keep it on one pin only so that it will be handy when you want to use it later.

LED Feedback

The Test mode will display the firmware version and then have you go through a is a sequence of steps you need to perform to make. During the test mode, the RED LED will provide feedback, so you know that each step has been completed. See the Test Mode section towards the end of this document.

Board Version

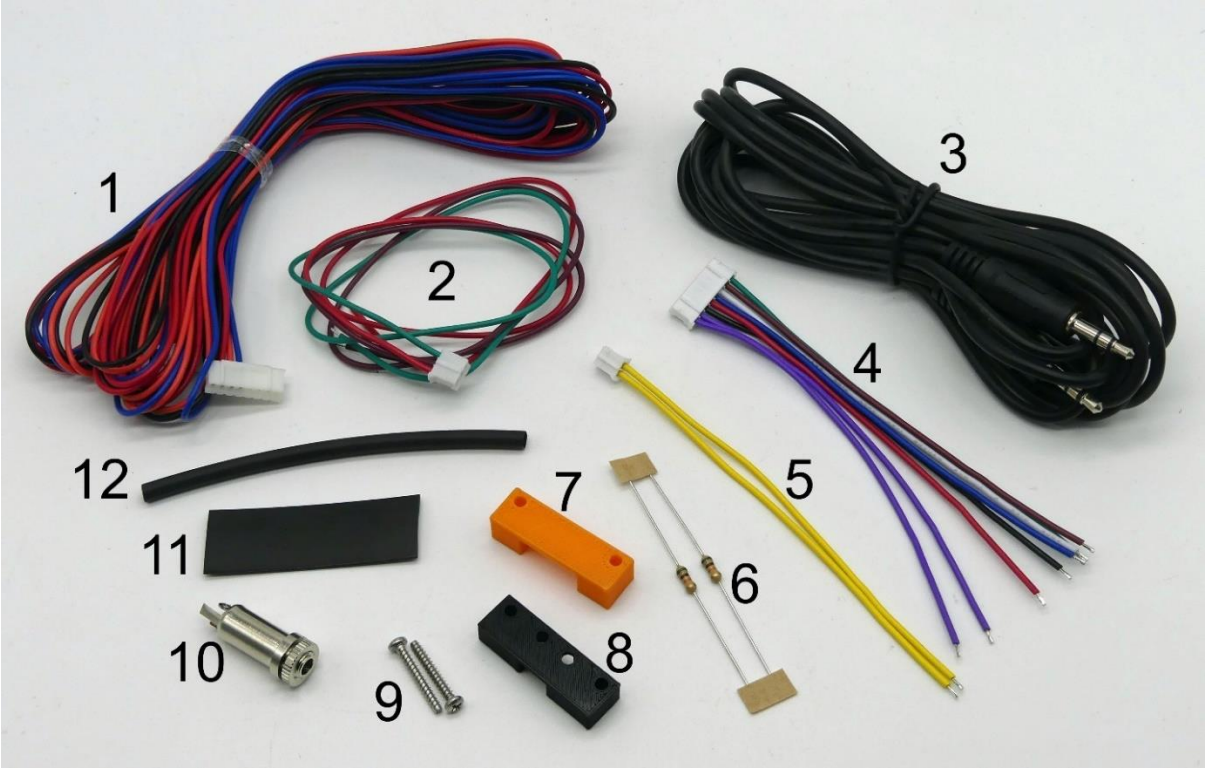
Separate from the firmware version is a board version number that is part of the copper on the top side of the board.

Usage Notes:

V1.4: The Spengler wand by itself will shut down in about 30 seconds if you do not activate anything while the wand's rumble motor is running. The KeepAlive feature will only keep the wand up and running when it is in the idle mode (no rumble motor running) but can keep the wand running indefinitely.

V2.0: This version of the Spengler Link will also keep the wand alive indefinitely with the rumble motor running. The Rumble motor does take a significant amount of current, so could shorten your battery run time. The rumble motor _may_ not be designed to run continually for hours, so we recommend that you occasionally de-"Activate" the wand so the rumble motor is not continually running all day! It should be fine to leave the bar graph light on for extended times.

Spengler Link Kit Contents:



The Spengler Link contains multiple parts to complete the installation into your wand.

1) 5VDC 4-wire power cable (connects to Spengler Sound or Spengler Decoder board)
2) Link 3-wire cable (connects to the audio jack #10)
3) Stereo Audio cable, M-M 3.5mm plugs (from #10 to Sound or Decoder board)
4) Wand connections 8-wire cable (internal connections to the wand's circuit board)
5) Wand sound connection 2-wire cable (internal connections to the wand's circuit board)
6) 2x 51k 1/4W resistors for aiding rumble motor keep alive
7) Mounting Bracket for 1984 Wand (Secures the Spengler Link to the wand)
8) Mounting Bracket for Spengler Wand (Secures the Spengler Link to the wand)
9) Mounting screws (holds Spengler Link board on bracket and wand)
10) 3.5mm Stereo audio jack (for cable #5). You may have a jack that does not look exactly like this since there are two styles of jack available.
11) Larger heat shrink to cover the back half of the audio jack #10
12) Heat shrink for resistors #6 that connect to the wand's circuit board and wires #2 that connect to jack #10

And the Link board, packaged separately:



Installation into the Spengler Wand

Getting started:
The first step is to unscrew the end cap from the handle and remove the battery pack so that nothing will be powered while we perform the disassembly and subsequent installation of the new electronics board.

***** ZAP WARNING RANT *****
A note of caution about static electricity. That zap you can give to someone or something when you rub you shuffle across carpet on a dry day and then feel and hear when you come in contact with someone or something like a doorknob is an ESD event (Electro-Static Discharge). This can be annoying or fun or both but can be very damaging to electronics.

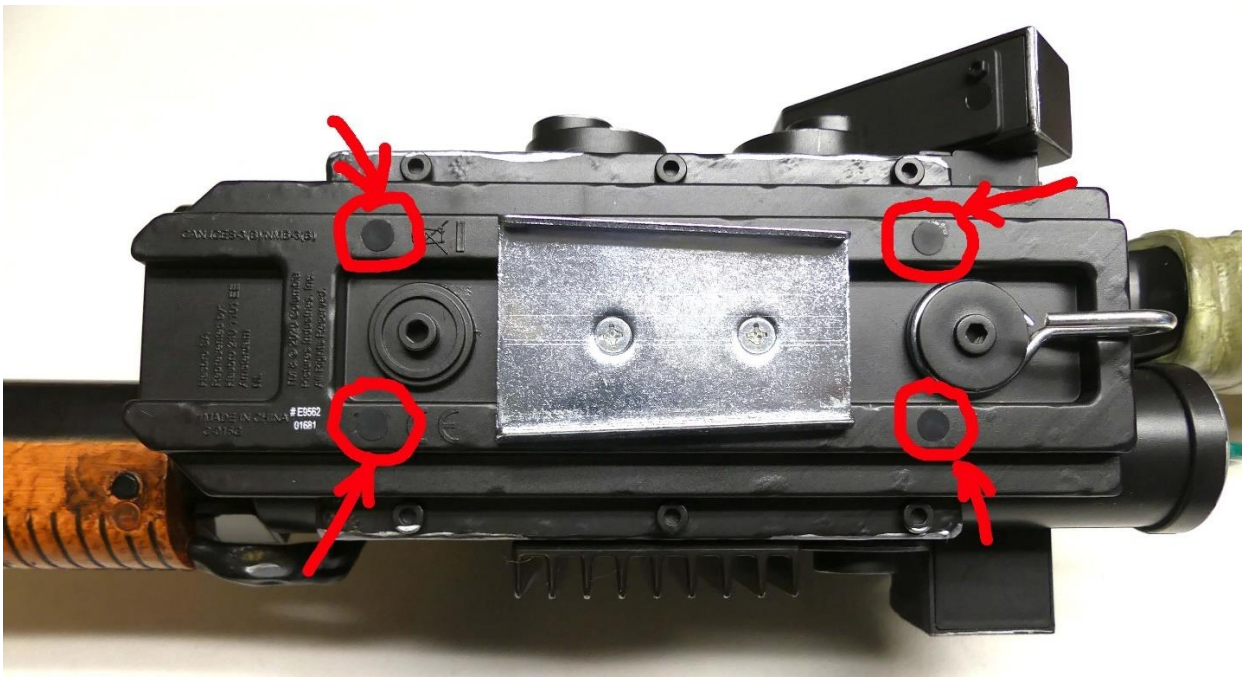
It is best to discharge yourself before touching any of the internal electronics or any of the electronics you are going to put in the wand, like the Spengler Link board. You can do this by touching something that is metal and is plugged into a 3 prong (grounded) output. If this is not practical, try not to walk around much when working on the electronics and do go touch those doorknobs before you start working on this.

Also be careful of others that may try and zap you while you are working, either intentionally or unintentionally! Just walking up and touching you while you are touching the electronics may cause problems.
***** END OF ZAP WARNING RANT *****

Open the wand up:
Start by removing the rails from the back of the Spengler Wand so we can access the inside of the wand.

Tools Needed:
- 1/8” drill bit and drill
- Small-Medium Philips head screwdriver
- Dental pick or needle – some small pointy thing

There are four screws holding the rails to the back of the wand and they are covered by glued on caps that and are located here:



Use the drill on low speed (screwdriver speed) and start to drill the center of the cap that covers the screw with the 1/8" drill bit. You want to drill in far enough for the bit to "grip" the cap, but not so deep that you will drill the head of the screw. The caps are about ¼" deep, but you only need to drill in about 1/16" to get the bit to grip onto the cap.

Stop drilling with the bit in the cap and pull then pull the drill away. It should pop the cap out. Keep the caps for when you want to cover back up the screw heads.
I tried with smaller bits, and they did not provide enough grip and just pulled the bit out and left the cap in place. Tried to pry that out with the dental pick but they were too stubborn.

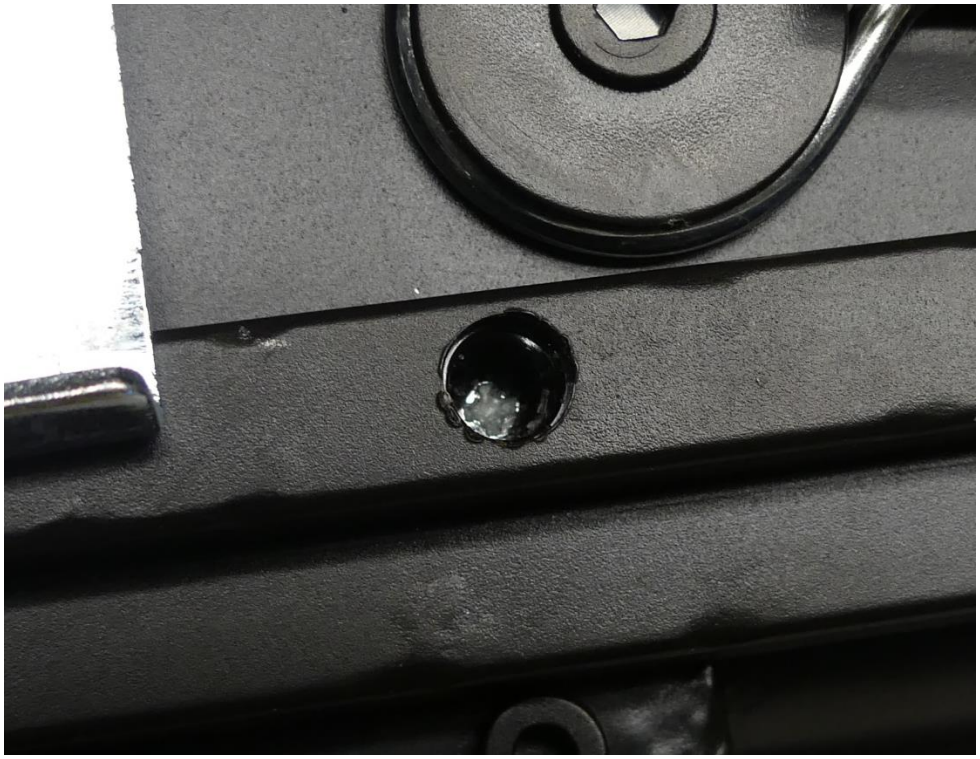


Once the caps are out you may have glue sitting in the hole and filling the head of the Philips screw making it difficult to unscrew. Use the dental pick (or needle) to scrape out the glue and clean it out of the Philip's head slots so that the screwdriver can have a good connection with the screw head.

Before:



After:

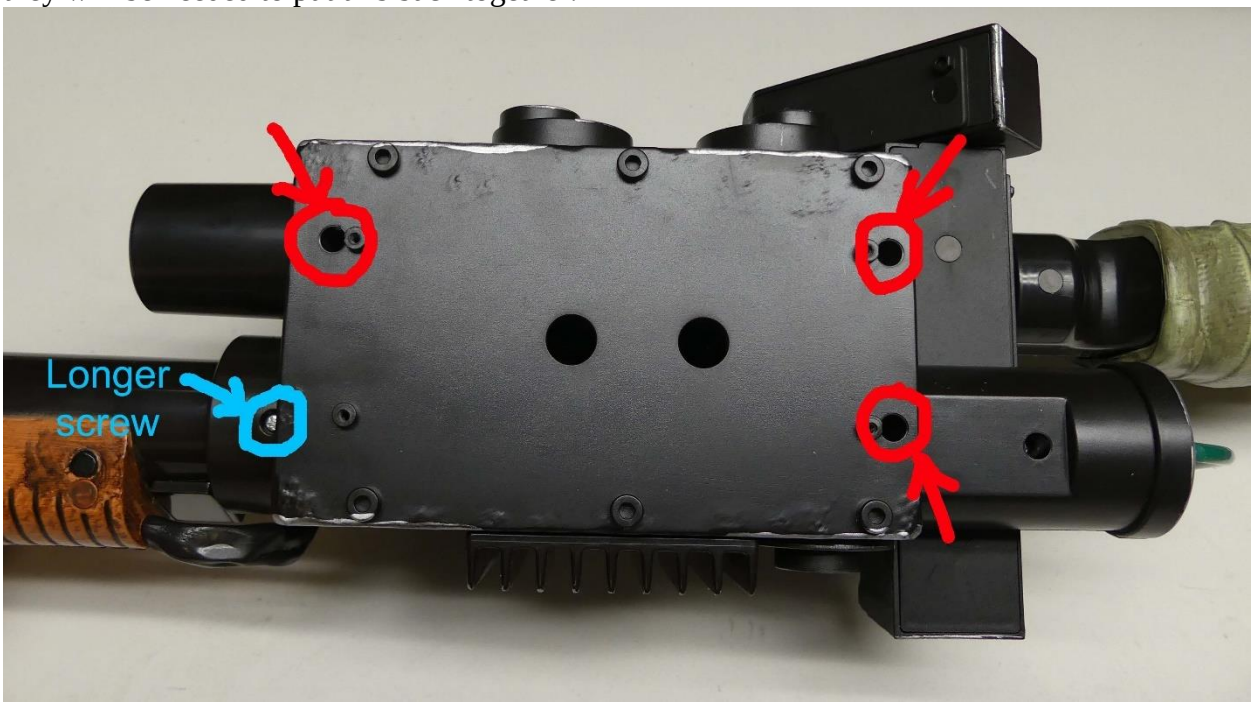


Once the glue residue has been removed, use the screwdriver to remove the four screws. Keep the four screws so you can put them back in when we are done installing the electronics and cables. I use an egg carton to hold, separate and organize the tiny parts that I am removing.

Remove and set aside the rails.

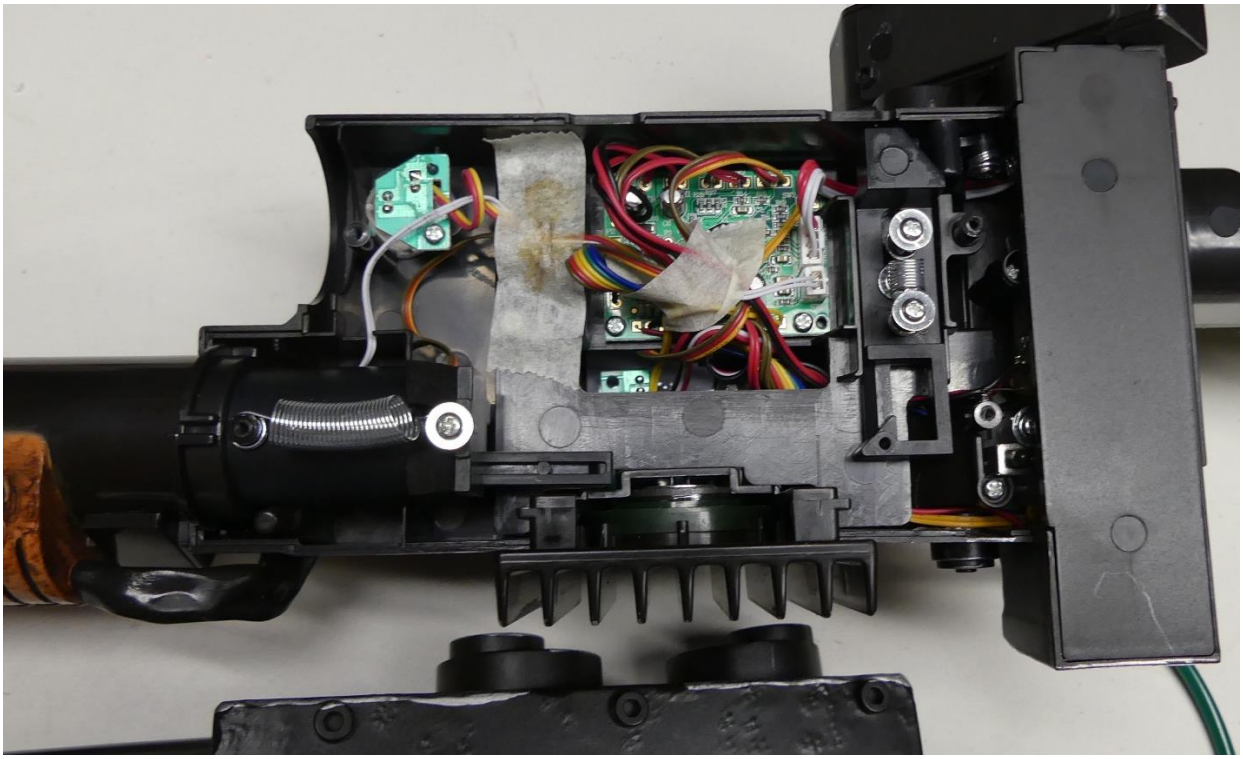
Remove the wand body bottom:
We do want the wand tip popped out so there is more room for us to maneuver around, so if the wand top is pushed in, pull on the green level and have the wand pop out before you remove the screws from this bottom piece.

Remove the next set of 4 screws that are holding the bottom piece in place: 3 short screws in the main body of the wand and one longer screw that goes into the wand tube. Keep the screws since they will be needed to put this back together.



Lift the bottom piece off and leave the heat sink and speaker in place attached to the wand. The wires that go to the speaker may become damaged if you remove the heatsink/speaker and just let it dangle and bounce around while doing the rest of the mods. The green tubing will keep this bottom panel close by, but it is a pain to remove so leaving it attached and dangling should not be a problem.

You should now have a nice view of the internal workings of the wand:



Making a pathway for new cables:

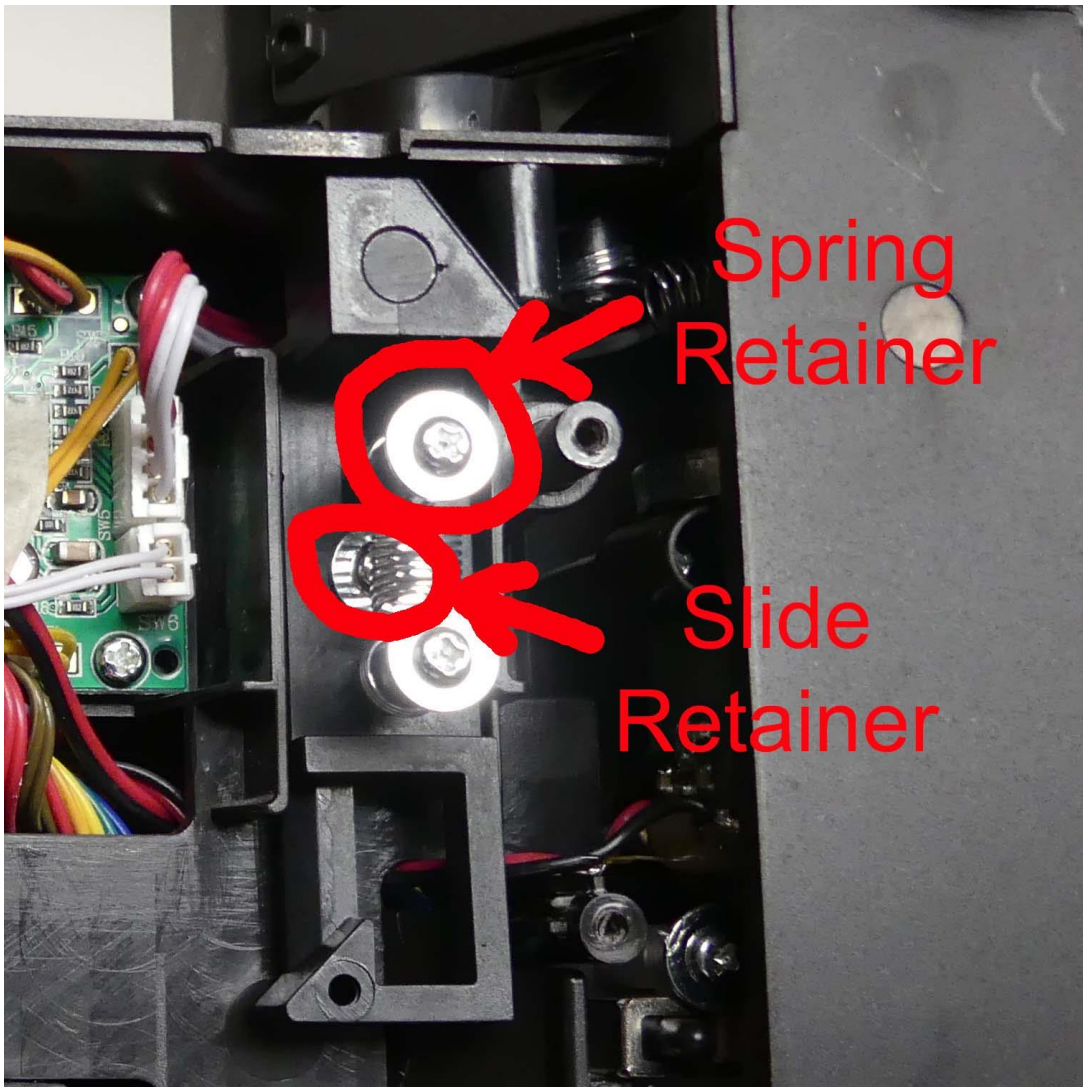
In this step we need to make a hole that goes from the inside of the wand body into the handle so that the wires can get from the Spengler Link to the outside world.

Tools Needed:

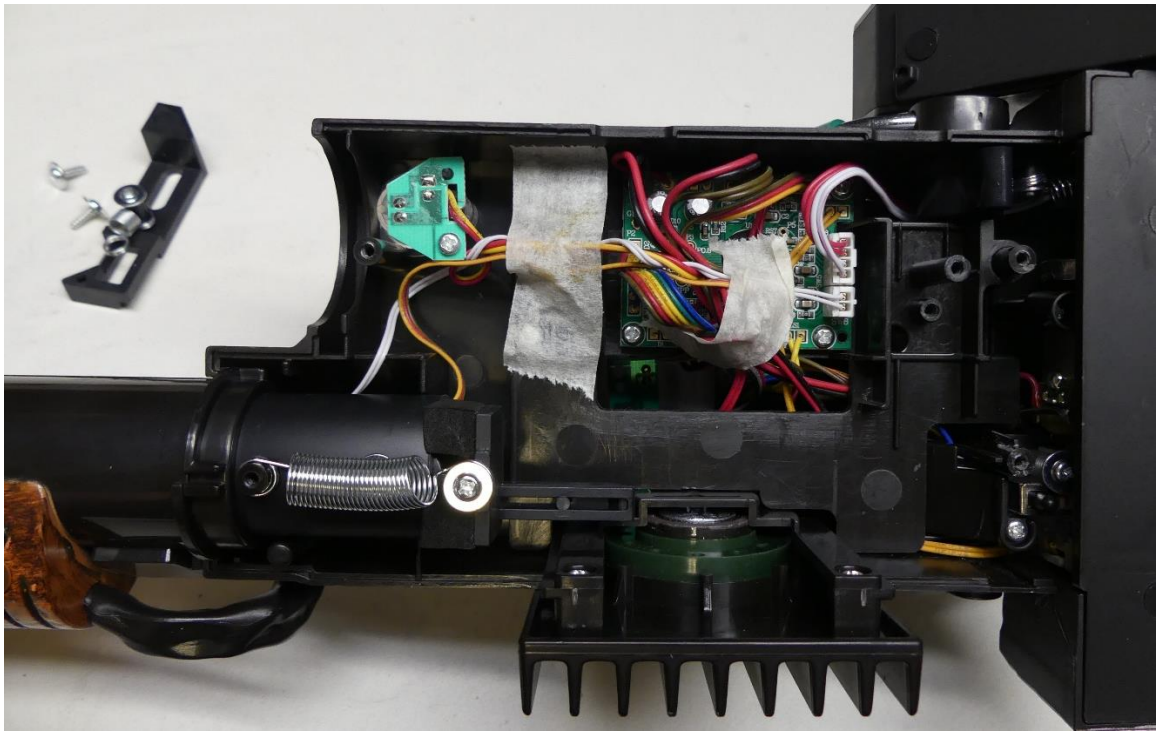
- 1/4” drill bit (and maybe a 1/8” bit) and drill
- Small-Medium Philips head screwdriver
- Dental pick
- Needle nose pliers

Remove the sliding latch mechanism:

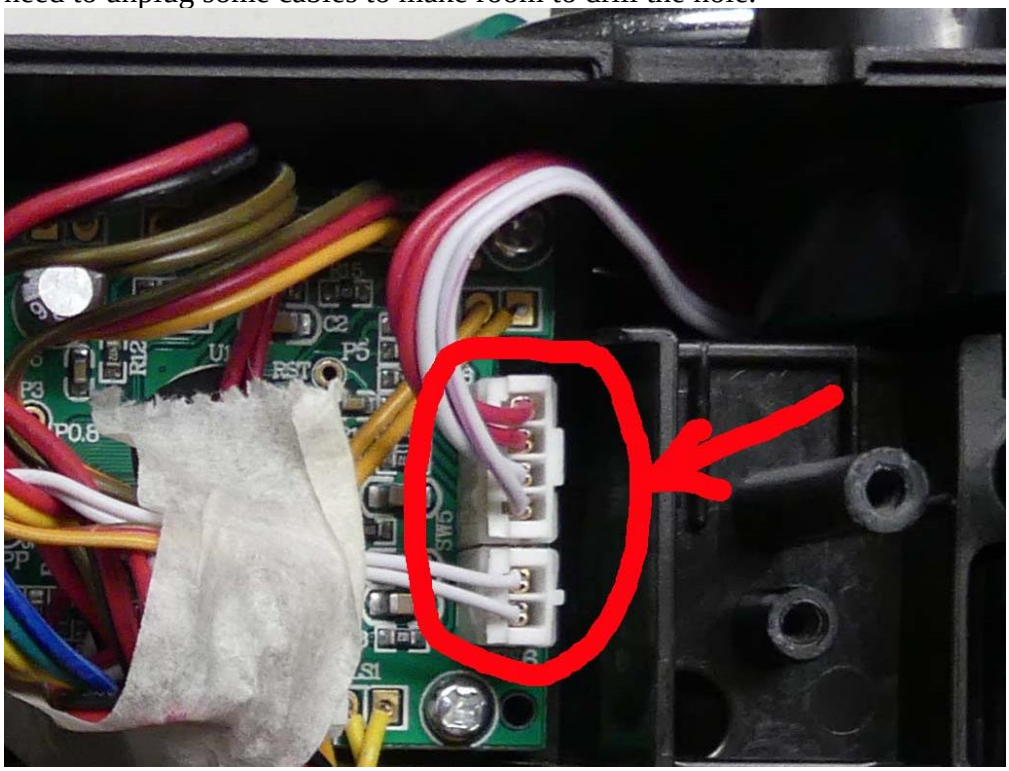
Only two of the screws need to be removed. First remove the spring retainer screw, and then you can life the end of the spring over the post to gain access to the second screw (Slide Retainer). Remove this screw and the slide mechanism can now be lifted out.



Keep the screws and the sliding mechanism in a safe place since we will need them when we reassemble the wand.

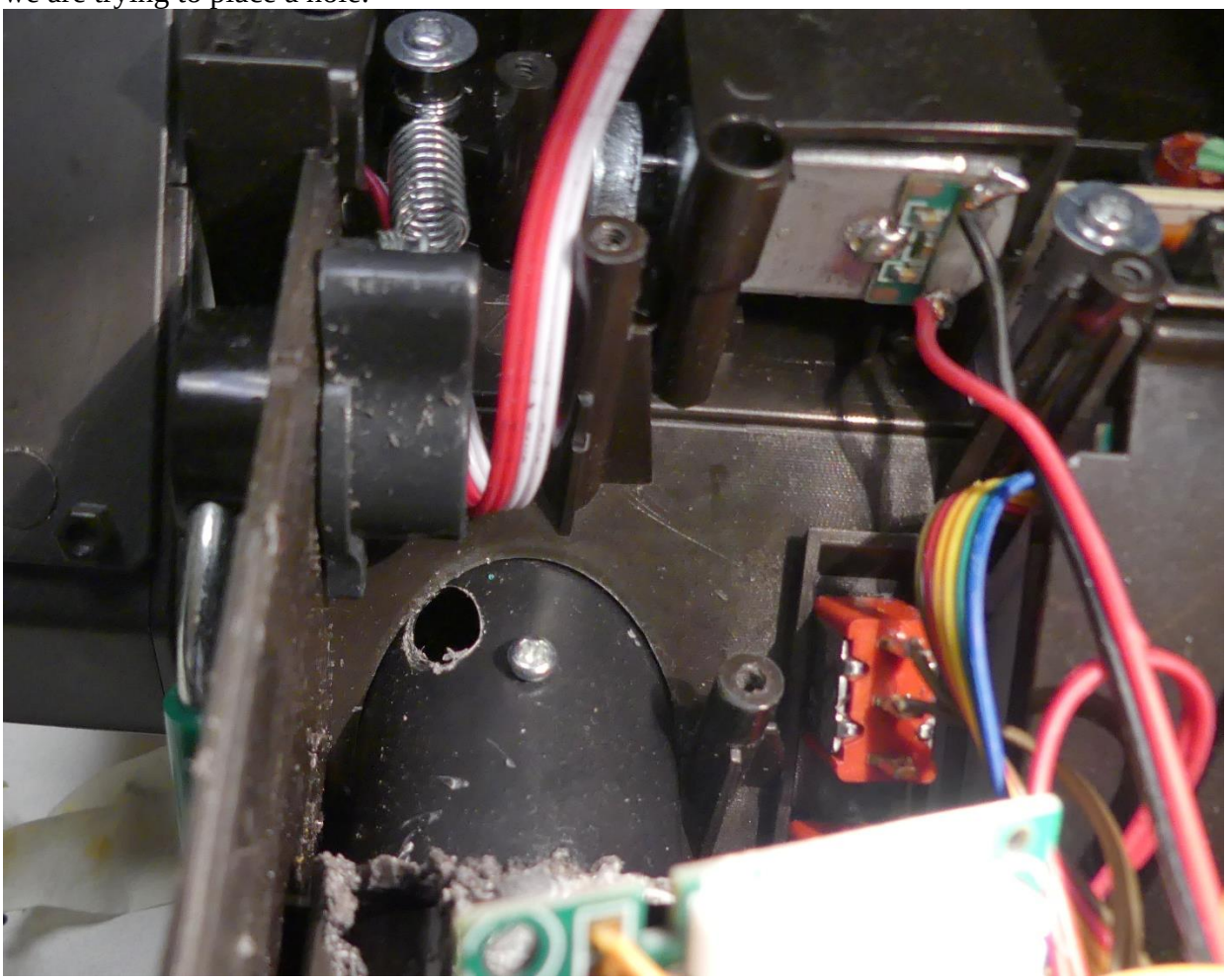


Next, we need to unplug some cables to make room to drill the hole.



The cables are held in place by a couple of tabs on the right-hand side of the connector that go into indents on the socket. It is just friction but holds them tightly. Not sure the best way to remove these – you can pull from the wires, and they will give, but it does stress the wires to do that. I use a curved dental pick and pry them up from the sides of the connectors where there is a lip for the pick to grab on to. I tried pliers and that did not go too well since the connectors are quite easy to squeeze and possibly damage.

*** FYI ***
Here is a torn-up wand (NOT what we want you to do with your wand!) just to show you where we are trying to place a hole:

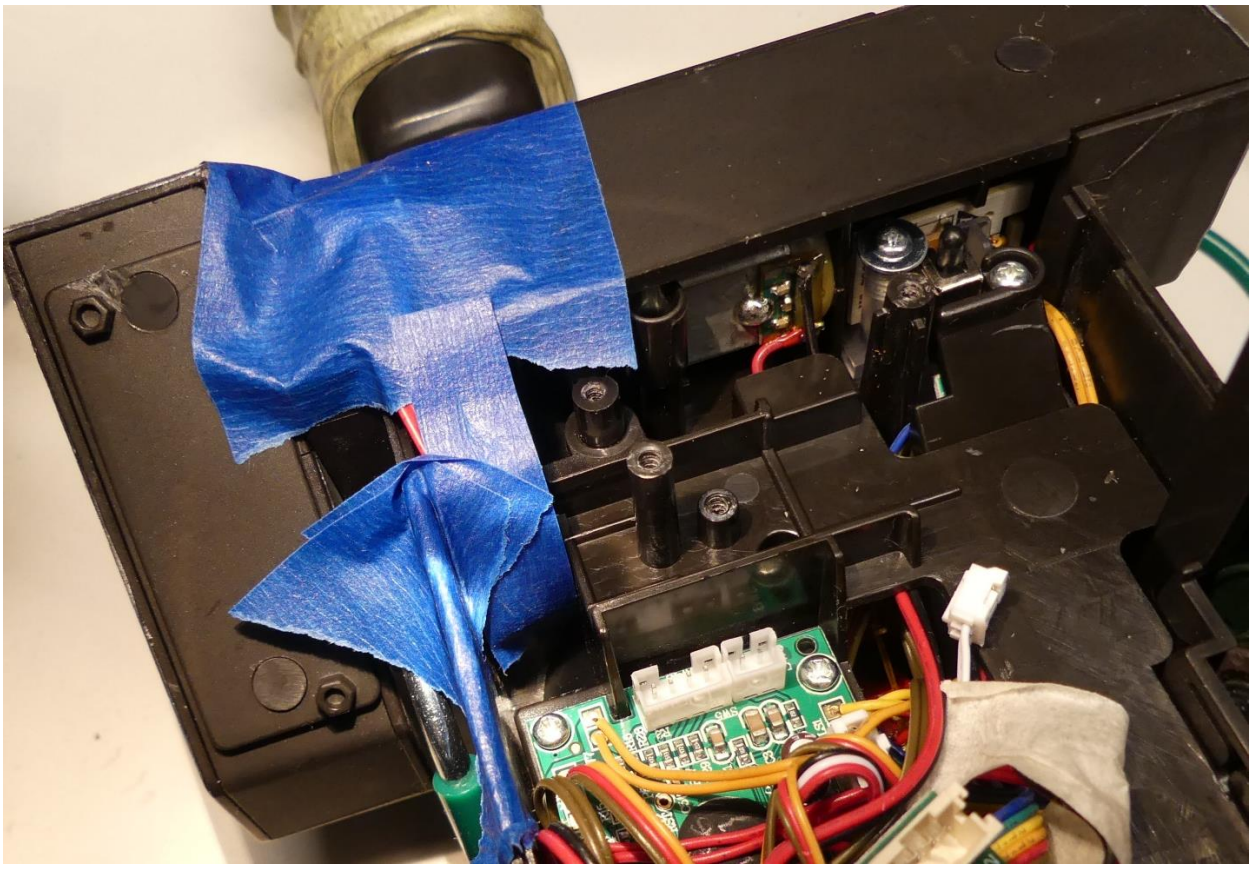


The plastic face just above the tube is the face of the wand so we do not want to drill that, but we want to get as close as possible to that since the inside of the wand ends about where that hole is so we cannot be very far from that edge or the wires will have nowhere to go.

*** END OF FYI ***

Use some tape to hold one of the cables we just unplugged out of the way and wrap the edges with a couple of layers of masking tape to protect those items from a slide contact from the drill bit. We do NOT wand the drill bit to touch the tape, it is there as a little bit of protection in case we do slip…

Here is what it should look like before we start to drill:

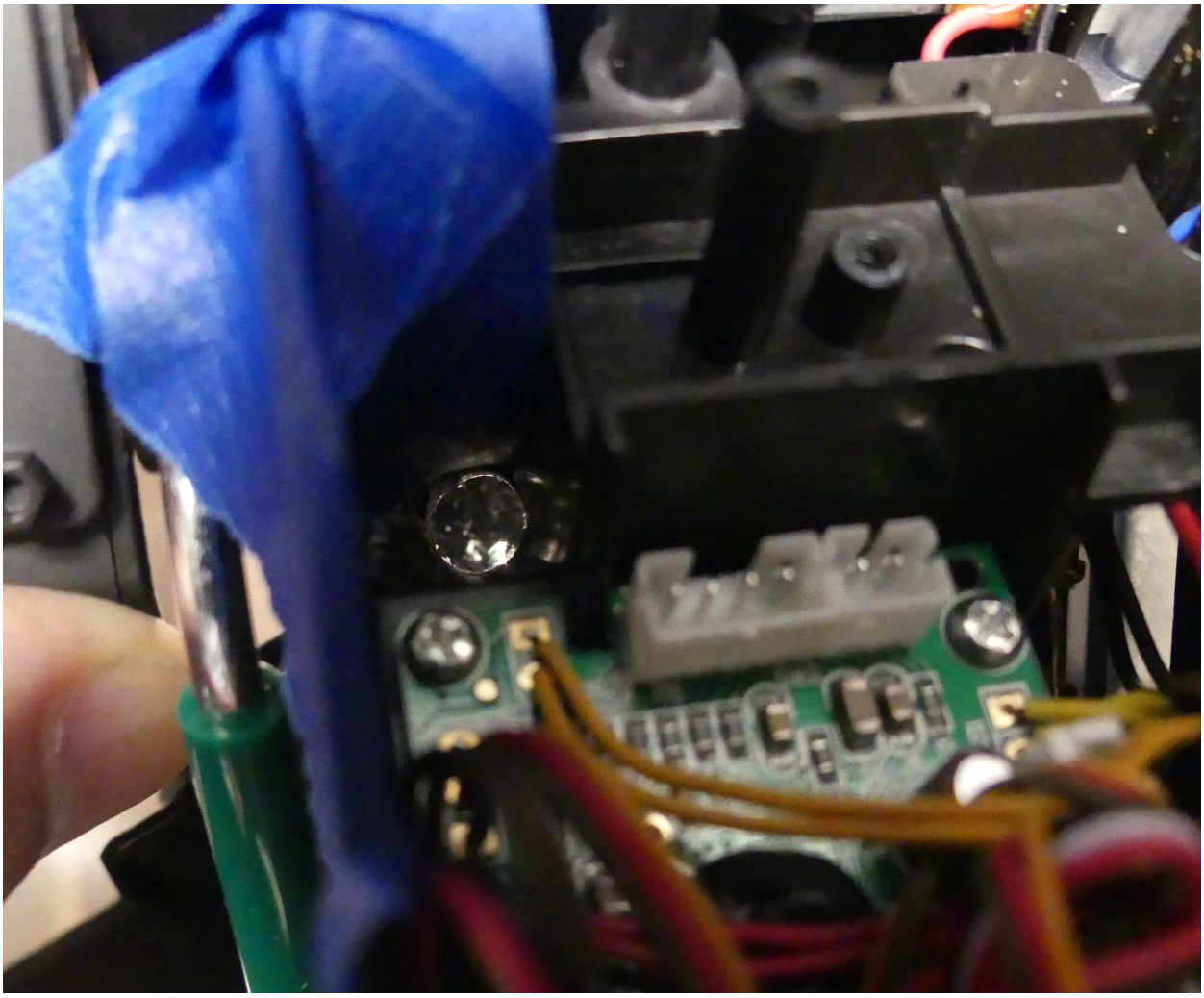


I used the 1/8" bit first to place the hole where I wanted the ¼ bit to dill next. The smaller hole was not up against the plastic face, but about 1/8" away. You do not have to do this as a two-step process, I just like to have the ability to see where the smaller hole is located so I can adjust placing the larger hole a bit more accurately.

The initial hole does not have to go all the way through, using a smaller bit (1/8") or just care with the final drill bit (1/4") just start an indent and get that placed where you want it before committing to drilling the main hole.

You will be drilling at an angle and nearly touching the circuit board. Try not to go too deep into the hole as you do not want to drill through the tube and on to the other side of the handle's tube! There are contact springs that the drill bit can end up being very close too inside the tube. I did not have any trouble with those, but if you could not extend the drill bit very far through the tube material then you would be sure to not hit the springs.

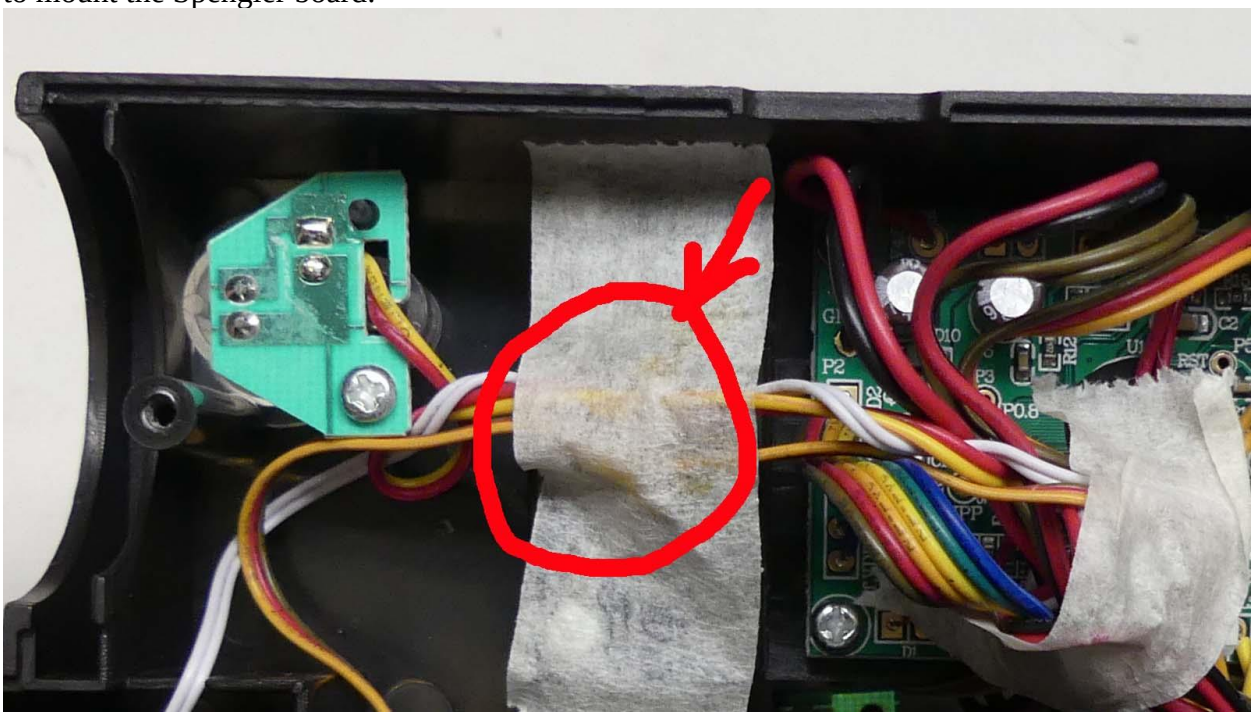
Here is a photo of the wand after it was drilled. I used a flashlight shining into the end of the handle to light up the hole so I could see it from this angle. The contact spring is the shiny part that is seen through the hole I drilled (on the lower right-hand side of the hole).



The camera angle on this image is about the same angle that you will have the drill bit at when drilling this hole.

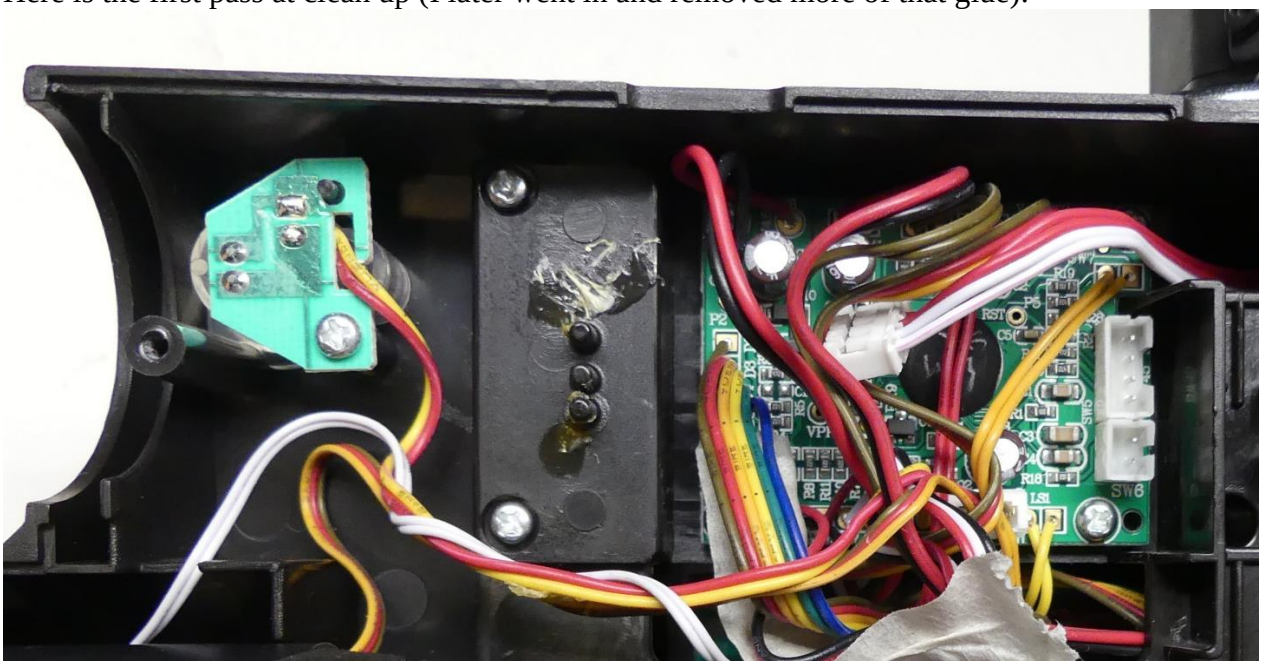
There was a lot of debris from the drilling. I just blew most of it out and used a dental pick to get some of the larger chunks out of the way. The edge of the hole was in pretty good shape, but you could use a file (rat tail) or a small flat screwdriver to remove any rough edges or small chunks of plastic that were left over aver the drilling.

Next let's clear a path for the few cables that are currently glued and taped down where we want to mount the Spengler board:

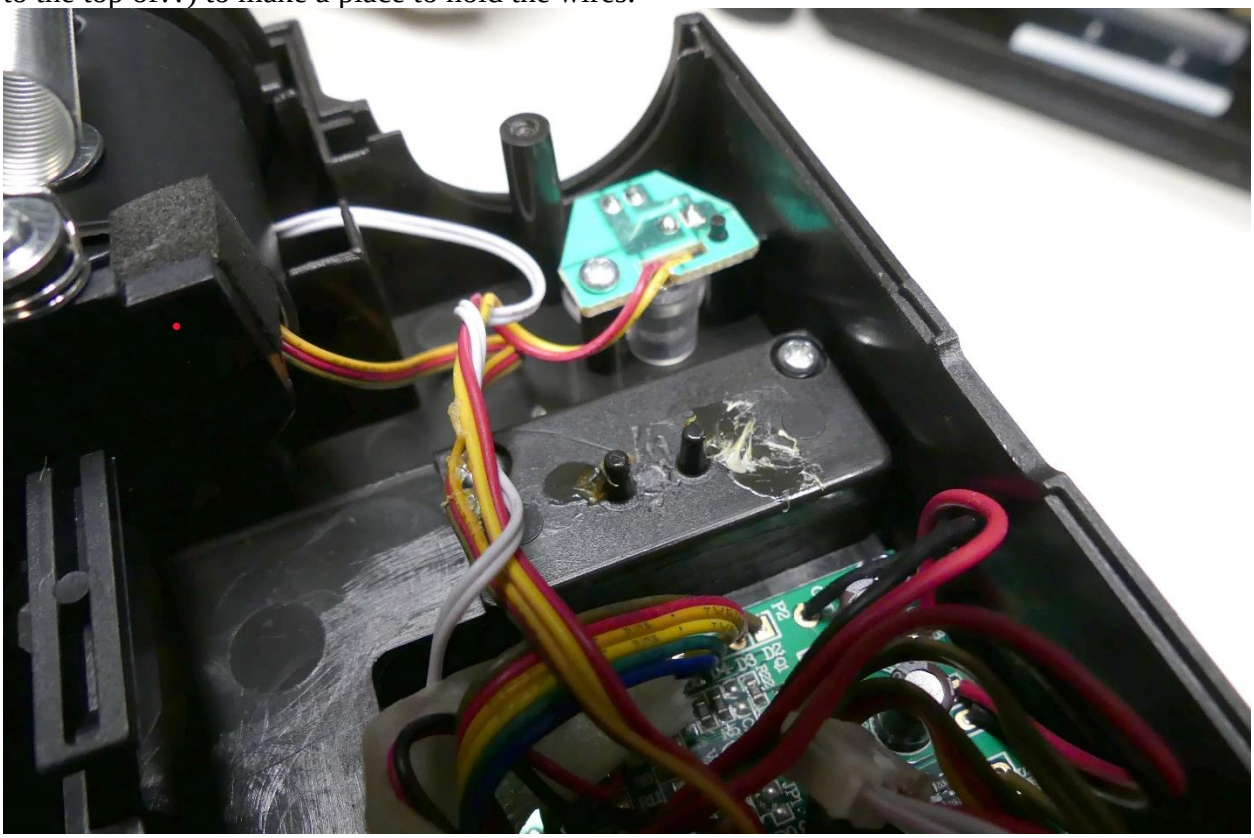


Peel off the white table and the wires should be exposed. They are glued down around (haphazardly!) under the tape, so just take your time and free the wires from the posts. Then remove the glue around the posts. A small flat screwdriver or your favorite dental pick both work well at removing the sticky stuff.

Here is the first pass at clean up (I later went in and removed more of that glue):



I then removed the center of the three posts (why are there three posts that they glued the wires to the top of??) to make a place to hold the wires:



Two remove the center post, I just used needle nose pliers and grabbed the center post as close to the base as possible and then rocked it to the side and it came off easily.

The 1984 wand is a little different, so needs a different mounting bracket. Both brackets use the same mounting holes and cover the wires and the molded in posts.

Soldering the Spengler Cable to the original electronics circuit board

In this step you will solder the Spengler Link cable to the original electronics board so the Spengler link can see what is happening and either supply or receive power.

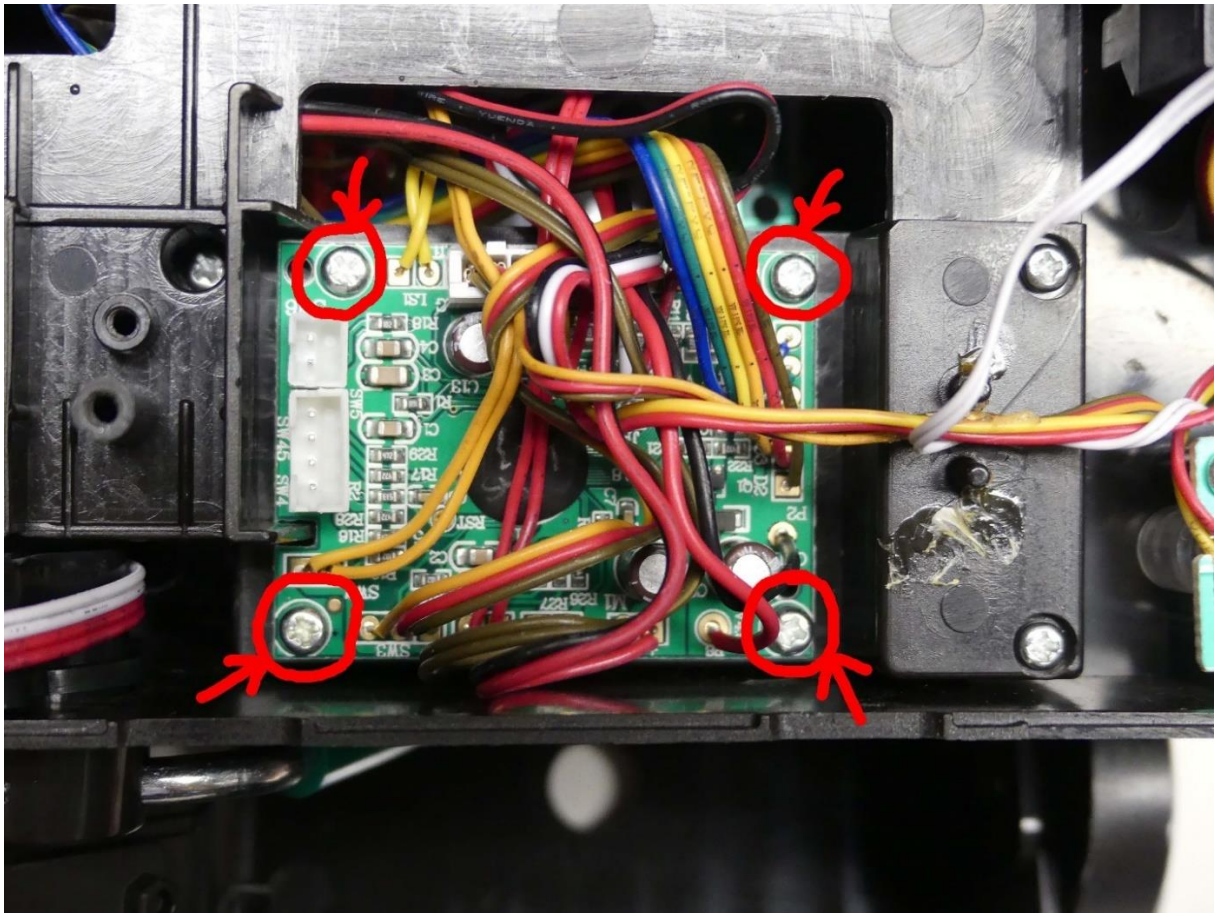
Tools Needed:

- Small-medium Philips head screwdriver
- Soldering iron and solder
- Wire cutters (diagonal or flush)

Parts needed

- 2 resistors, #6
- Heat shrink #12
- 8-wire cable #4
- 2-wire cable #5

Remove the four screws that are holding the original electronics circuit board in place:



Keep these four screws since you will be needing them to hold this board in place after the soldering has been completed.

*** Optional Improvement with V2.0 of the Spengler Link board ***

The KeepAlive function when the rumble motor running was dependent on the position of the top rotary dial: If the dial was in one of the “detent” positions, the KeepAlive worked fine. If the dial was in-between detent positions, the switch would short out the connections and the wand would not be kept alive with the rumble motor going.

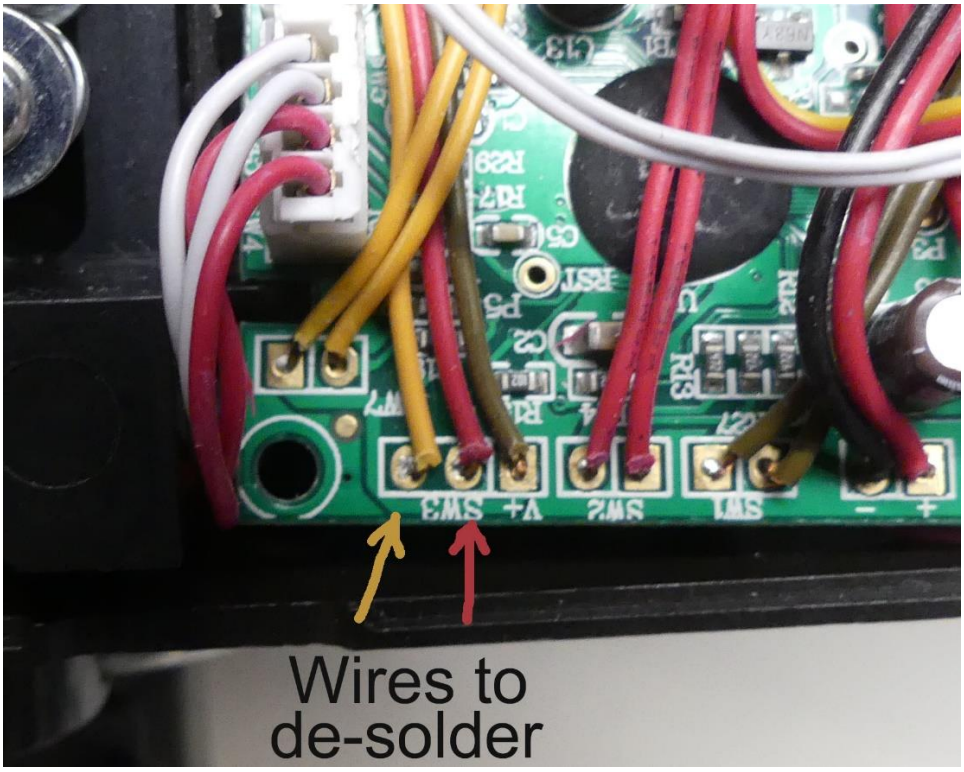
To make this more robust, the V2.0 of the board is designed to drive the output differently and relies on the addition of two external components between the wires and the original circuit board to work effectively. This involves the two 51K ohm resistors (#6) and heat shrink tubing (#12) to cover the connections.

This step is ***_optional_***, so is not required. If not installed, the KeepAlive will be sensitive to the top dial position. If these parts are installed, the KeepAlive should work without regard to the wand’s top dial position.

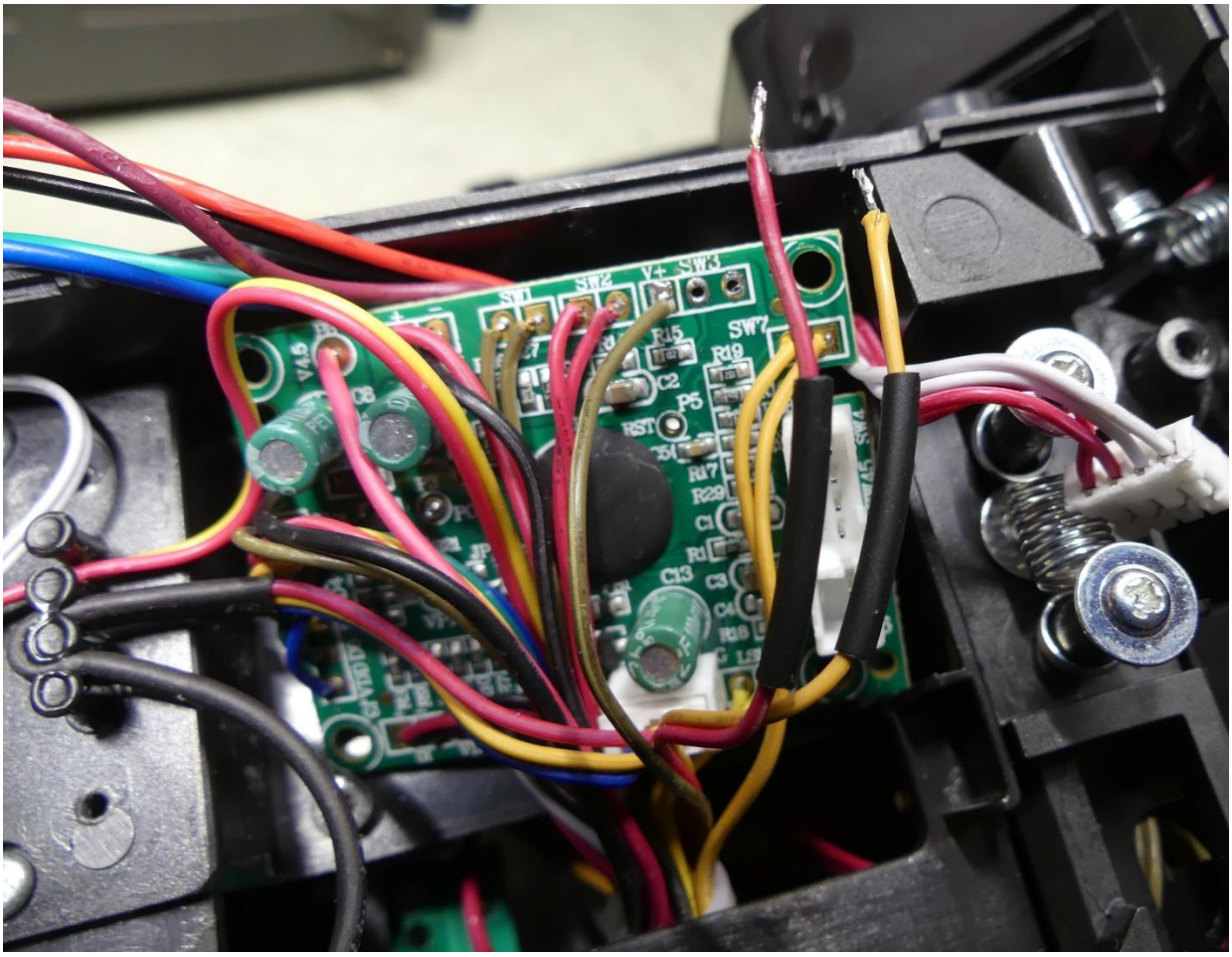
Installation of the upgraded parts (#6 and #12)

Two wires that go between the top dial knob sensor and the original circuit board need to be separated from the original circuit board. These are part of 3 wires that are together and connect to “V+ and SW3. Only the two wires labeled “SW3” need to be disconnected. They are the YELLOW and RED wires and order does matter or else the switch will be reversed.

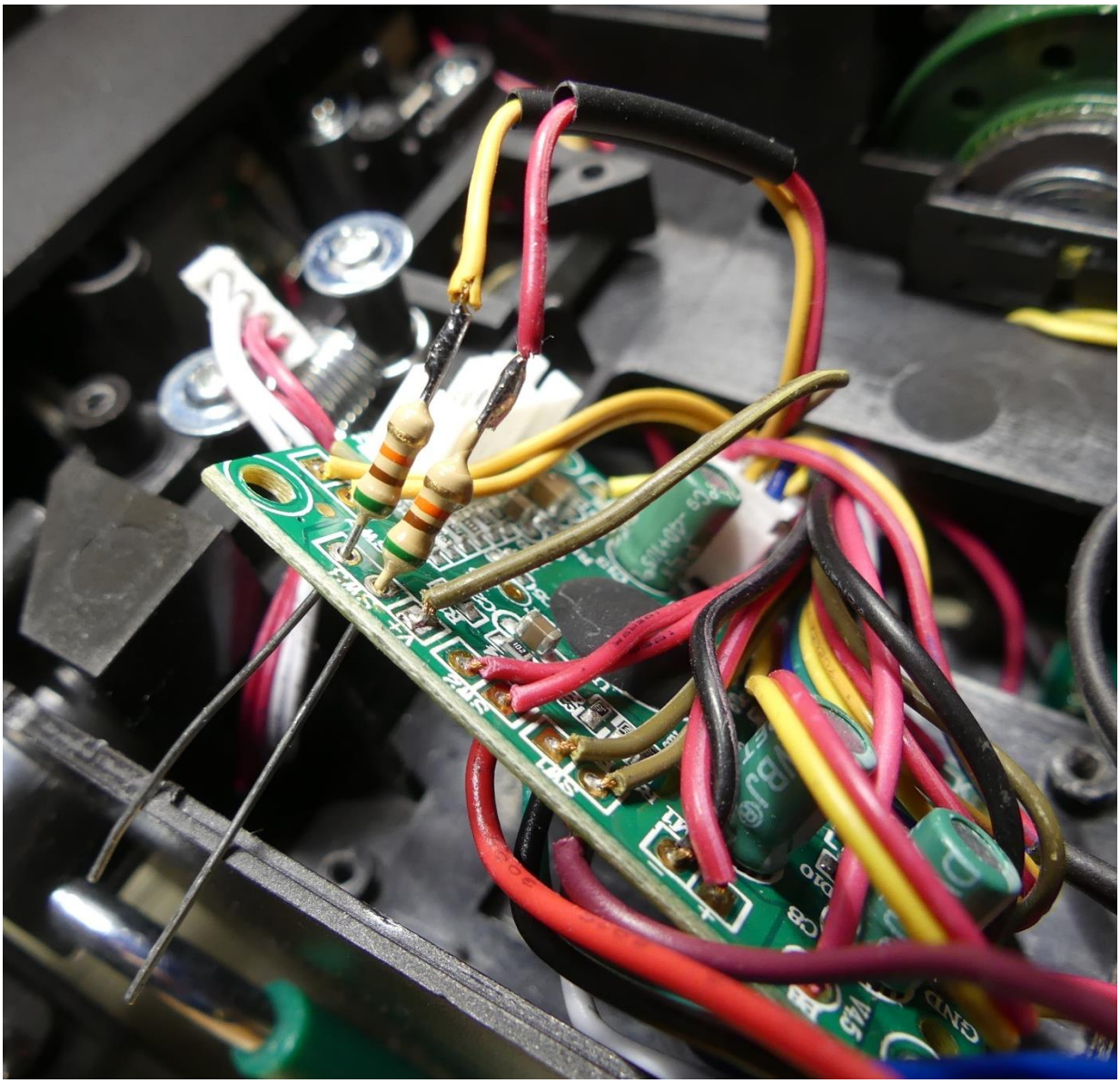
The SW3 YELLOW wire is closest to the corner of the circuit board.
The SW3 RED wire is next to the BROWN wire that is connected to “V+”



Desolder the wires from the original circuit board and clean up the circuit board pads/holes. Then cut the heat shrink tubing in half and slip one piece over each wire:

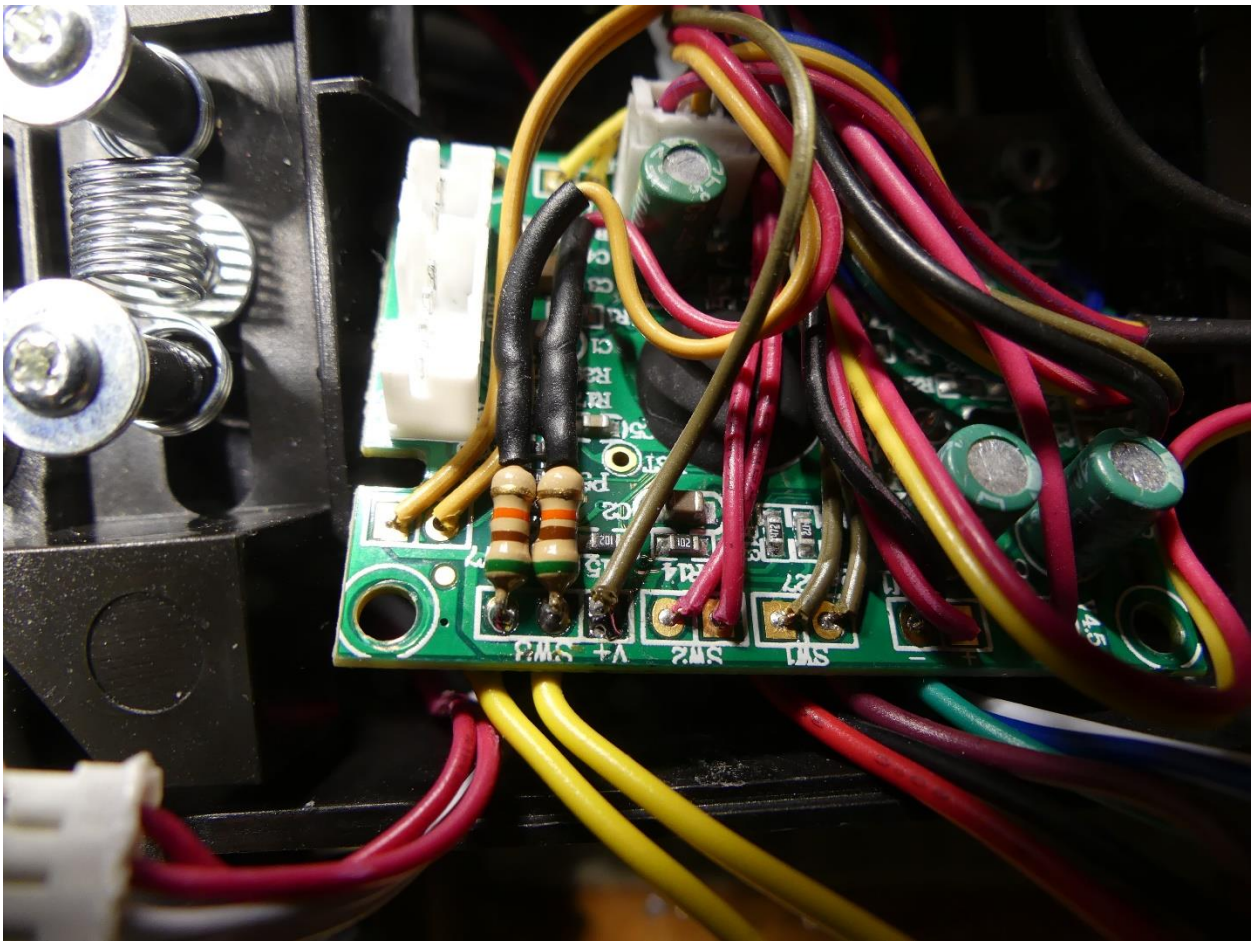


Next cut one side of the resistor leads to about 3/16” long and solder one to each end of the wires’ exposed ends:



The other ends of the resistors are placed in the holes, but not yet soldered in place.

Next slide the heat-shrink over the soldered portion and carefully use a heat source to shrink the tubing. Take care not to melt any of the wand or other nearby wires. You may need to remove the resistors from the holes on the circuit board to get the heat-shrink tubing farther away from wires and other meltable items!



After the heat shrinking is completed, solder the resistor on the bottom side of the circuit board and trim the excess leads that are sticking way out on the bottom side of the board. The resistor attached to the YELLOW wire goes in the SW3 hole that is closest to the corner of the circuit board. The resistor attached to the RED wire goes to the SW3 hole that is next to the "V+" connection

Then bend them over and dress the wires so they will not interfere with any of the following steps.

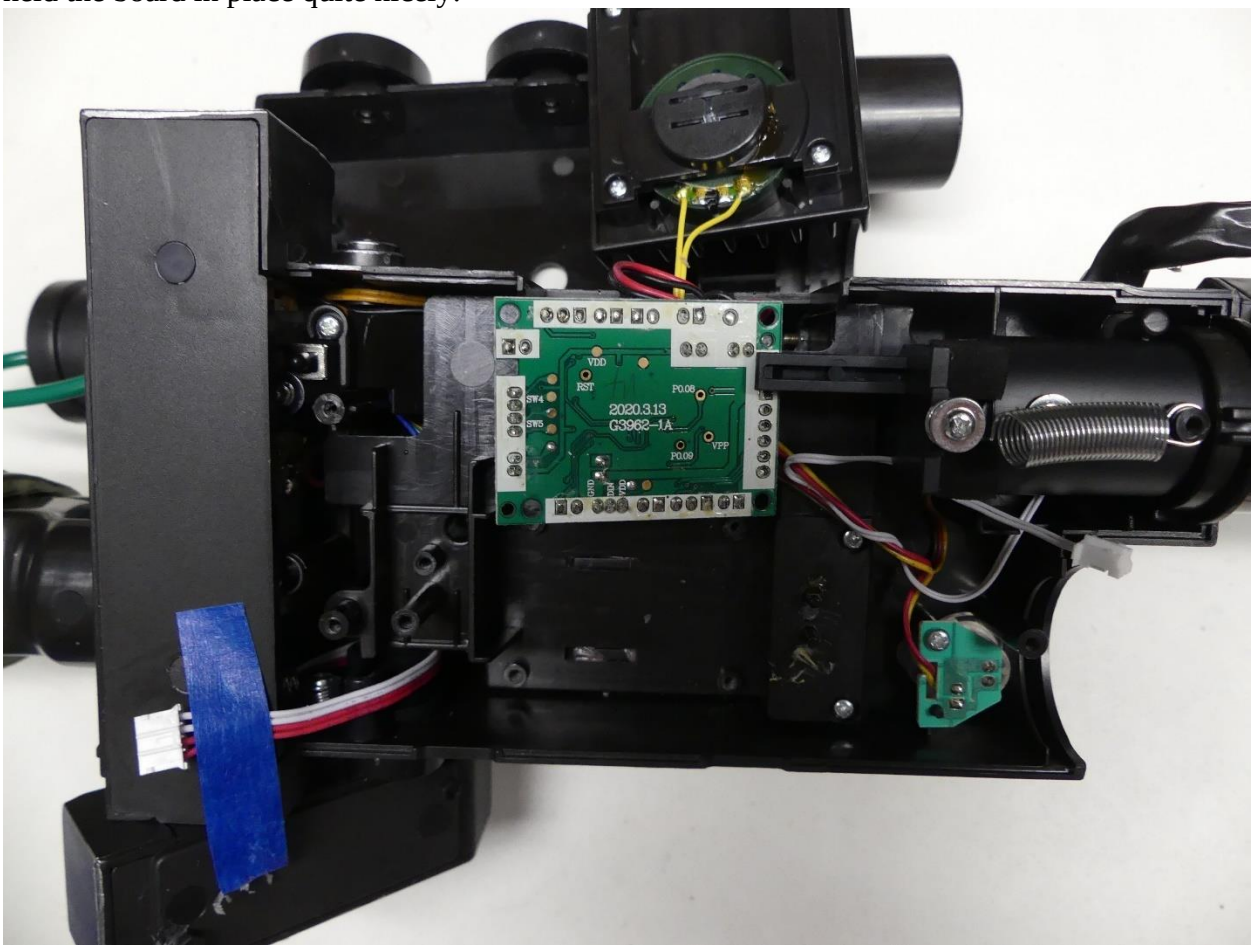
This photo was taken after I attached the 8-wire and 2-wire cables to the back side of the board – which we will do in the next step.

*** End of Optional Improvement for V2.0 of the board ***

Cables #4 and #5 Installation:

For attaching cables #4 and #5, I lifted and pulled out the heat sink with the attached speaker to perform the soldering. Take care not to pull on the speaker wires.

Lift up slightly and flip the board over in a position that will allow soldering to the bottom of this circuit board. You may want to remove the tape and make sure not to pull too much on any of the whiles while repositioning the board. The end of the lathing mechanism on the wand tube held the board in place quite nicely:



All 8 wires of the cable #2 will be attached to different locations on this board.

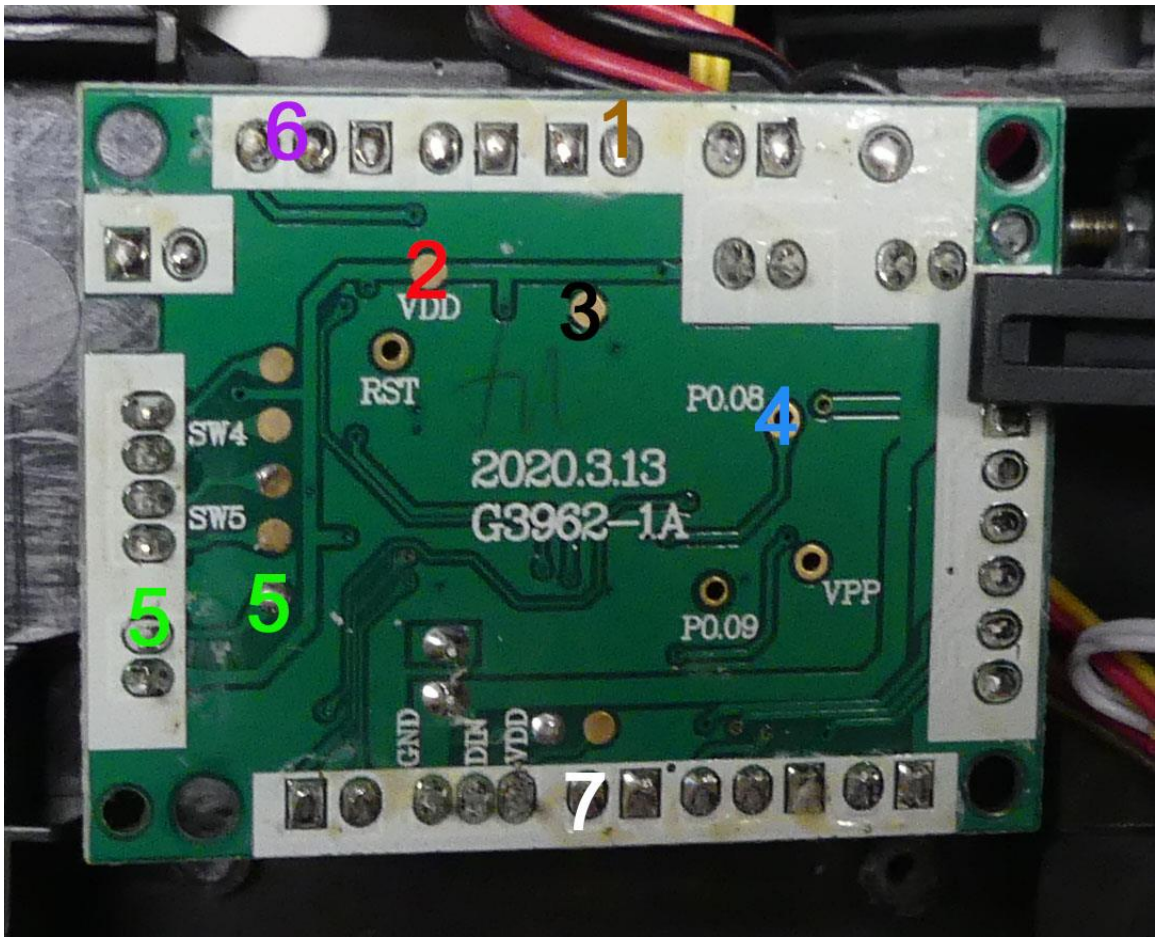
When soldering, tin the wires (even though they are already tinned) and the pad to be soldered to prior to making the connection. Having the same solder on each will make it easier for the soldering process.

Also note:

- Do not overheat the wire as it can melt the insulation
- Keep the tinned end of the wire short enough not to stick out of the solder pad area and onto an adjacent pad or wire end (use a flush or diagonal wire cutter)
- Make sure the solder does not bridge to an adjacent solder pad or wire

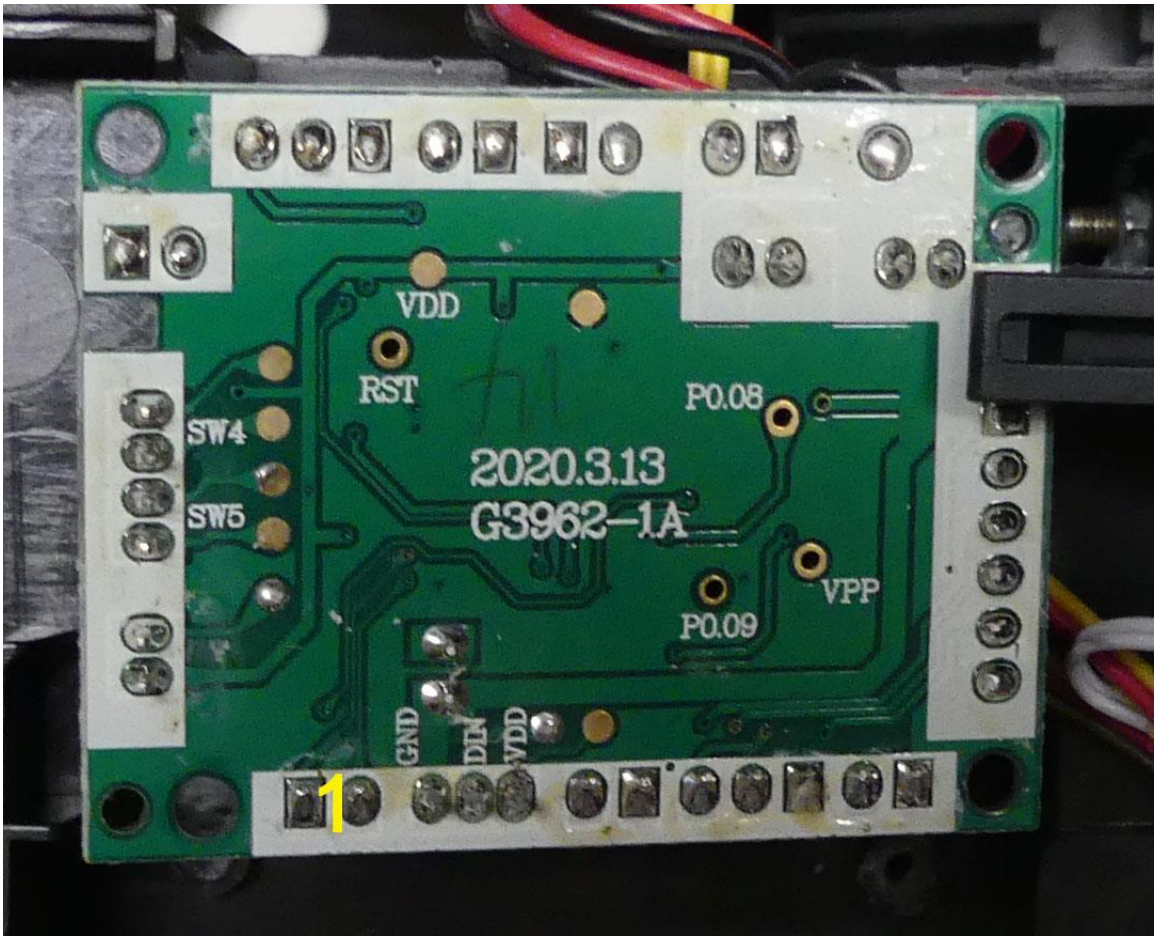
Recommended order of soldering for 8-wire cable #4:

1) BROWN wire, top of the board, 4th pad in from the right
2) RED wire, upper middle left on a gold pad labeled “VDD”
   Pre tin the gold solder pad for easier attachment of the wire.
3) BLACK wire to a gold pad to the right of where you soldered the red wire
   Pre tin the gold solder pad for easier attachment of the wire.
4) BLUE wire to the open pad that is to the right of the black wire marked “P0.08”. The blue wire may be able to be inserted into the hole and then soldered or just soldered to the surface like the previous wires. If you stick it through the hole, take care that it does not protrude out the other side and touch some other wire. It will get hot enough to melt insulation on some other wire if it is touching. If it sticks out too far on the other side it could also be bent over and make electrical contact with something it shouldn’t, so be sure and cut off any excess amount of tinned wire that sticks out.
5) GREEN wire left side of the board, the second pad from the bottom, OR the gold pad to the right and slightly higher than the pad on the left edge of the board.
6) 2x PURPLE wires, top of the board, leftmost two pads
   Order does not matter, just one purple wire to each of the two pads. Make sure they are not shorted together. Same pads as the added resistors #6 were installed.
7) WHITE wire, bottom of board, the 6th pad from the left.

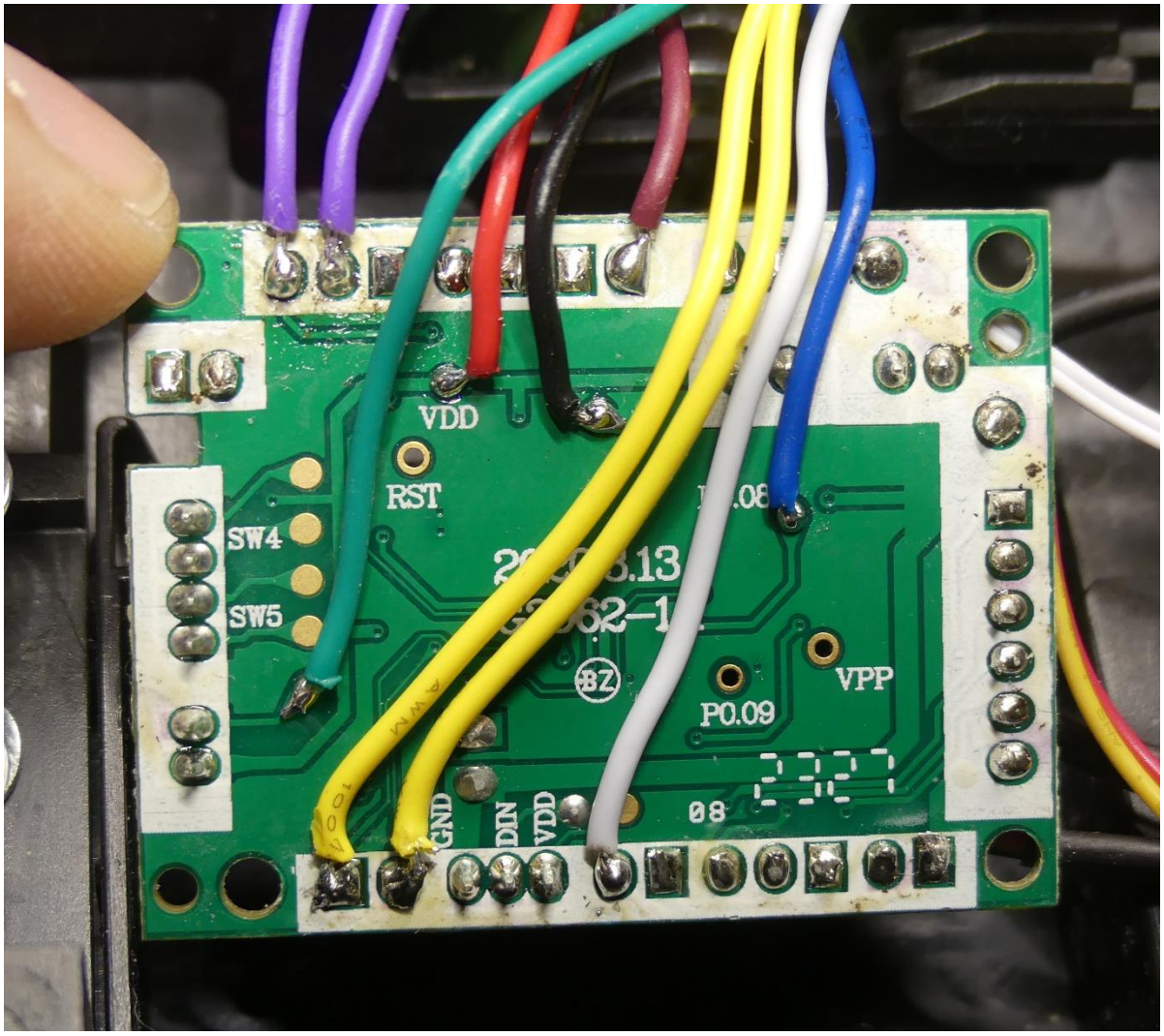


Placement of wires for cable #5:

1) 2x YELLOW wires, bottom of the board, leftmost two pads
   Order does not matter, just one yellow wire to each of the two pads. Make sure they are not shorted together.



Here is a picture of the finished board still in the soldering position:

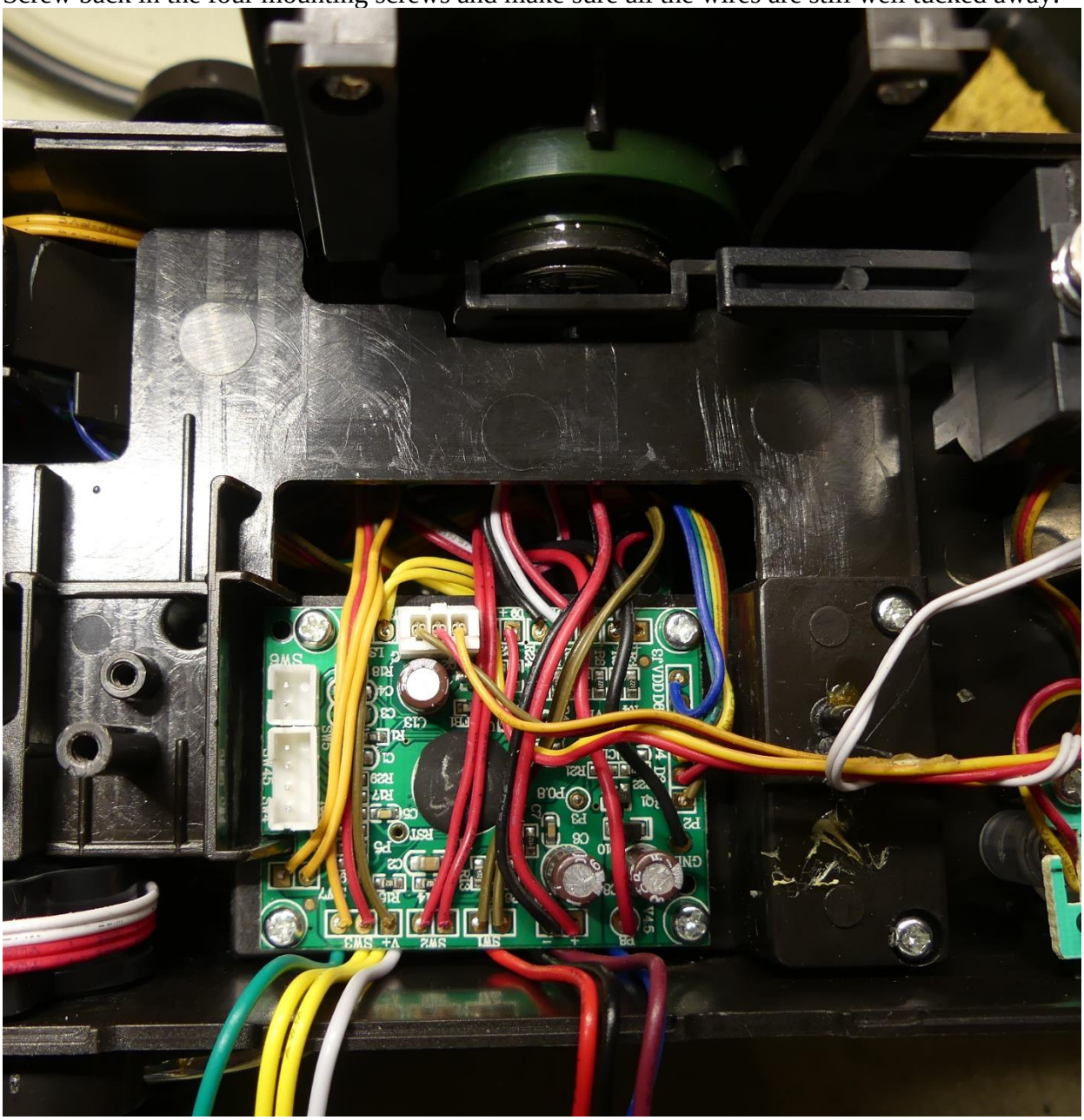


Make sure the wires all reach the upper edge of the board and stay flat against the board. Try to order the wires so there are no overlapping wires that will get squished when we mount the board.

Once the wires look good, carefully flip the board over and place it back where it used to be mounted. Fold the new wires out of the way and see if you can dress the remaining wires so that none will stick up and interfere with anything. Focus on keeping the original wires tucked under where the tube slides in and out so they will not get caught in the moving tube mechanisms.

You may want the heat sink and speaker to be out of the wand while you dress the wires, so you have more access to the wires. Once you have that done put the heat sink and speaker back in place and be careful not to trap any wires between the heat sink and the wand body.

Screw back in the four mounting screws and make sure all the wires are still well tucked away:



Recommended interim testing:

Put enough back together to be able to test that the wand still works as before:

1) Plug in the two original cables that were unplugged before (2 wire white and 4 wire red and white) back into the board,
2) put the batteries back in the wand and secure them,
3) you should be able to test the wand and make sure that everything works as before:
    a. Power up the wand (bottom face toggle switch, speaker makes sound and slo-blo LED comes on),
    b. make sure the vent light still works (top face toggle switch),
    c. activate the rumble motor (make sure motor works and the bar graph display),
    d. press the ear button to change to slime blower,
    e. fire to make sure the Wand tip and other LEDs are operating properly.
    f. Power the wand back down (bottom face toggle switch)

When done, remove the battery and unplug the 4 wire (Red and White) cable and tape it back out of the way for the next step. It should be fine to leave the 2-wire white cable plugged in to the board.

Installing the new cables

In this step you will solder the Spengler Link cable to the original electronics board so the Spengler link can see what is happening and either supply or receive power.

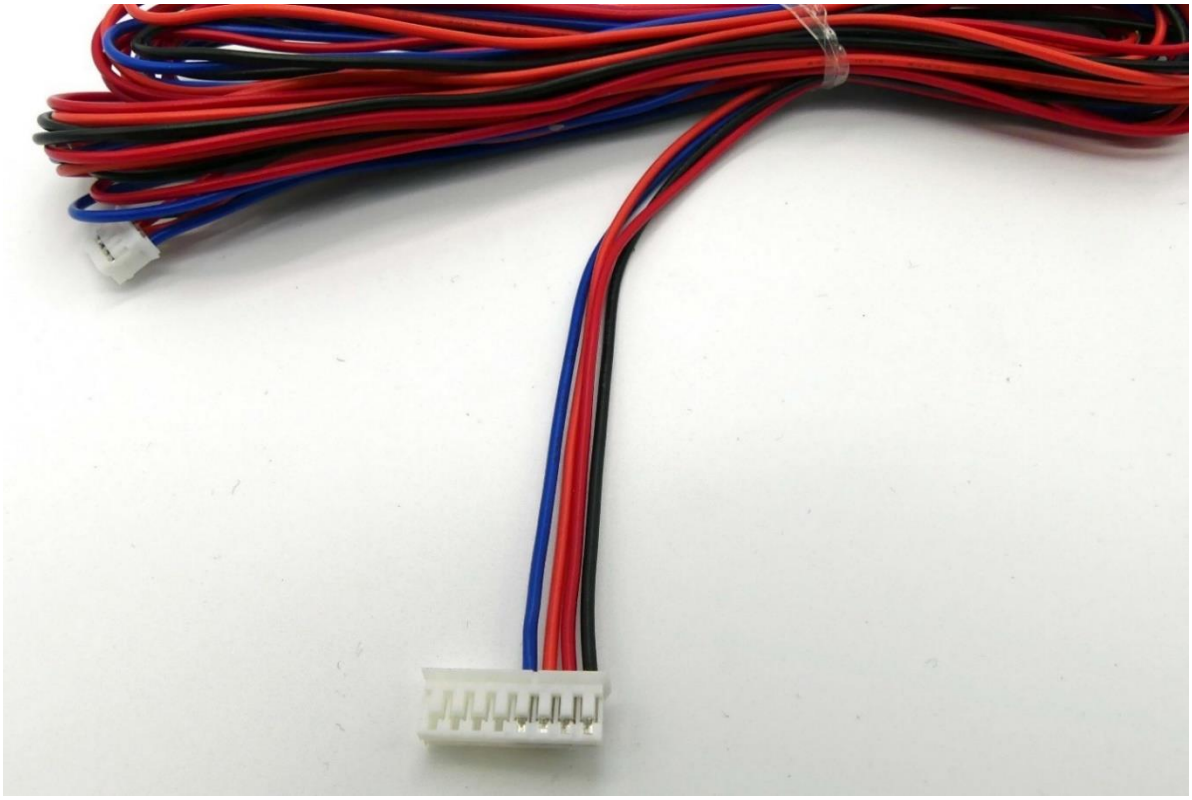
Tools Needed:

- Dental pick or jeweler's flat screwdriver
- Soldering iron and solder
- Wire cutters (diagonal or flush)
- Rotary grinding tool (or files)
- Small-medium Philips screwdriver
- Drill and drill bits (1/16", 3/16" and 15/64")

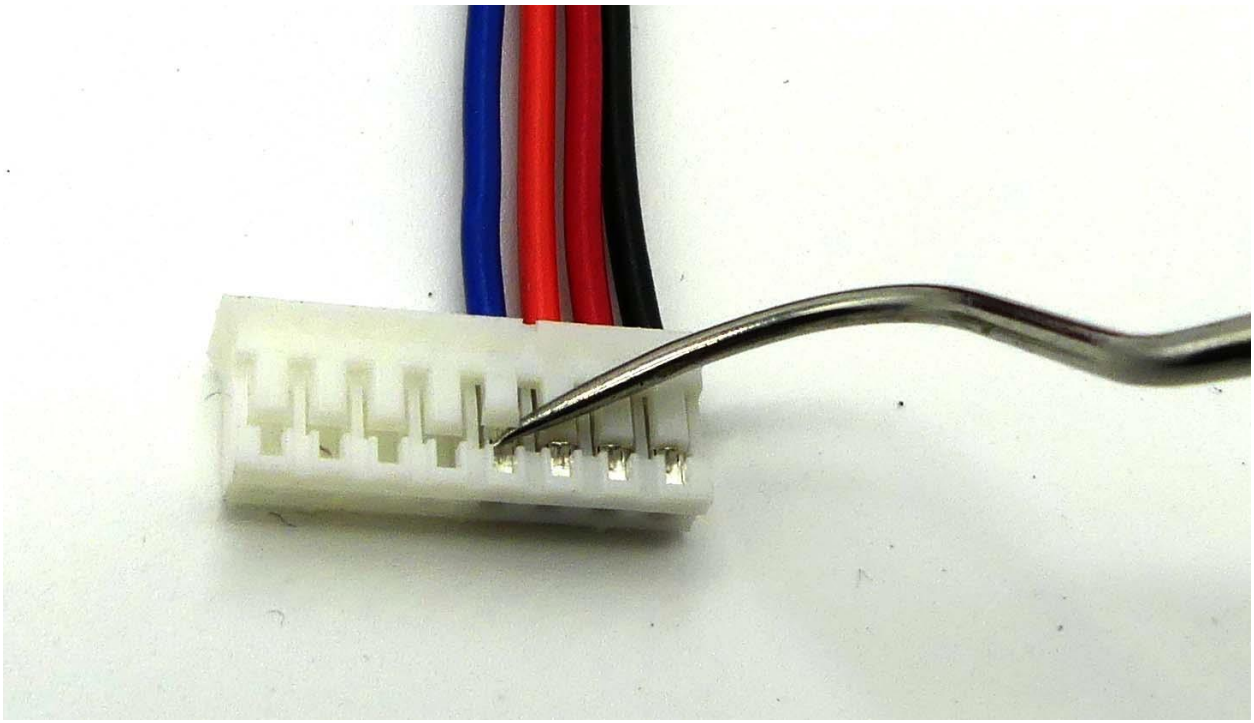
Parts needed

- 3-wire cable #3
- 4-wire cable #1, if planning on removing the wand batteries
- 3.5mm Jack #8
- Epoxy to connect the two end cap parts that are currently held by a screw

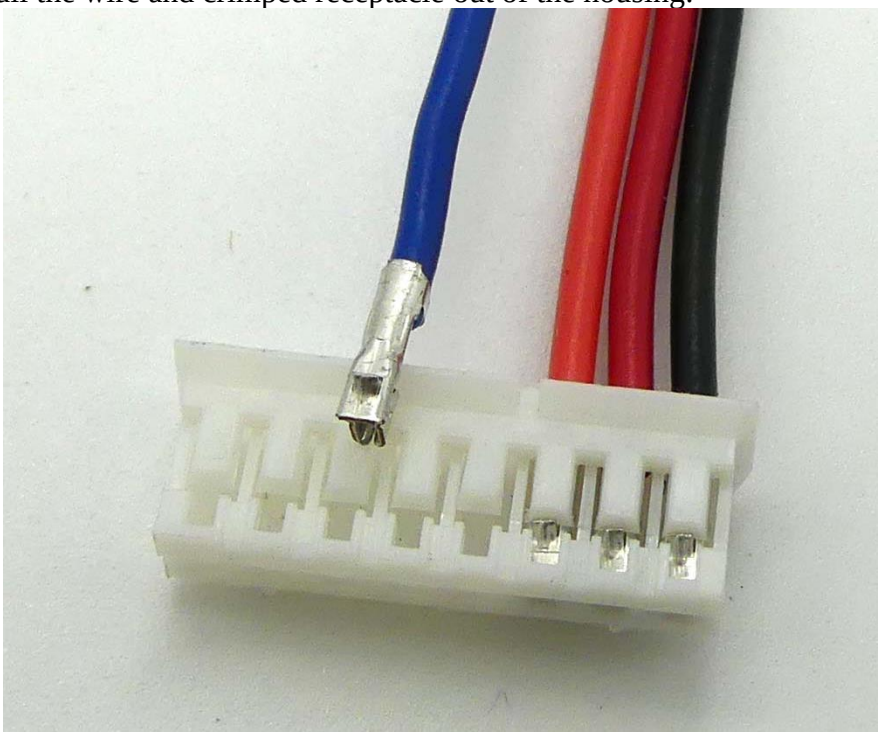
Cable prep for going down the rabbit hole
If you will be installing the 4-wire cable #1 That can be used to replace the batteries in the wand with power from your pack's battery, then you will need to remove and reattach the wide connector from the cable. It is just too big to fit down that hole you just drilled out.



With the dental pick or a small jewelers flat screwdriver, gently lift the tab a small amount to release the crimped-on connector for one wire at a time. Take great care not to bend the small tab too much in any direction as it can break and then the connector housing may no longer be useful.

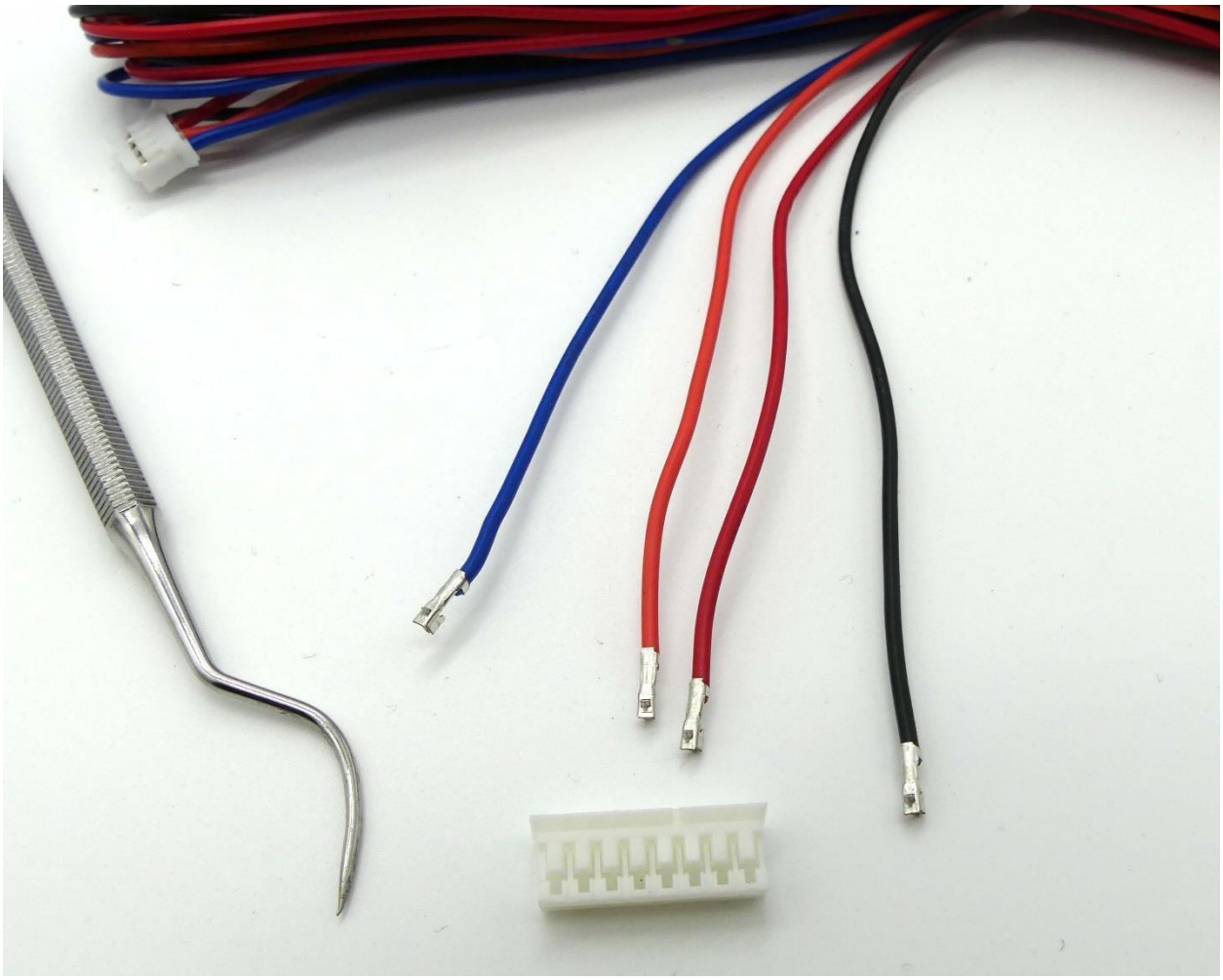


Then gently pull the wire and crimped receptacle out of the housing:

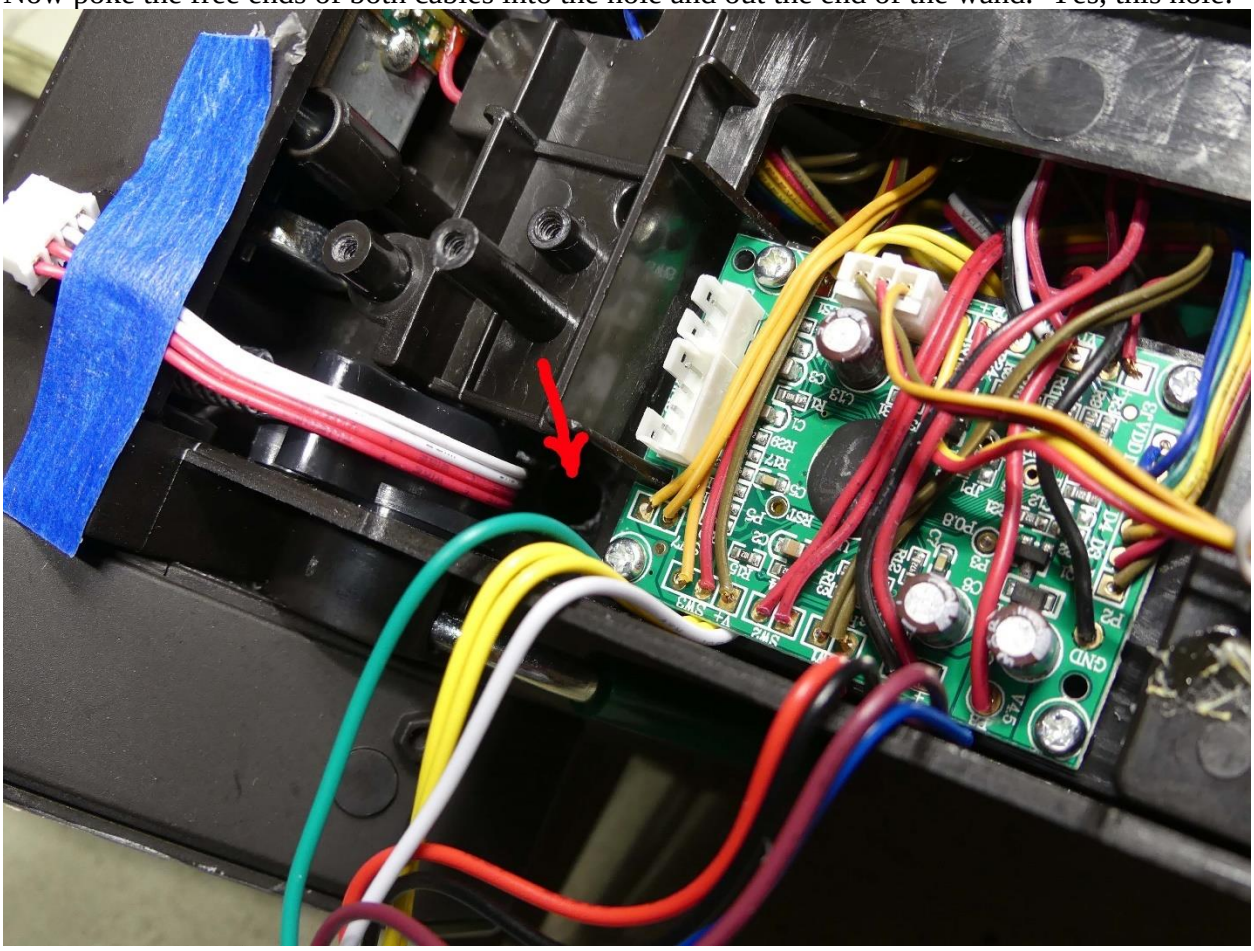


Yes, the order does matter when putting it back together, but that is why there are pictures of it here, so you do not have to write down the order.

Do this to free the remaining 3 wires. You will need to keep the wire housing and reattach after the cables have been threaded, so don't lose it!



Now poke the free ends of both cables into the hole and out the end of the wand. Yes, this hole:

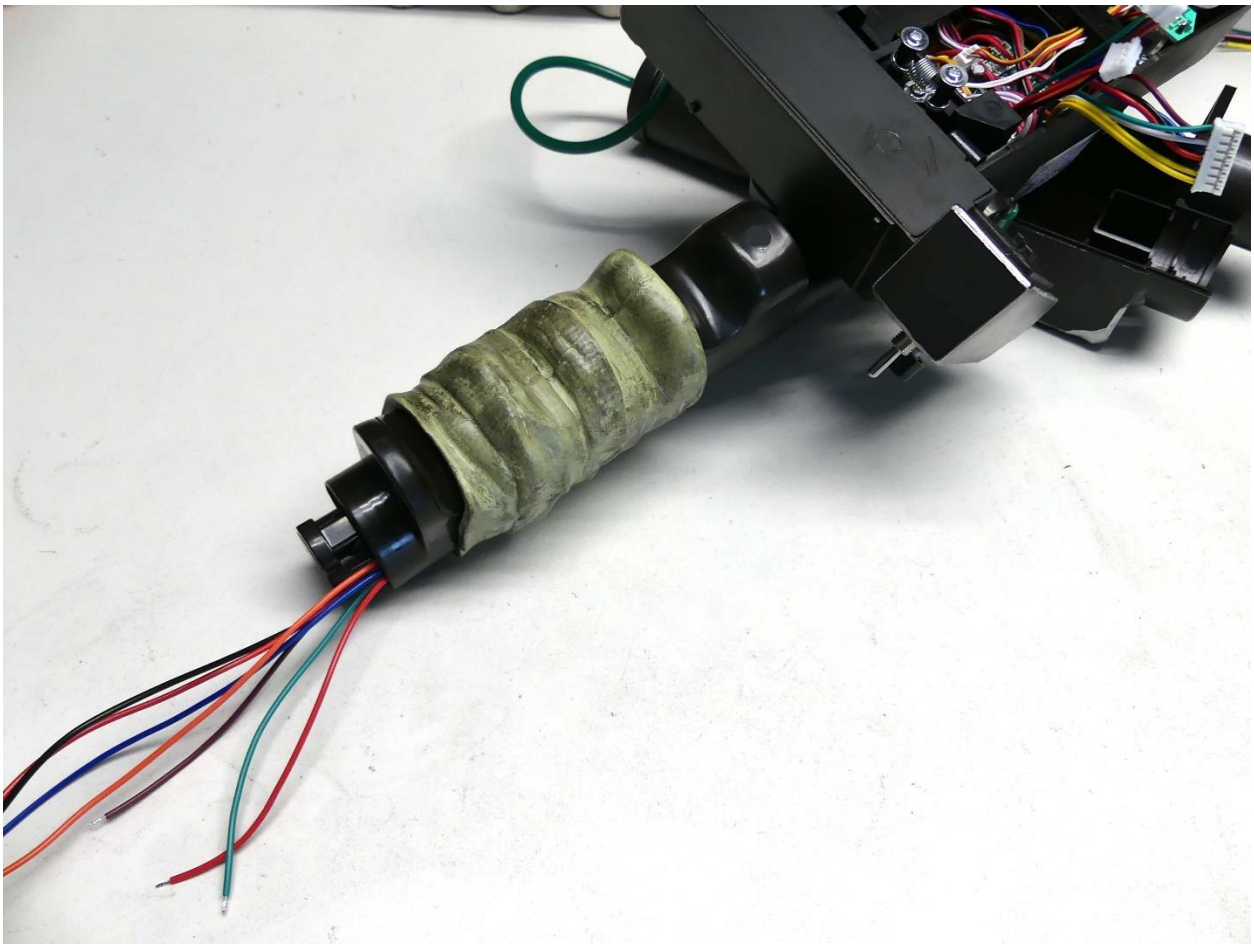


I did the 4-wire cable 1 or 2 wires at a time and first since the crimped-on ends are larger than the bare wires. Next, I pushed all 3 wires of the 3-wire cable at one time.

Make sure the wires are straight before inserting.

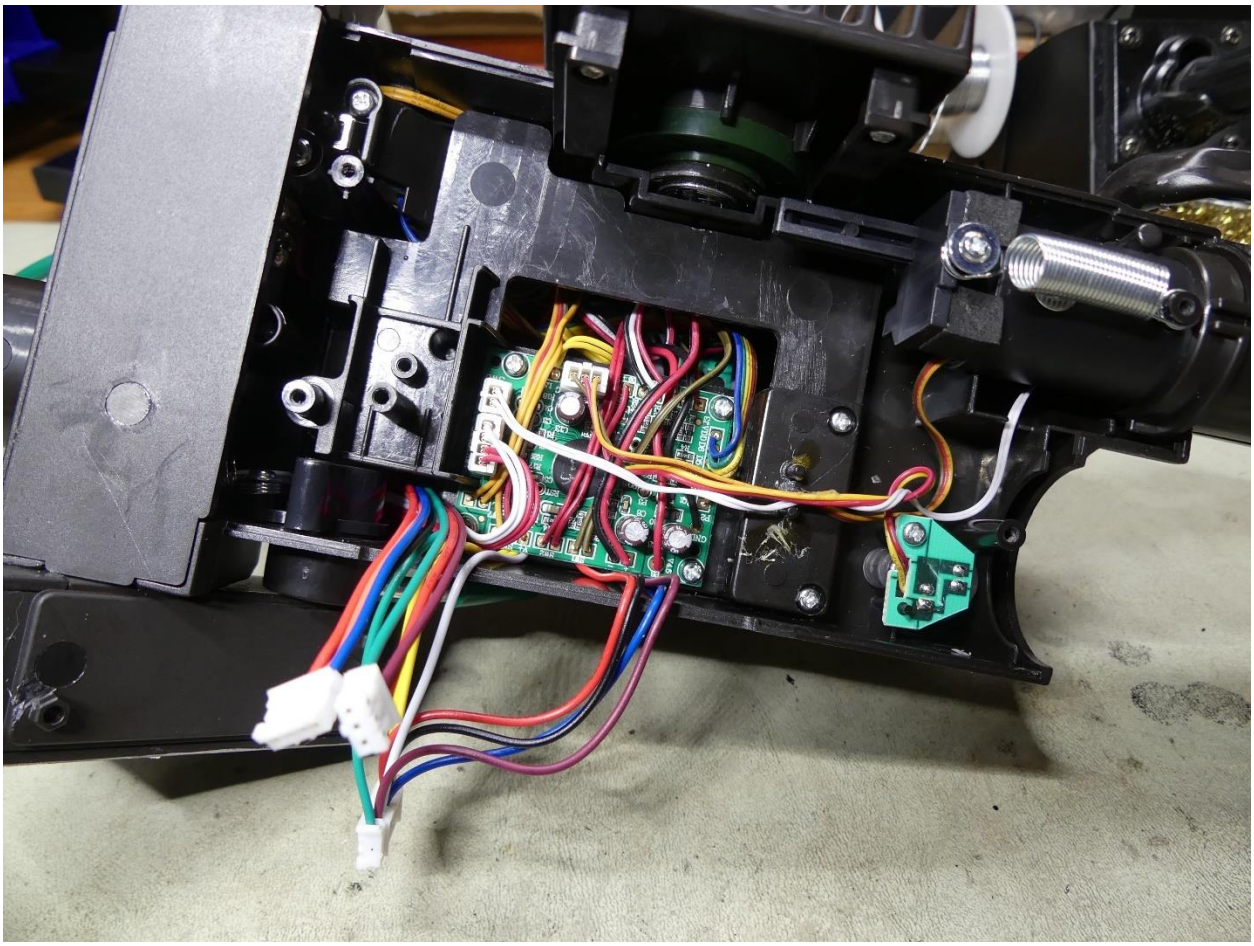
The ends of the wires sometime get stuck very close to the end of the handle tube, I just used a flashlight to see in there and then move the wire a bit with my finger and then it came out. You could do something more elaborate (fish tape, etc.) but I didn't find it necessary.

Pull the wires almost all the way through leaving just a bit of the wire back inside the wand. Don’t sweat it though, the connectors will stop you from pulling the wire all the way through.



In the above image I slid the battery in just to see if all the wires would fit along with the battery. They fit fine on the side of the battery. This is not needed since if you plan on using the battery you only need to install the 3-wire cable since the 4-wire cable is used to replace the battery.

You can now plug the original two cables back into the circuit board: the 2-wire (White) and 4-wire (Red and white) cables.



Prepare the handle end caps

This will show how to mod both the flat end cap to hold the 3.5mm stereo jack and the hose connector that can either hold the single connector or opened up to be able to let the connector and cables pass through it.

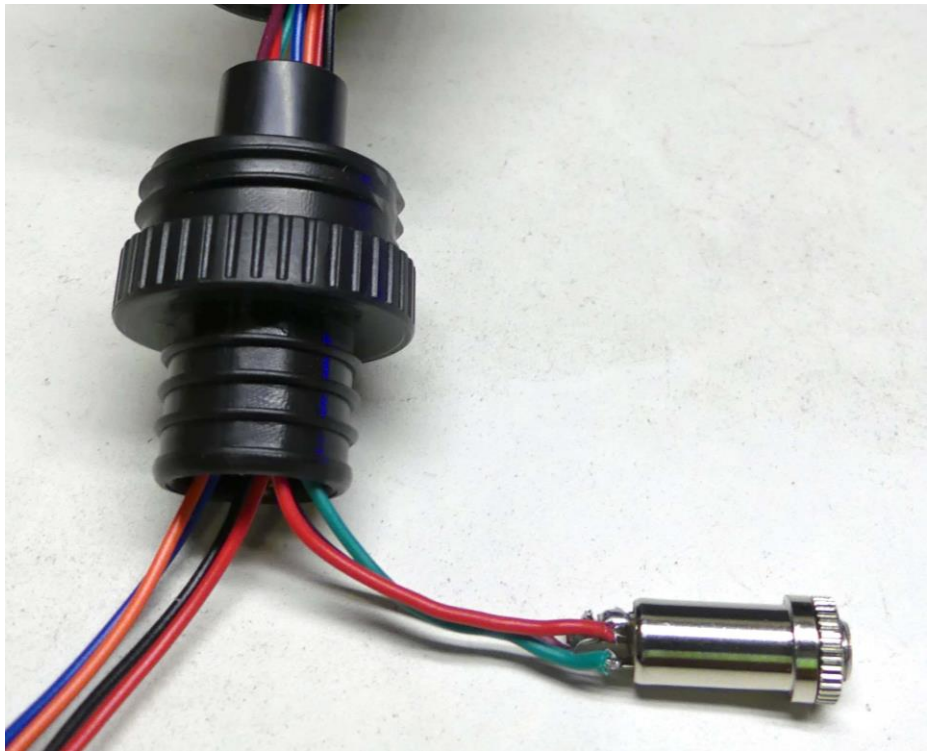




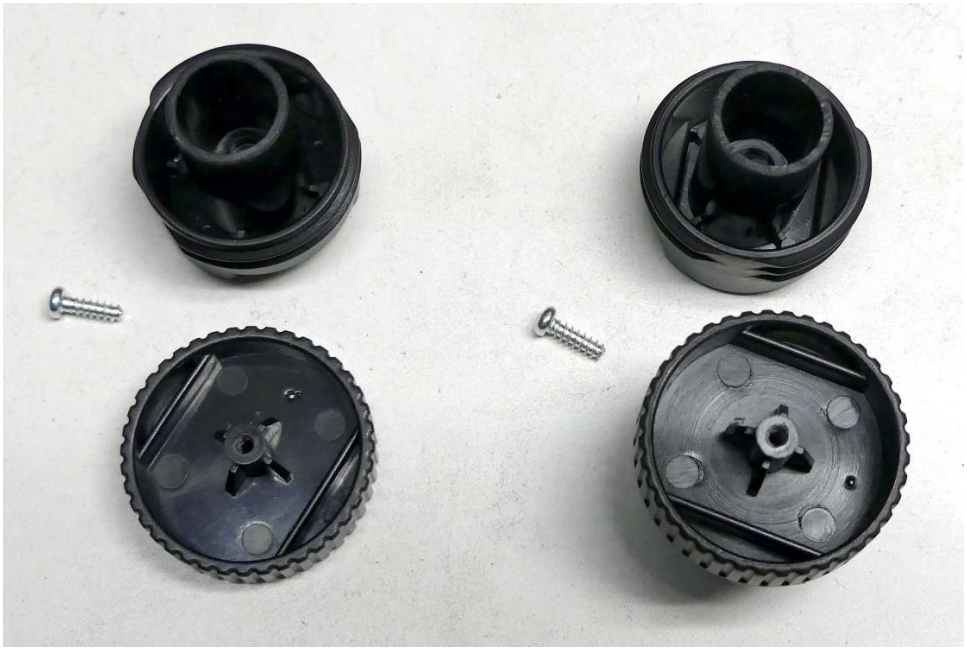
The goal is to have end caps that look like this:



Or this:



Start by removing the center screw and separate the end caps into two pieces. We are not going to use these screws again but keep them just in case. Hoarder instinct kicking in!



Before we get to grinding, first drill a hole through the screw post so we know where the center of the cap is. After we grind the post away it makes it easy to get a hole in the center!
Use a 1/16” drill bit since it will easily fit inside the post hole. After drilling, I flipped this around to show where the hole will end up:



Next, it's grinding time!



Here are the bits I used:

#2 is for initial removal of a lot of material. Actually, only a little at a time so as not to heat up the rest of the plastic too much and have it deformed. Remove a little, let it cool down, remove any globs of material, then repeat.

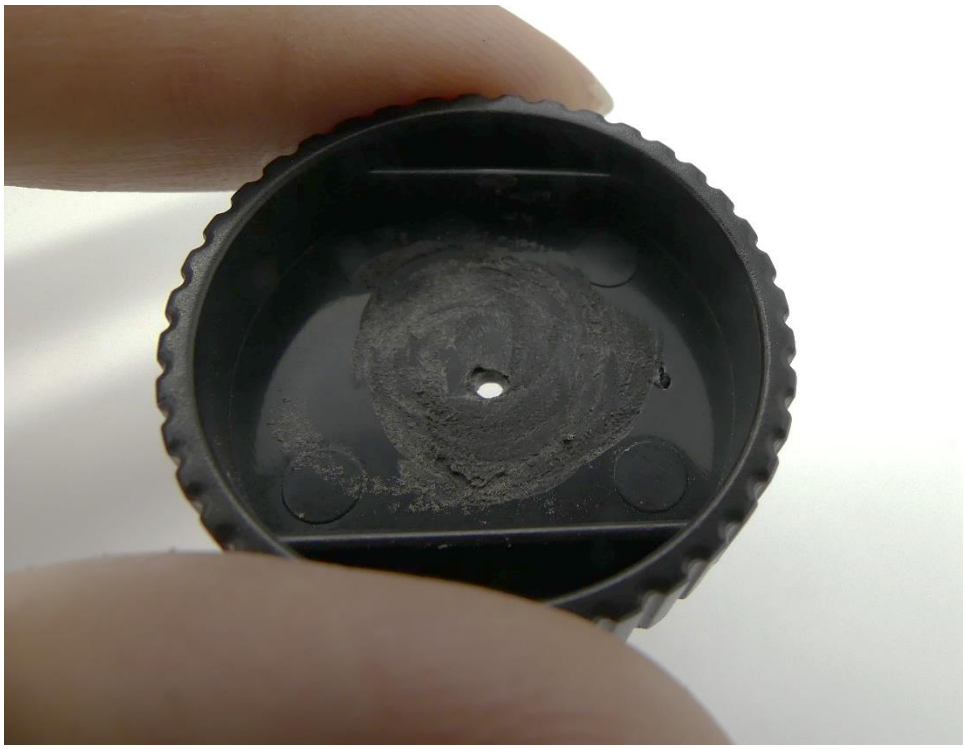
#1 is for cleaning up the last ridges to make a flat surface.

#3 is used for opening a larger hole and then making it even wider. Also, to remove a lot of material like for leaving room to connect wires to the 3.5mm Jack.

Using the #2 grinding wheel remove most of the screw mounting post:



Next use the #1 grinding wheel to flatten out the surface:



Do this for both outsides of the end caps you intend to use.

For either (or both) end caps that your wand will use, just the 3.5mm stereo audio jack for, you need to drill a hole to allow the jack to screw into that end. Use a drill with a 15/64” bit to fit the 3.5mm stereo audio jack #8.

Compare your bit size next to the threaded portion of the jack. You do NOT want a hole that is too large as that will be a pain to fix!



Test fit the jack into the part that was just drilled.

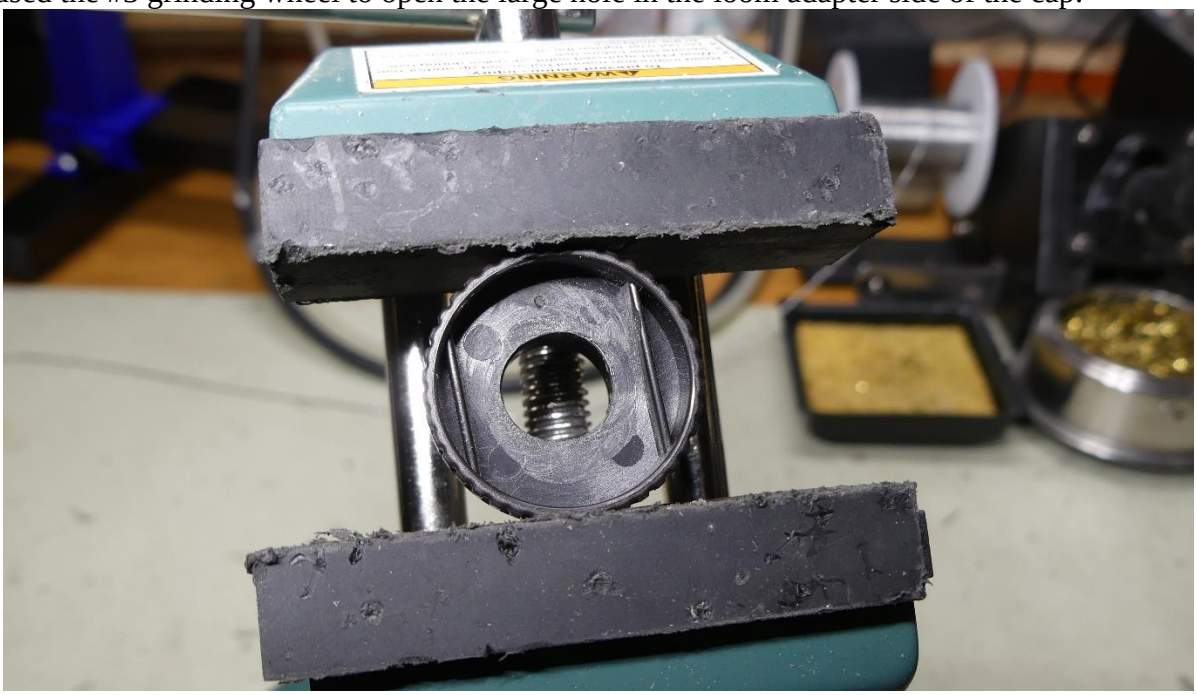




If you are just going to mount the 3.5mm stereo audio jack, make a 15/64” hole like for the flat end cap shown previously.

If you plan on passing the jack and 4 wires through the loom adapter end cap (the part that the loom attaches to and is on the outside of the wand when screwed in), a much larger hole is needed.

I used the #3 grinding wheel to open the large hole in the loom adapter side of the cap:





The inside portion of each cap needs some significant material removal to make room for the jack and wires. The same modification is needed independent of what you chose to do for the outside portion of the cap.

Starting with this:



Then using the #3 grinder (smaller diameter than the main inset so we do not damage the inset area) make it look like this:



If you are going to use a battery, then we want the other end of these pieces to have a way to let the wires out, but still hold the battery. More Grinding!

I start by making a 3/16” hole in the end about where the bottom of the opening should be:



Then using the grinding wheel #3, make a nice opening without sharp edges:

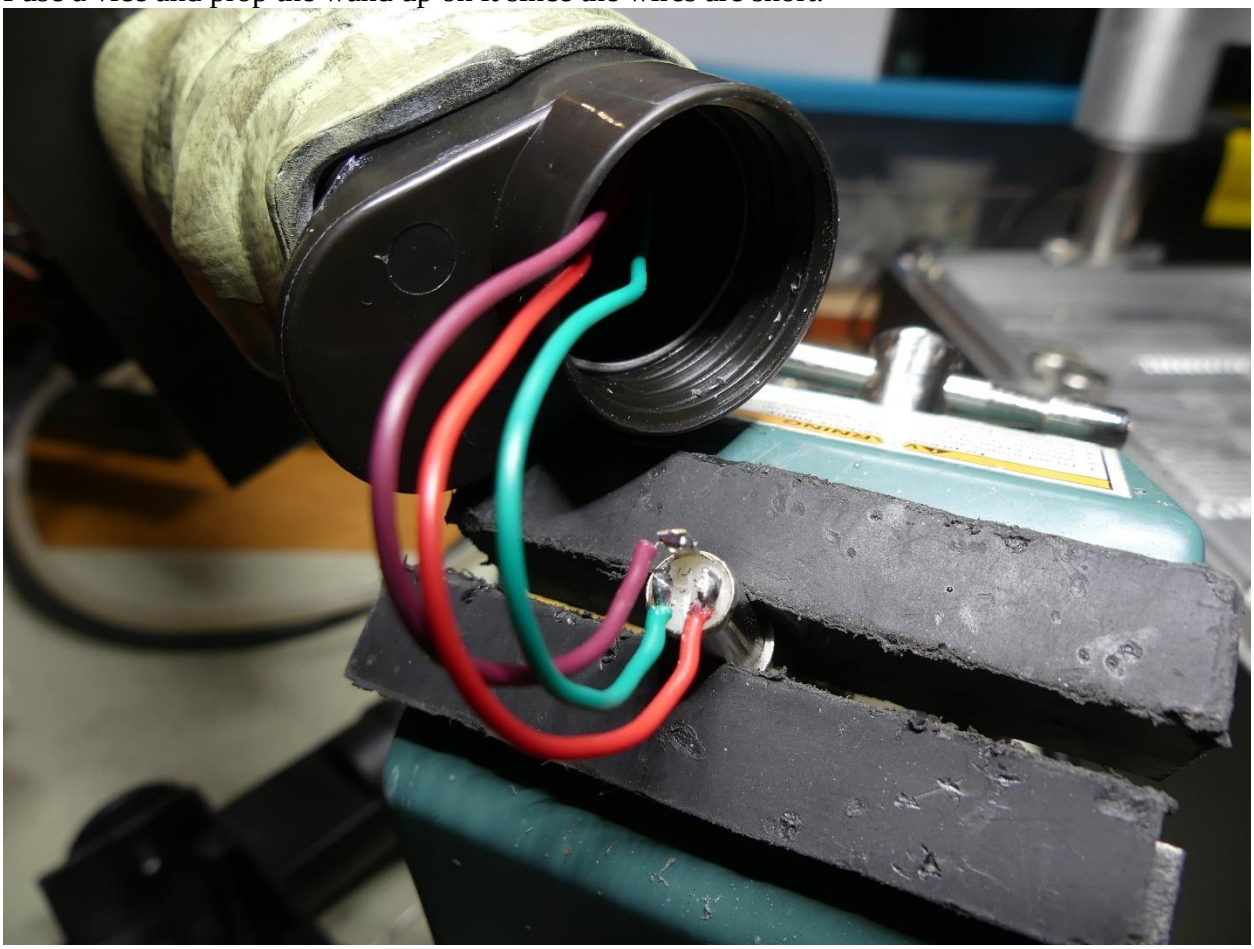


Test fit the parts together (with the 3.5mm audio jack if it is mounted) and make sure there are no fit problems. After we finish the connectors the two pieces will have to be permanently glued together since we removed the screw that was holding the two pieces together!

Soldering (and maybe some Heat Shrinking)!

The three wires from the cable #3 need to connect to the 3.5mm stereo audio jack #8.

I use a vice and prop the wand up on it since the wires are short:



The wires are connected as follows:

1) BROWN wire to the larger flat tab on the jack
2) GREEN wire to the left (silver) connector with a hole
3) RED wire to the right (brass) connector with a hole

Be careful not to bridge any solder between the GREEN or RED solder locations and the main body of the connector since that would short the signal to the brown wire and will not work!

For a free hanging connection, cut the heat shrink into about ½" lengths for these three wires and the rest can be used on other connections, or spare if you want and slip over the wire before you solder. Also slide all three wires (and their heat shrink tubing) into the larger piece of heat

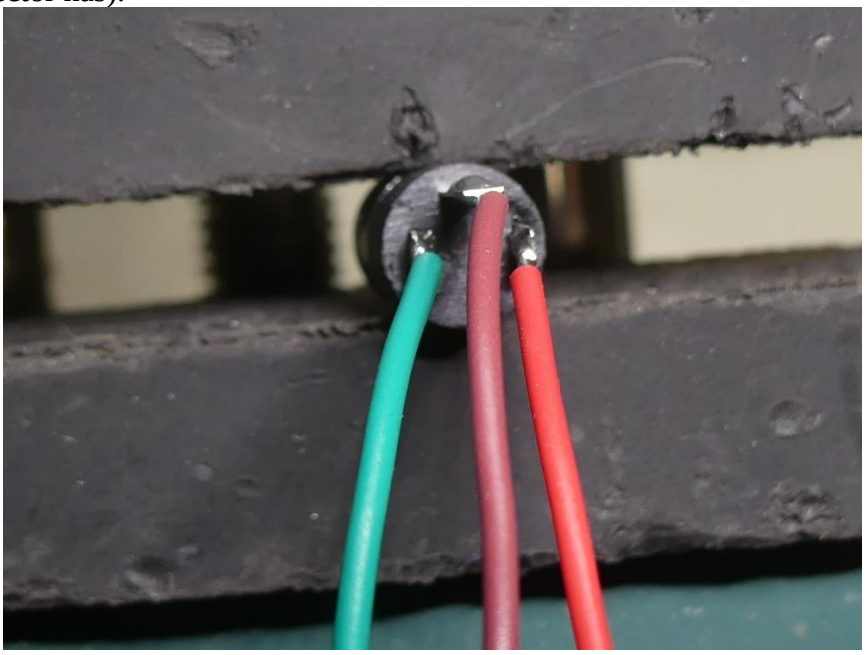
shrink tubing. (You can also use heat shrink on the mounted connector, but cut the heat shrink tubing shorter so the heat shrink does not extend past the end of the plastic cap when mounted)

You will also want to make sure the wire comes straight off the solder tabs, rather than at an angle like shown above when mounting in the end-cap. Still carefully examine to make sure no solder bridges down to the metal casing of the connector. After the three wires are soldered, slide the small heat shrink tubing down over the connection. Keep the larger heat shrink tubing out of the way so it does not shrink. Heat up just the 3 smaller heat shrink tubing coverings so they are secured and insulated by the small heat shrink tubing. Then slide the larger heat shrink tubing down over the wires and the body of the connector. This will hold the wires together and make the wire less prone to breaking.

Another style of connector may be included in your kit:



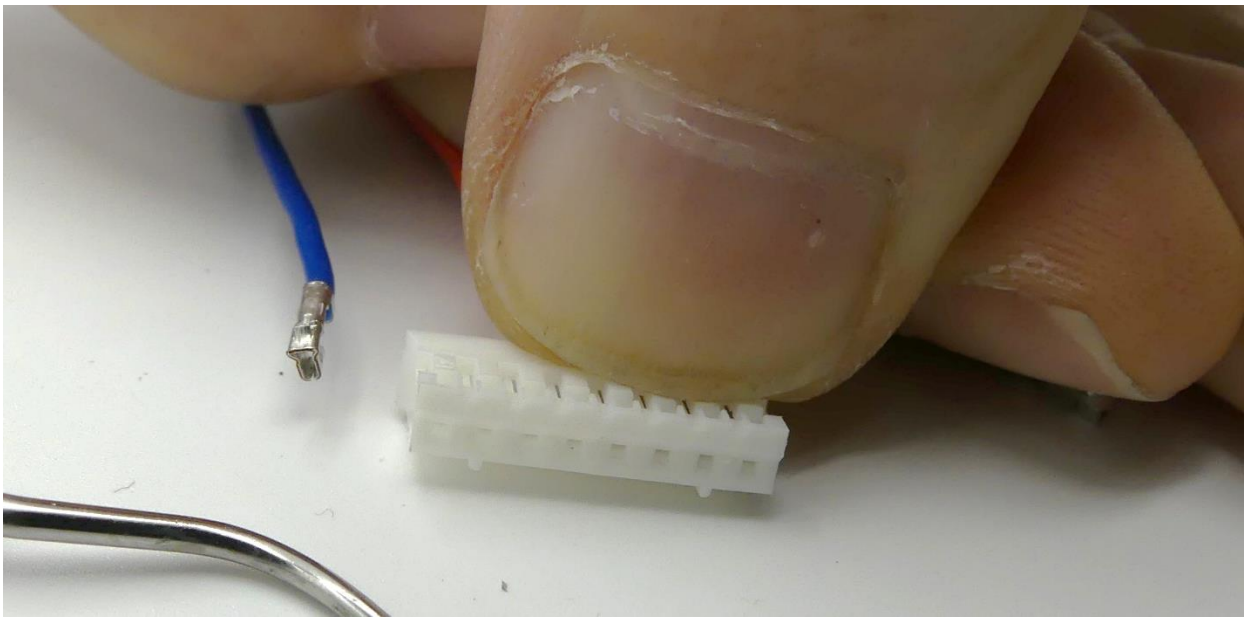
This connects the same way except that the tabs are all the same color (no brass-colored tab like the other connector has).



You can feed the wires through now and then glue the parts together, but if you made the holes larger enough (test it first!) you can glue the two pieces together and feed the wires through or mount the 3.5mm jack after they are glued together.

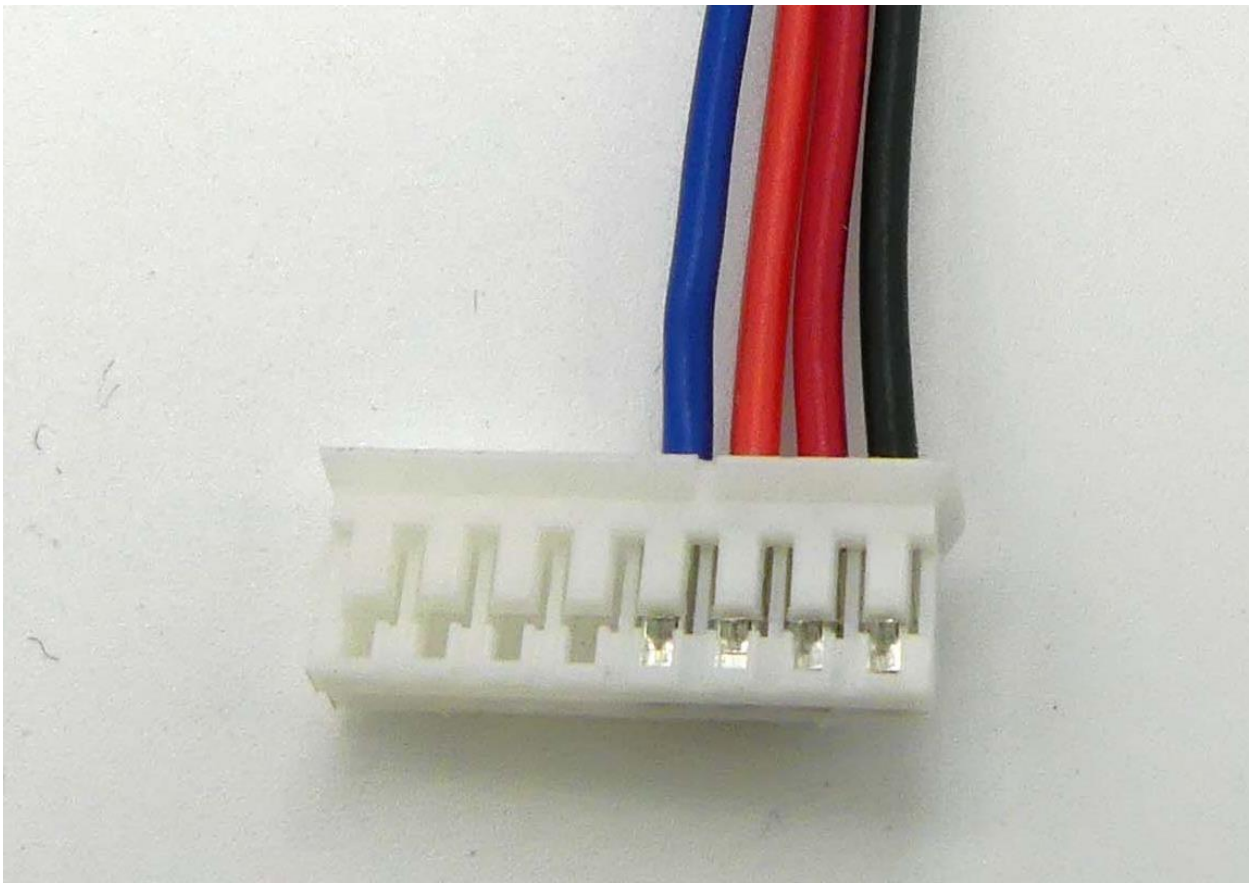
Feed the wires through and then lastly you need to put the connector back on the long 4-wire cable. Make sure the wires are fed through the endcap and connector in the correct direction since it will be a pain to swap later.

First make sure the tabs on the connector are flat (not sticking up) by pressing down on the tabs. Do not try and force the tabs inside the connector, just get them to at least be flat:



Then make sure the orientation is correct on the connector (tab side up) and that the crimped metal connector on the end of the wire is in the correct orientation (as shown above, the “flat” side with a small tab is facing up) and slide into the correct position in the connector. Then try to gently pull it out and that metal tab should catch on the plastic tab you fattened out so that the wire will not release from the connector.

You should end up with the wires in this order: BLUE, ORANGE, RED, BLACK
With the connector in this orientation: tabs face up as shown below.



You can tighten the nut on the 3.5mm stereo audio jack #8 with a set of needle nose pliers. Take care not to scratch the surface of the cap by first finger tightening the nut and then leaving a gap between the pliers and the surface before carefully tightening.

The cables and end caps should now look like this for the audio only connections:



And this for the dual audio and power connections:



Installing the Spengler Link Board (Finally!)

In this step you will install the Spengler Link board inside the wand.

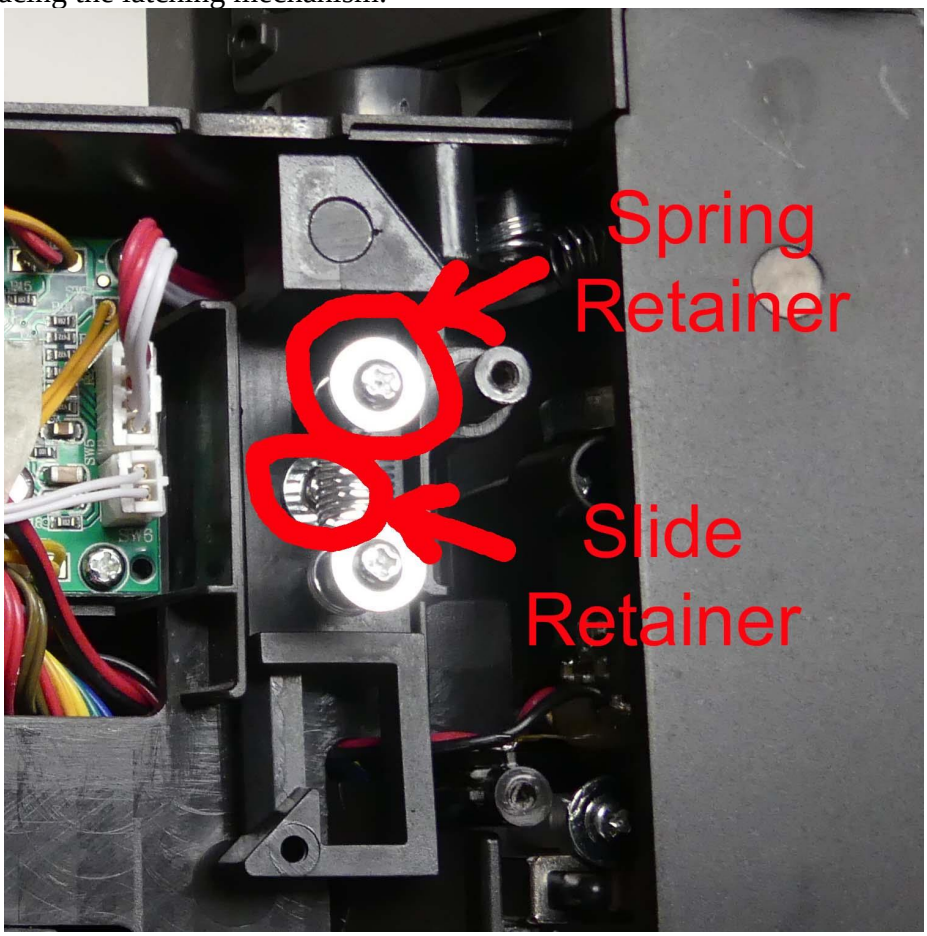
Tools Needed:

- 1/16” drill bit and drill
- Small-medium Philips screwdriver

Parts needed

- Mounting bracket Black #8 (Spengler) or Orange #7 (1984)
- Mounting screws #7 (two screws)
- Spengler Link board #4

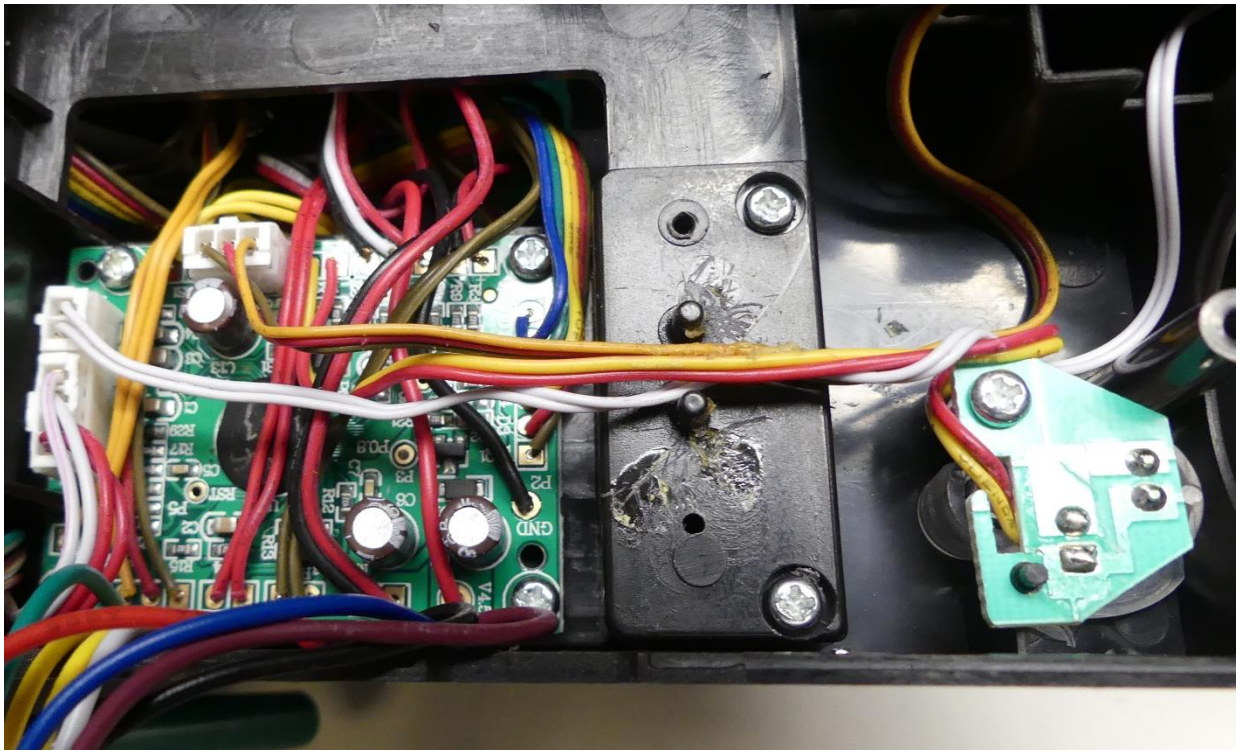
Start by replacing the latching mechanism.



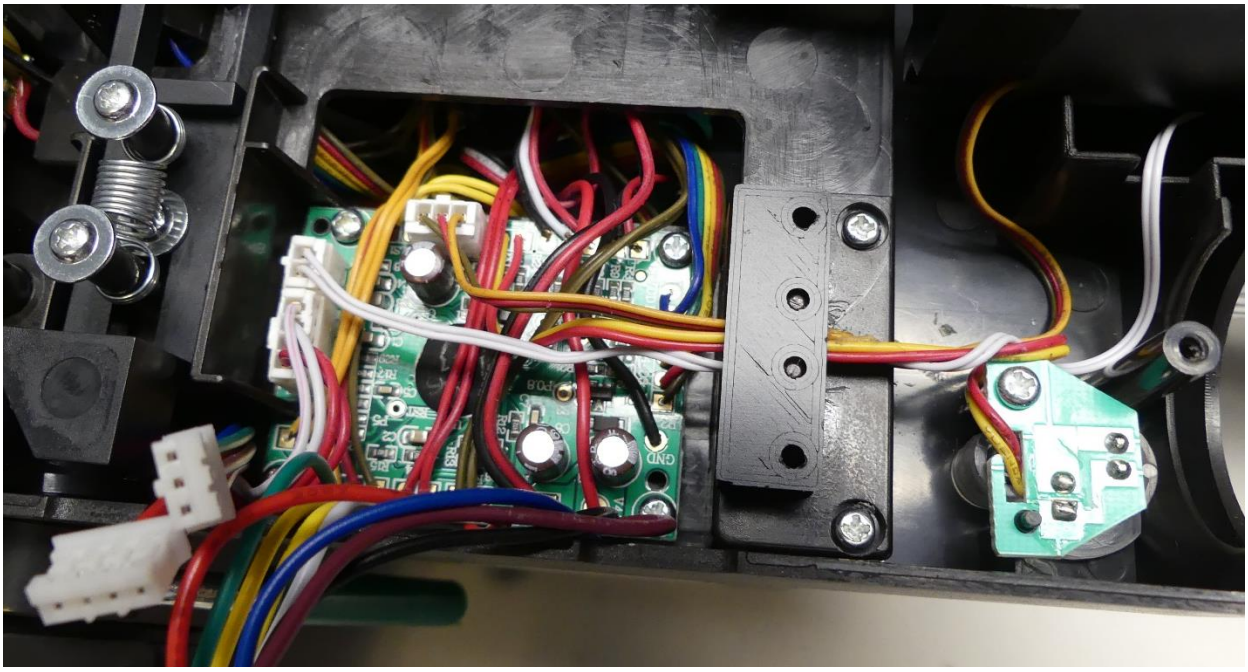
First slide the latching part with attached spring into place, then install the Slide Retainer screw (integrated washer) in the center position to hold the part to the wand. Tighten and the part should still slide freely.

Then slide the spring over the top post and put in the Spring Retainer screw to make sure the spring does not come off the post.

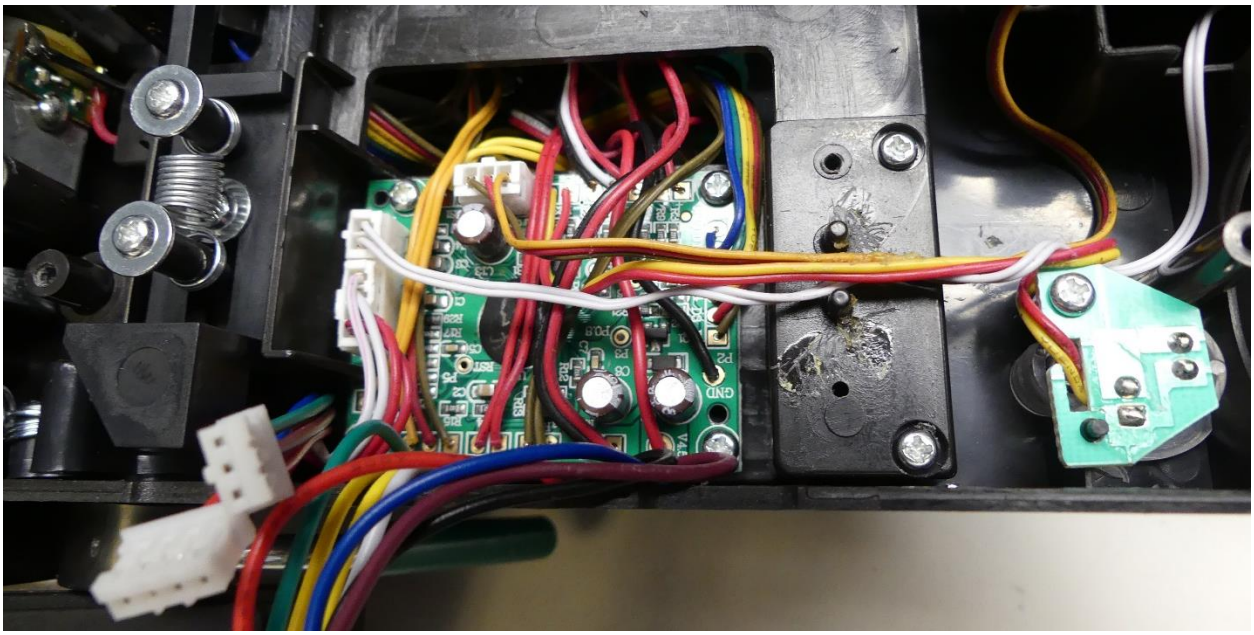
Next, place some wires in between the two posts:



Place the Spengler Link mounting bracket #6 over those wires and posts for a test fit. I did need to clean up the area a bit more that what is shown in the above image. The mounting bracket should sit flat and not pinch any of the wires it is holding in place. Once you have it able to sit comfortably in place, you need to drill two small holes for the mounting screws to use.



Drill holes with a 1/16” bit centered in each of the two outside mounting holes. I lifted the mounting bracket off for the following image so you could see the two holes that were just drilled. The mounting bracket should be on, and no trapped wires should be between it and the wand when fully seated before proceeding to the next step.

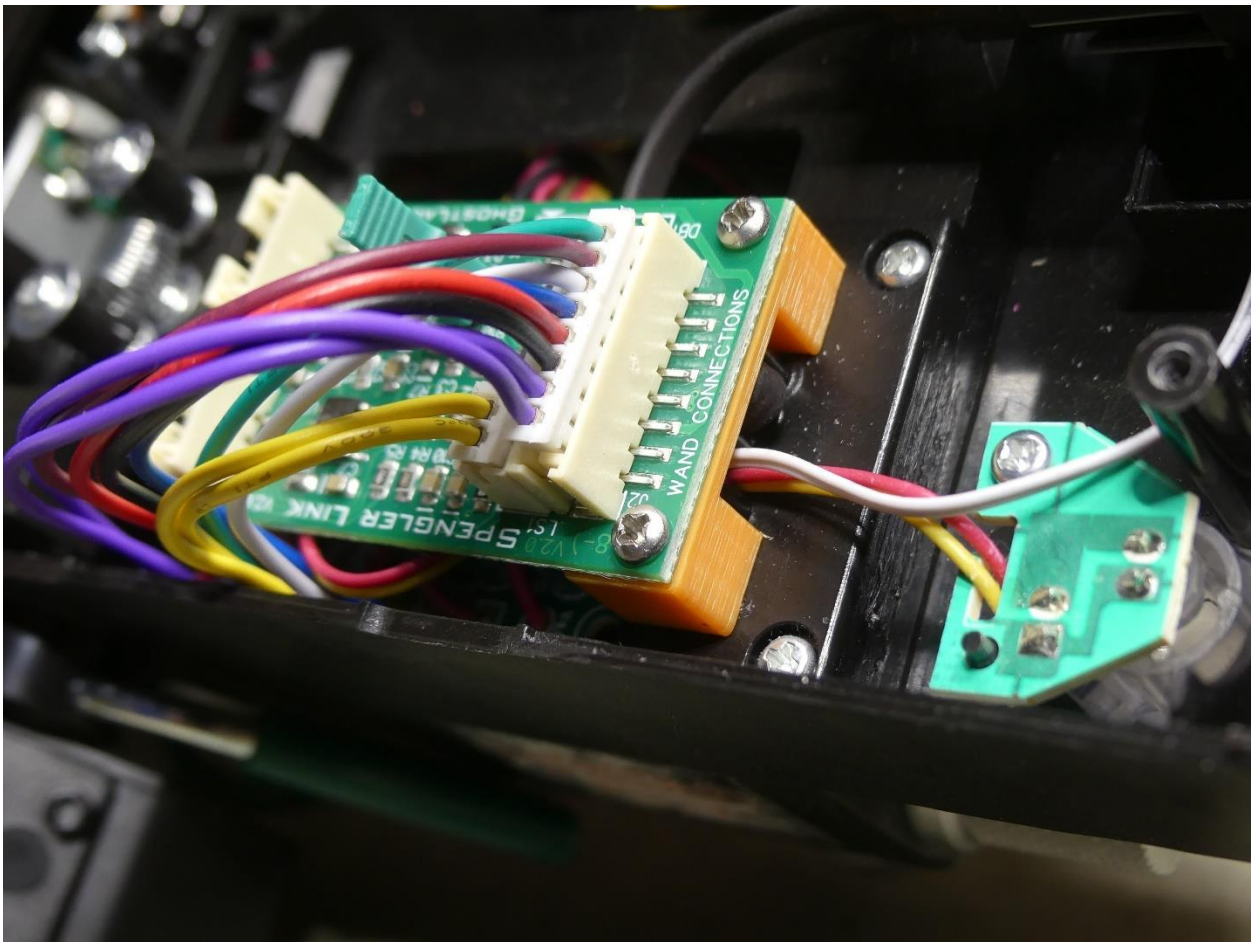


Next plug in the two or three cables that you added into the Spengler Link and move the Spengler link into position. Adjust the cables so that they reach the mounting location without being stretched too tightly.

*** WARNING ***
You can plug the cable in after mounting the Spengler Link but pressing in the 3-wire and 4-wire cables may stress the board too much, so it is recommended to only install or remove cables when the Spengler link is NOT screwed down.

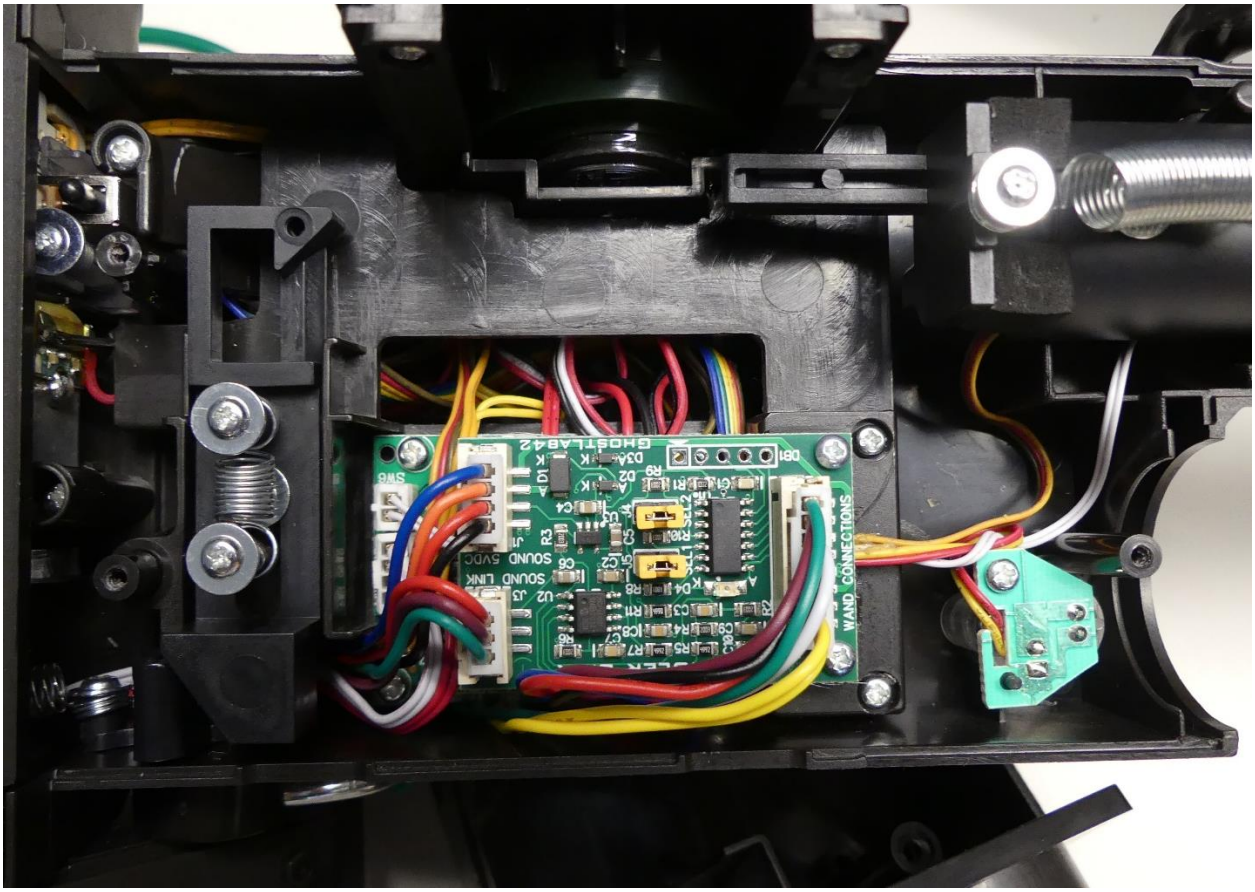
*** END OF WARNING ***

Mounting in the 1984 version is the nearly the same except for using the Orange mounting bracket #7:



Once in place use the two mounting screws #7 through the Spengler board mounting holes on both sides of the wand connector, through the mounting bracket #6 and into the wand body. Do not overtighten and strip the plastic.

Here is the board in position and the cables have been arranged to not interfere with any moving mechanism and allow access to the jumpers and the feedback LED.



Jumpers shown in test mode position.

Testing the Spengler Link Board

In this step you test the Spengler Link board to make sure the internal wand connections are working.

Parts needed

- Power
    - Batteries in wand
      OR
    - Spengler Link connected to the Spengler Sound Board that uses a 12V battery
      OR
    - Spengler Link connected to a Powercell board that uses a 12V battery

Power First
The wand does need power. You can just slide in the wand's original battery pack and make sure it does not slide out. Easy if you planned on using the battery pack and a little more difficult if you also have the 4-wire cable installed since it won't let you easily screw in the end cap with the battery pack installed (just screw it in far enough to hold the battery).

The Spengler Sound board is normally used to power the wand. Just plug in the power cable (8 position connector with the 4 wires in it) and that should power the wand when the sound board is powered.

Verify that the wand is getting power
Turn on the wand and make sure it functions normally. If not, look at the power sources and determine what is not powered or connected. Also make sure the connectors are fully seated on the Spengler Link Board.

Perform The Self-Test
Step 1:

Place all the wand's toggle switches in the down position (wand off, vent light off, activate off)

Step 2:

Place the "TEST" jumper on the Spengler link across both pins and immediately watch the feedback LED.
It will flash to indicate the firmware version and then wait for you to perform the next step.
For firmware version "2.1" the LED with flash two times for the main version, a series of short flashes to indicate a decimal point and then one flash for the minor revision number.

** Troubleshooting **
If you do not get any flashing at this point check that the battery or power supply is connected. Verify that the wand has power by powering it up and down.

If the wand appears to have power, then this is an indication that the RED and BLACK wires of the Wand Connection cable #1 may not be attached in the correct place or may not be soldered properly. If you have a Voltmeter or DMM you can check that there is voltage between these two locations and then check that the board has voltage: You should be able to measure a voltage of 2.5V to 5V between pads 1 and 3 (one is the square pad) on the 5 pads labeled DB1 on the bottom edge of the board.

Also verify the wand connection cable is fully seated in the Spengler Link board.

Step 3:

As long as the jumper is on TEST pins the Link LED should flash one time and then pause. Remove the Jumper and the flashing should stop.

** Troubleshooting **
If you do not get any flashing at this point check that the power up/down switch on the wand is in the power down position. If it is not, place it in the down position and this should allow the LED to flash indicating the test jumper is seen.

If the feedback LED does not flash, then it is an indication that the BROWN wire of the wand connection cable #2 is not making a good connection with the wand's circuit board. Remove the battery and remove the mounting screws for the Spengler Link and the original circuit board. Move the Spengler link off to the side and flip the original circuit board over and verify that the BROWN wire is in the correct position and that it is not shorted to something next to it.

Also verify the wand connection cable is fully seated in the Spengler Link board.

Step 4:

Remove the TEST jumper. Or at least make sure it is only on a single pin, so it is not indicating to start a self-test. Leaving the jumper on one pin is handy to not lose the jumper so it is available for later use.

Step 5:

Turn the wand on (lower face plate toggle switch to the up position). The feedback LED should flash three times to indicate the Spengler link noticed the power up.

** Troubleshooting **
If you do not get any flashing at this point check that the power up/down switch on the wand is in the power up position. If it is not, place it in the up position.

If the feedback LED does not flash, then it is an indication that the BROWN wire of the wand connection cable #2 is not making a good connection with the wand's circuit board. Remove the battery and remove the mounting screws for the Spengler Link and the original circuit board. Move the Spengler link off to the side and flip the original circuit board over and verify that the BROWN wire is in the correct position and that it is not shorted to something next to it.

Also verify the wand connection cable is fully seated in the Spengler Link board.

Step 6:

Press and hold the wand ear button. The feedback LED should flash four times, pause, and repeat as long as the button is held to indicate the Spengler link noticed the ear button press. The flashing should stop when the button is released.

** Troubleshooting **
If you do not get any flashing at this point check that the ear button is being pressed firmly.

If the feedback LED does not flash, then it is an indication that the GREEN wire of the wand connection cable #2 is not making a good connection with the wand's circuit board. Remove the battery and remove the mounting screws for the Spengler Link and the original circuit board. Move the Spengler link off to the side and flip the original circuit board over and verify that the GREEN wire is in the correct position and that it is not shorted to something next to it.

Also verify the wand connection cable is fully seated in the Spengler Link board.

Step 7:

Flip the activate toggle switch to get the wand's rumble motor activated. The feedback LED should flash five times to let you know the Spengler Link has seen the rumble motor working. It will then pause for a short moment and then cause a wand mode change to Slime blower mode and then flash six times to let you know that it has tried to change the wand mode.

** Troubleshooting **
If you do not get any flashing at this point check that the rumble motor has started up.

If the motor is started and the feedback LED did not flash, then it is an indication that the BLUE wire of the wand connection cable #2 is not making a good connection with the wand's circuit board. Remove the battery and remove the mounting screws for the Spengler Link and the original circuit board. Move the Spengler link off to the side and flip the original circuit board over and verify that the BLUE wire is in the correct position and that it is not shorted to something next to it.

Also verify the wand connection cable is fully seated in the Spengler Link board.

Step 8:

Flip the vent light toggle switch up (top toggle switch on the face of the wand) and the feedback LED should flash seven times to let you know the Spengler Link has seen the Vent light turn on.

** Troubleshooting **

If you do not get any flashing at this point check that the orange light by the Clippard valve is turned on. Make sure the correct toggle switch was used and that the vent light is controlled by the toggle switch while the rumble motor is running.

If the switch was in the up position when the activate switch was turned on (and the motor started), this test will run immediately after the Step 8 tests so you may miss the flashing for this step.

If the orange light is on and the feedback LED did not flash, then it is an indication that the WHITE wire of the wand connection cable #2 is not making a good connection with the wand's circuit board. Remove the battery and remove the mounting screws for the Spengler Link and the original circuit board. Move the Spengler link off to the side and flip the original circuit board over and verify that the WHITE wire is in the correct position and that it is not shorted to something next to it.

Also verify the wand connection cable is fully seated in the Spengler Link board.

Step 9:

Listen and/or watch the wand bar graph. The wand should increase and decrease the wand vibration motor intensity in a slowly increasing and then decreasing cycle

** Troubleshooting **
If this does not work very well or only ramps in one direction or the other (just moves to the highest or lowest intensity vibration and bar graph display setting and then no longer moves, it could be because the top knob is not well seated in a detent. The rumble motor keepalive will still work but can change your setting over time rather than being unnoticed if the knob is not in the correct position.

If you did not install the optional fix resistors, then even the rumble keepalive will not necessarily work while the knob is in this position between detents.

If this does not work with the knob in a desirable position, check the PURPLE wires and make sure they are connected to the correct position on the back of the main wand circuit board.

If the purple wires short the two pads together, the to knob will not enable adjustments even in normal (non-test) mode operation.

Step 10:

Flip the power up/down toggle switch (bottom face plate toggle switch) down to power down the wand. The feedback LED should flash rapidly to let you know the Spengler Link has seen the power down and has exited test mode.

Testing Audio output

When you have the Spengler Sound board powered and connected to a speaker, you can test that the audio signal coming from the wand can reach the audio amplifier and its speaker.

Make sure the volume is set to a nominal level and is powered up and the audio cable is fully plugged into the desired 3.5mm jack.at both ends of the black audio cable.

Power up the wand and see if the power up sound is coming out of the speakers.

** Troubleshooting **
If no sound is coming out it could be a problem in several places:

1) Check the audio cable. If you have an MP3 player or music player, plug the wand end of the audio cable into the player and verify that sound from your player can be heard out of the speakers. This verifies that the problem is either from that point out towards the speaker or between the wand's jack and the wand' internal connections.

2) Problem between the connector and the wand's internal connections
    a. Verify that the 3-wire sound link cable #3 is fully seated in the Spengler Link connector.
    b. Verify that the 8-wire wand connection cable #2 is fully seated into the Spengler Link connector.
    c. Verify that the 3 Sound Link cable wires #3 are correctly soldered to the back of the 3.5mm stereo audio jack #8. Also make sure there is no solder bridge between the two tabs that hold the RED and GREEN wires and the surrounding metal case.
    d. If there is still no sound, then the problem may be with either of the two YELLOW wires of the wand connection cable #2 not making good connections with the wand's circuit board. Remove the battery and remove the mounting screws for the Spengler Link and the original circuit board. Move the Spengler link off to the side and flip the original circuit board over and verify that the YELLOW wires are in the correct position and that they are not shorted to something next to it.

Testing Digital pulse link

When you have the Spengler Sound board and the pack lights (GBFans powercell and cyclotron lights or Spirit Pack Lights), plug in the audio cable with the wand powered down, make sure the startup switch is shorting the input (no auto pack power up)_and then turn on the power to the electronics boards (Spengler sound, pack lights, etc.)

The pack lights should stay off and the sound board should be quiet.

Turn the wand on (power up toggle switch, bottom toggle on the face of the wand, to the up position) and the wand and the pack lights should start up.

** Troubleshooting **
If no response from the pack lights, there are a couple of places to look for issues:

1) Check the audio cable. Make sure it is fully plugged in on both ends. Does the audio portion work (if you have an audio path available to hear from)?
2) Do you have another stereo audio cable you can try?
3) Verify that the 3-wire sound link cable #3 is fully seated in the Spengler Link connector.
4) Verify that the 3 Sound Link cable wires #3 are correctly soldered to the back of the 3.5mm stereo audio jack #8. Also make sure there is no solder bridge

Another check:
Have the 3.5mm stereo audio cable plug into the Audio Input jack on the Sound board. This is NOT the correct connection for actual use but works great for testing. With the wand powered and turned off (no lights or sounds on the wand), you should be able to hear a periodic "clicking" sound coming out of the sound board's speaker. This is a control pulse from the wand trying to tell the sound board that the wand is in power down mode. If you turn the wand on, you should hear the start up sound play through the sound board's speaker. This is a way to test BOTH the control (clicking) and the audio signals from the link that go through this cable.

If you only hear the clicking (no wand sounds) coming out the sound board's speaker when the cable is plugged into the correct "Wand" input, then the Red and Green wires are probably reversed when soldered on to the 3.5mm jack in the handle of the wand.

Put the wand back together

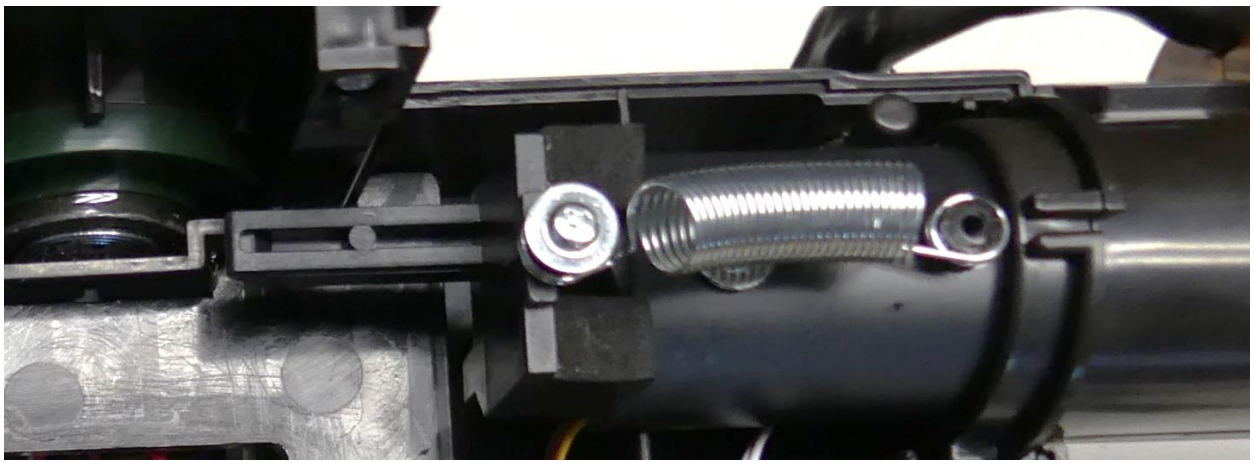
In this step you will be putting the wand back together. Basically putting the pieces you took apart back together now that you have verified that the wand is working properly.

Parts needed

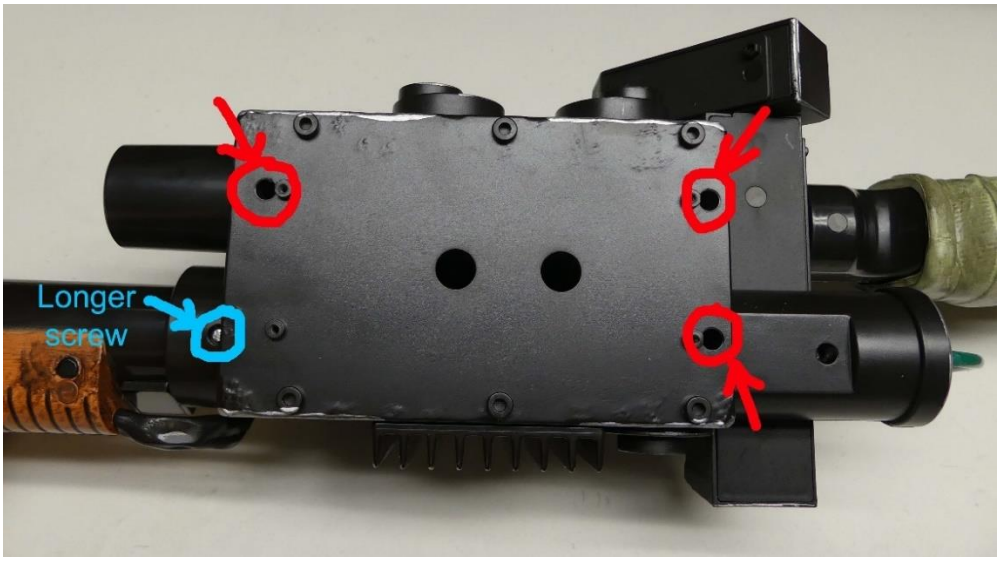
- Small-medium Philips screwdriver

Make sure all the wires are tucked away and routed away from any of the sliding latch or tube mechanisms.

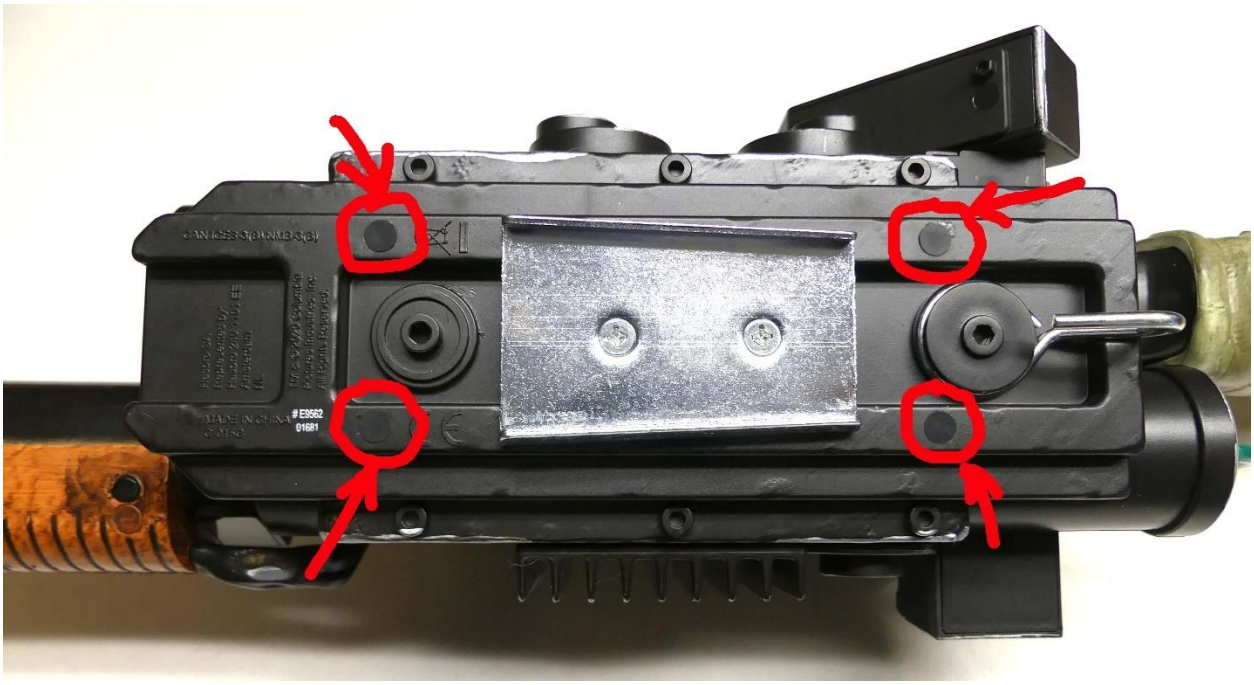
Make sure the wand tube is extended out and attach the free end of the spring from the wand tube mechanism to the post that has a place for a screw:



Place the bottom cover on and hold in place and make sure the pop mechanism is working. Once verified, secure it with the 4 screws you removed (1 longer screw by the wand tube and 3 shorter screws):



Then reattach the rails with the four screws that were removed earlier:



You can put the caps that covered the screws back in if desired. They do now have holes in them, but you can fill those holes before painting if that is something you want to do. Do not get any filler into the screw heads since you may want access to the inside sometime in the future and you will want to be able to uncover those screws!

Have fun and keep Bustin!

Advanced Use Information

The following information is for anyone that wants to make their own connections to the Spengler Link board, or just want to know a bit more on what the Spengler Link is outputting.

You are free to do what you want with this information as it is freely available for anyone to use how they want for personal or commercial purposes.

Stereo Audio Jack:
1 - Audio (2V p-p capacitive coupled signal should be compatible with most audio amplifiers)
2 - Common (or "ground")
3 - Output pulses to indicate what is going on (< 0.7V normally, > 2.4V isolated pulses ranging from 8 to 56mS in 6ms steps

Single isolated output pulse description:
8ms Power Up
This is also used to indicate that the wand has gone back to proton mode and will show up after a very fast powerup/down/up cycle where no power down pulse is sent out since we want the pack to stay powered up continuously

14ms Power Down
No additional power down sound is desired since the wand will make its own power down sound. The GBFans sound board will make its own power down sound, so they may compete a bit. If this is not desired, do not connect the output from the Spengler Decoder to the power up/down input on the GBFans sound board.

20ms Overheat start

26ms Vent Start (manual or auto)

32ms Mode Change
The wand modes will cycle sequentially through the four available modes: Proton, Slime, Stasis and Meson

38ms Song Request
The same pulse is used to start and stop the song. The new GBFans sound board has a uSD

44ms Intense Fire ON

50ms Intense Fire OFF

56ms Power Down with sound
This is a superset of the power down pulse in that it also requests a power down sound

To make sure you can unplug and plug in the wand and still know what is going on, the Spengler Link will periodically send power down signals while powered down.

Spengler Link to Pack Connections
The connectors are sometime labeled backwards, so the pin numbers may be reversed… Sorry about that – the documentation is convoluted at best and is different for different manufacturers of those connectors.

SOUND LINK (J3)
Pin 1 – Link Pulses, GREEN wire
Pin 2 – GND, BROWN wire
Pin 3 – Audio out, ORANGE wire

SOUND 5VDC (J1)
Pin 1 – GND quiet, BLACK wire on cable
Pin 2 – +5VDC quiet, RED wire on cable
Pin 3 – +5VDC noisy, RED wire on cable
Pin 4 – GND noisy, BLACK wire on cable