

Lightning Rig Saver Production Unit Version #2 12/11/2020

Lightning
Rig Saver
V2

Lightning Rig Saver V2 in use at my QTH
12/11/2020

LRS Version 2

Version #2 changes:

- Found and fixed a “sneak circuit” for lightning in the disconnect Limit Switch (LS) being close to the Antenna coax connectors
- Improved the air gap to approximately 4.5 inches;
 - V1 voltage breakdown to LS $\leq 30KV$
 - V2 voltage breakdown $\geq 340KV$
- Incorporated magnetic linkage to limit switch for failsafe disconnect limit
- Incorporated an Electronics enclosure to make it easier to assemble, disassemble and experiment with encoder feedback if desired
- Reduced Outer Box rig coax dimensions to enable connection of coax without disassembly
- Changed pictures to show updated design and build
- Version #2 *.stl files will be loaded on thingiverse.com
- Node-Red files updated by Alan WA8WUD for local only or remote w/GUI

Intro:

- Many Ham Radio Remote Stations are at risk for lightning strikes and/or lightning induced damaging voltage differentials.
- Wouldn't it be great if you could automatically physically disconnect your Antennas, remove external grounds and unplug your rig(s)?
- I am sure you are thinking that would be great, but why I would want to disconnect the antenna ground...well that is another ground path that goes through your rig and house ground that could "let the smoke out" as they say.
- So how do you do this remotely? Continue reading and see how I do it with "push-on" PL-239's and SO-239's and a mechanical actuator controlled by a RPi-zero-w.

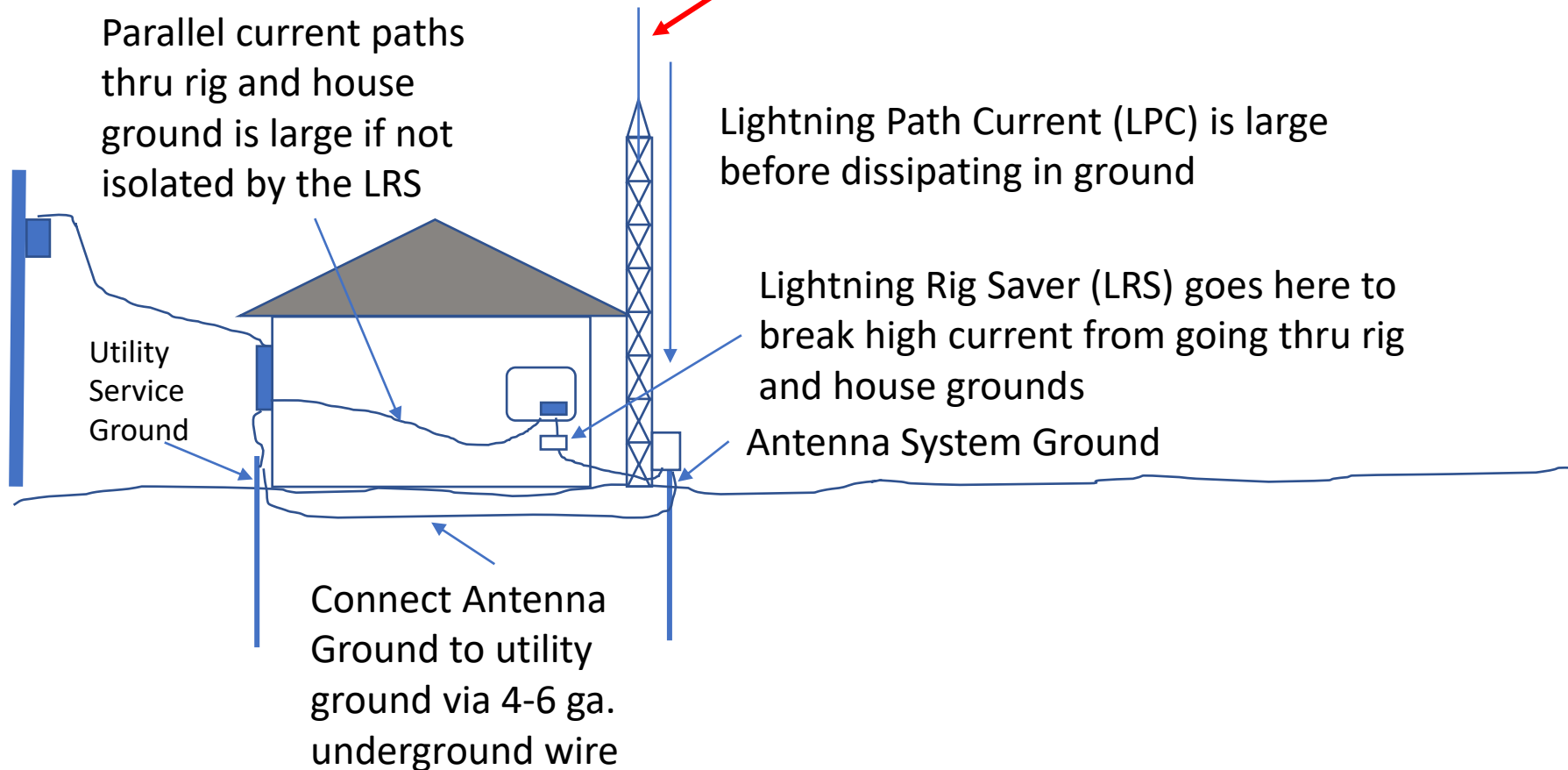
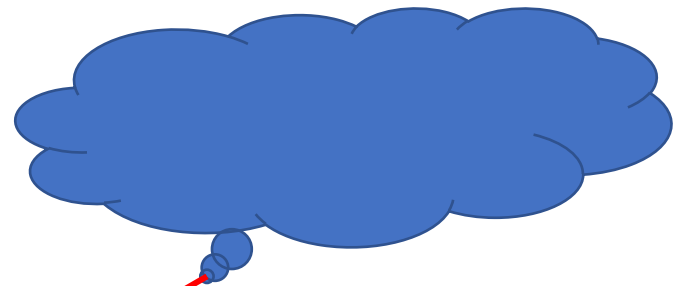
The safest your rig can be from lightning is physically unplugged from the antennas and power outlets.

Intro (continued):

- I have found that these PL-239 “push-ons” can be reliable at 100w; however, I have never tested them at 1500w. As tight as they go together they maybe able to handle the high power. Someone will have to try them. (Mark, K5XH says he uses them @ 1500 watts)
- Disconnection of Power and house ground from your rig can be done by WiFi controlled contactors by this unit; however, you must pay attention to NEC codes in you area. If you just disconnect the 12Vdc and house ground from your rig you will probably meet the code.

The safest your rig can be from lightning is physically unplugged from the antennas and power outlets.

Current/voltage between rig and house grounds are easier to isolate during a lightning strike if rig and antenna grounds are separated



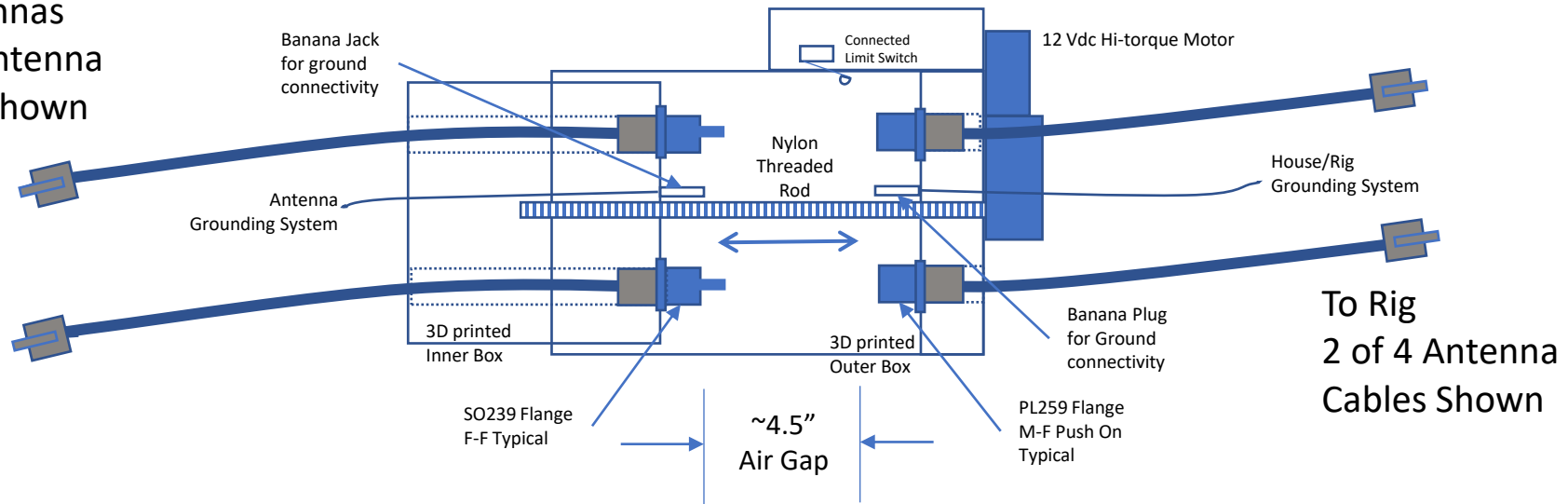
Requirements:

- Easy to place inline for up to 4 Antenna circuits
- Able to handle 100 watts, hopefully 1500 watts (1500w with “push-on” PL259 confirmed by Mark K5XH)
- Able to disconnect of all possible paths for lightning to pass through your rig though the use of WiFi controlled electro-mechanical means to unplug and isolate your rig(s) from antennas and power.
- Monitors a local Weather API for Thunderstorms and will send a signal to disconnect your antennas and any other WiFi enabled devices. Reconnect them when all clear.
- Notifies you via SMS text if antennas are disconnected and reconnected because of Thunderstorms.
- Unit is to perform all the disconnects in a fail safe manor:
 - If thunderstorms are active in your area
 - If you lose local internet connectivity
 - If you lose house power
 - Notify rig that antennas are connected/disconnected for PTT enable/inhibit

The safest your rig can be from lightning is physically unplugged from the antennas and power outlets.

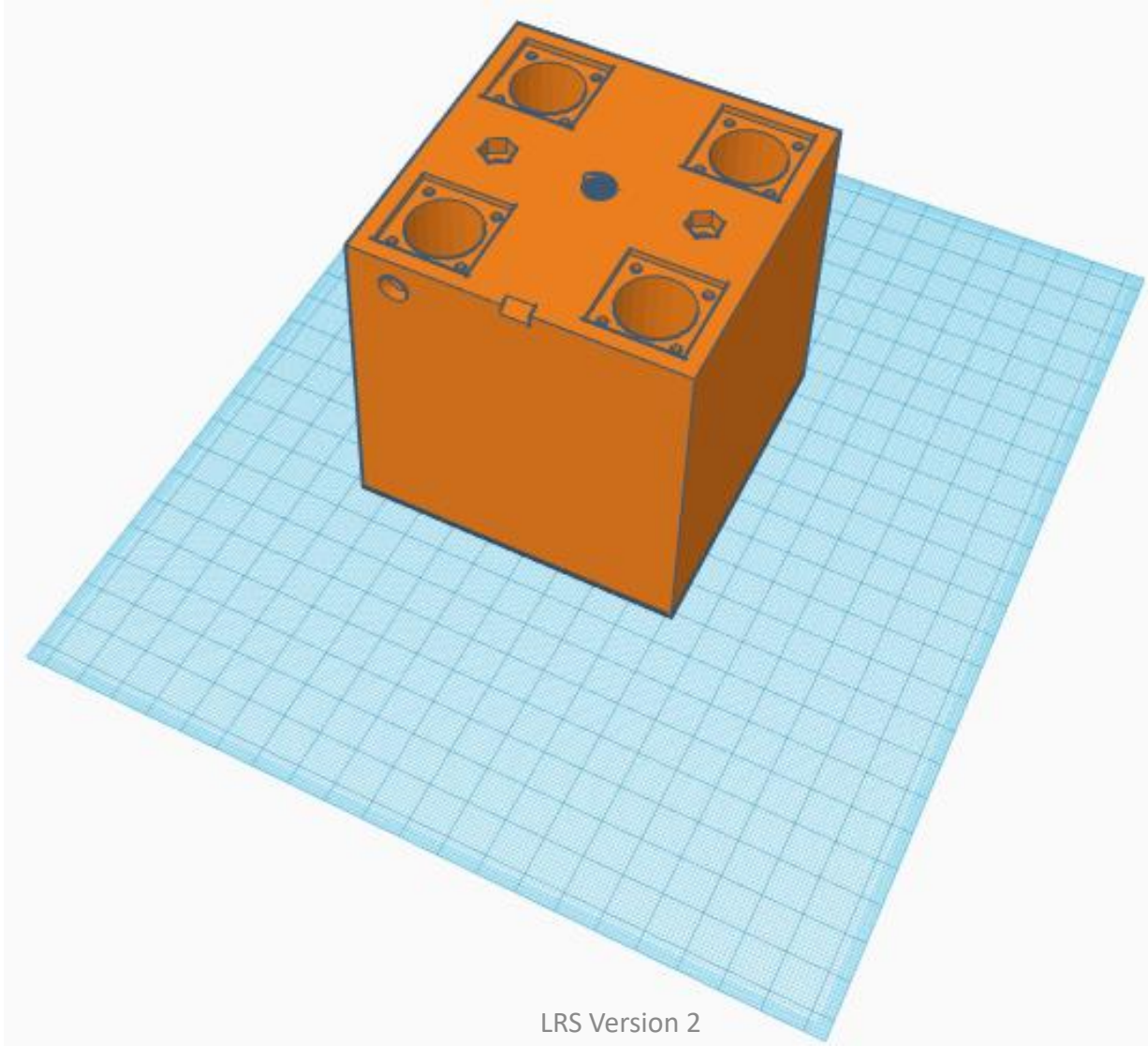
Antenna/Ground Isolation Diagram V2:

To Antennas
2 of 4 Antenna
Cables Shown

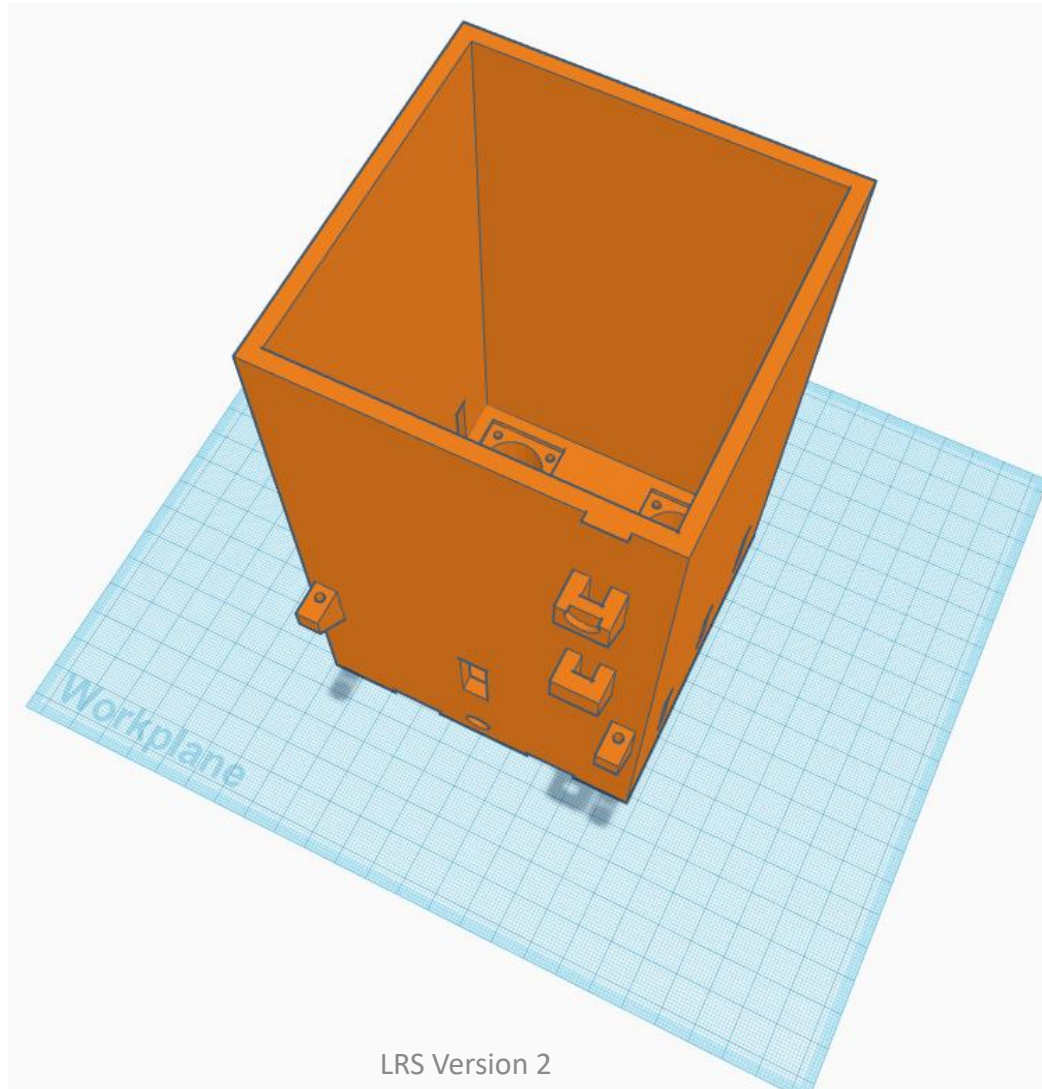


Side view

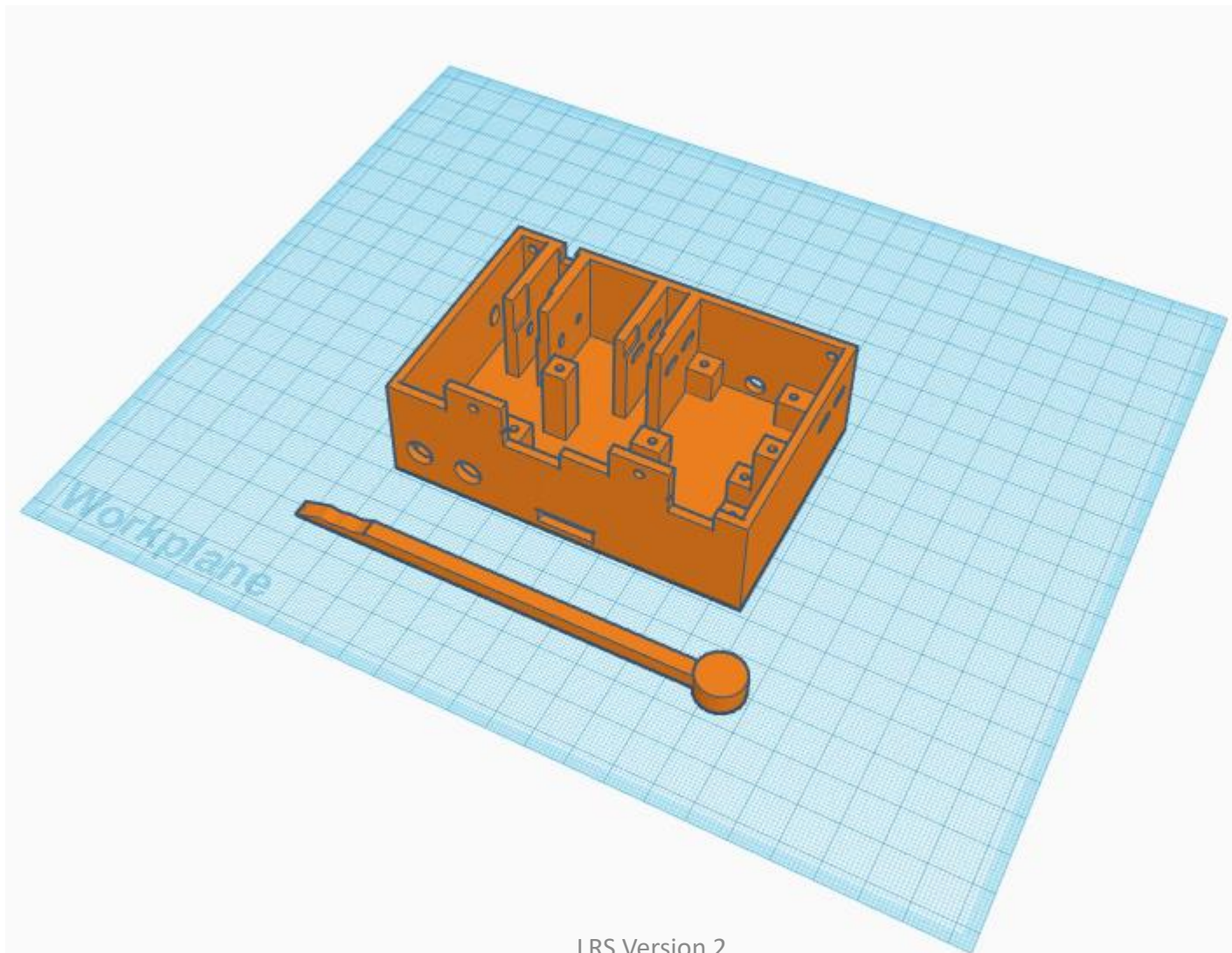
Major Part 3D Printed Inner Box V2:



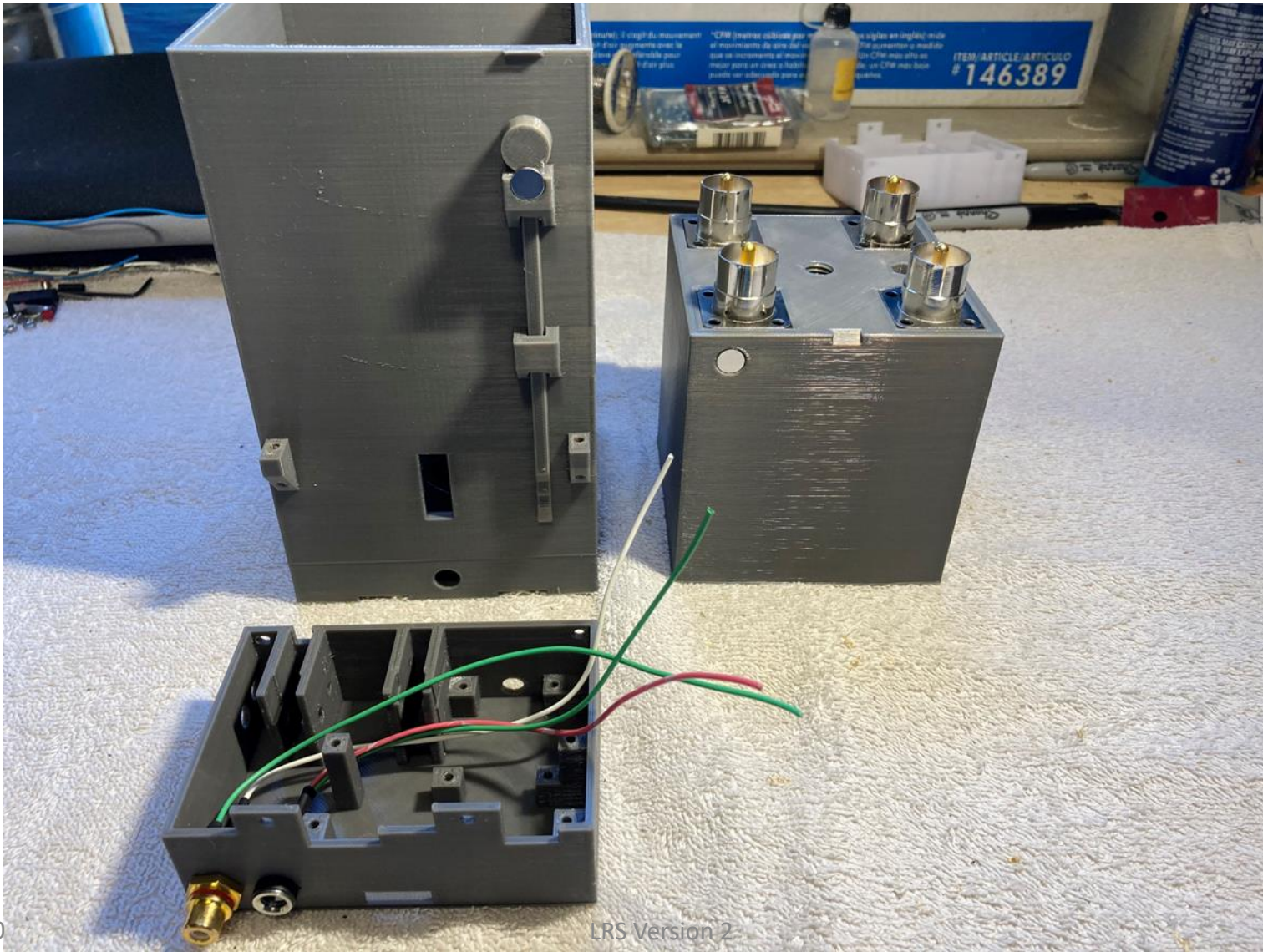
Major Part 3D Printed Outer Box V2:



Major Part Electronics Box V2:



Major Parts V2:



Major Parts V1/V2:

- Micro Limit Switches:



- 3/8" x 6" Nylon Threaded Rod and 6mm to 10mm coupler:



Major Parts V1/V2:

- Backup Battery:



- Raspberry Pi Zero W:



Parts List:

Item #	Part #	Qty.	Description	Source	Cost
1	LRS Outer Case	1	Outer LRS case, 3D printed in PETG, 93m, 28hrs	User Supplied	\$.
2	LRS Inner Case	1	Inner LRS case, 3D printed in PETG, 63m, 22hrs	User Supplied	\$.
3	LRS Electronics Box	1	Box for Electronics, 3D printed, 15m, 6hrs	User Supplied	\$.
4	GW-370 (40RPM)	1	12 Vdc High Torque Gear Motor 40 RPM	https://www.ebay.com/itm/232964282593	\$8.25
5	Motor Reversing Relay	1	Motor Reversing Relay	https://www.ebay.com/itm/131049557086	\$2.68
6	Rpi-zero-w	1	Raspberry Pi Zero with Wifi	https://www.adafruit.com/product/3400	\$15.
7	Micro Limit Switches	2	Micro Limit Switches	https://www.ebay.com/itm/313089668535	\$8.14
8	Rigid Coupler	1	Rigid Coupler, 6mm to 10mm	https://www.ebay.com/itm/324243270572	\$8.7
9	Nylon 3/8"-16 Rod	6"	Nylon 3/8"-16 threaded rod approx. 6" long	https://www.ebay.com/itm/253006680001	\$18.47
10	Push on UHF Connector	4	Flange Mount Push on UHF Male to Female Connector	https://www.ebay.com/itm/274159304978	\$12.79
11	Flange mount UHF	4	Flange Mount UHF Female to Female Connector	https://www.ebay.com/itm/131049557086	\$13.12
12	Coaxial Pwr Connector	1	Coaxial Power 12Vdc Receptacle	Ebay or Junk box your choice 8mm hole	\$.
13	RCA Jack	1	RCA Jack	Ebay or Junk box your choice 8mm hole	\$.
14	Banana Plug	4	Banana Plug/Receptacle	https://www.ebay.com/itm/174367078633	\$11.51
15	12 Vdc 6800 mAH Battery	1	12 Vdc 6800 mAH Battery	https://www.ebay.com/itm/193564028690	\$25.
16	M3 x 20mm screw	4	M3 x 20mm Pan Head screw for Motor Mount	Available at most local Ace Hardware Stores	\$2.
17	M2.5 x 16mm screw	4	M2.5 x 16mm Pan Head screw for Limit Switch	Available at most local Ace Hardware Stores	\$2.
18	M2.5 washer	4	M2.5 washer for L.S.	Available at most local Ace Hardware Stores	\$1.
19	M2.5 lock washer	4	M2.5 lock washer for L.S.	Available at most local Ace Hardware Stores	\$1.
20	M2.5 nut	4	M2.5 nut for L.S.	Available at most local Ace Hardware Stores	\$2.
21	#6 x 0.5" screw	40	#6 x 0.5" Pan Head wood screw	Available at most local Ace Hardware Stores	\$4.
22	Wire	2 ft.	24ga stranded wire	Junk box	\$.
23	Magnets	5	8mm x 1.5 Neodymium Magnet	https://www.ebay.com/itm/161794664564	\$7.99
24	Three position switch	1	MT103 3pst	https://www.ebay.com/itm/382941395385	\$5.95
25					
				Total	\$149.6
Notes:					
1	Items 1-3 require you have a 3D printer or a friend that has one. Need approximately 0.5 kg of PETG				
2	Item 4 the lower the speed the higher the torque capability. I have used 100rpm but its torque is marginal at this speed				
3	Item 7, 8, 23 & 24 comes with a quantity more than you need...share with others				
4	Item 9 comes in 24" and must be cut, only need ~6". Share with others				

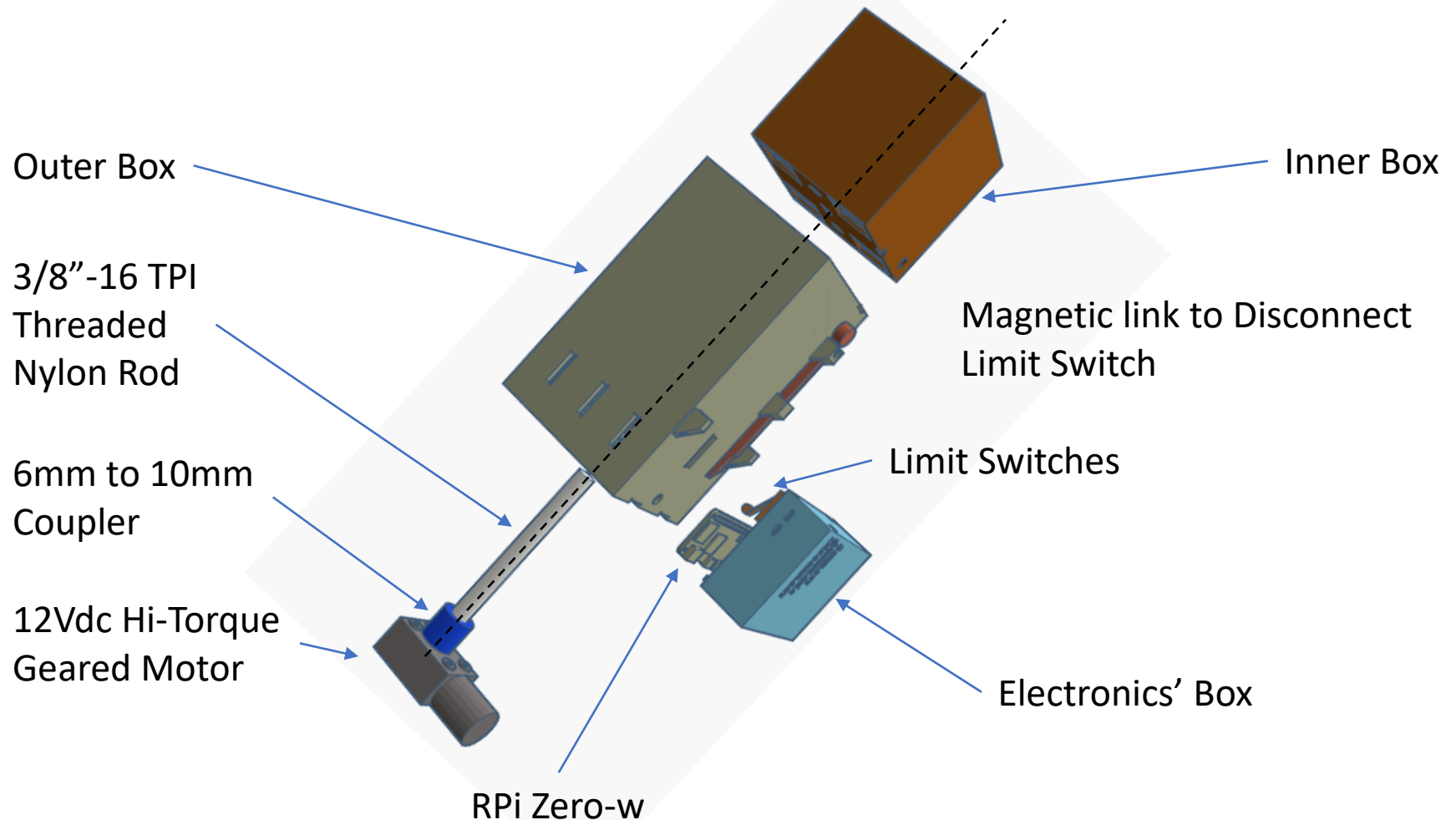
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Assembly:

- First you must find a 3D printer; either you have one or someone you know has one. I used the Prusa MK3S for my build.
- Make sure you have enough filament of the color and material you like. To print this project you will need a 1kg roll to be on the safe side. I used Sunlu PETG @ \$19/1kg roll from Amazon.
- Printing the inner part will take 18 hours and 63 meters of filament
- Printing the outer part will take 28 hours and 93 meters of filament
- Your print time will very depending on your printer, material and infill used.
- FYI, a 1kg roll of 1.75mm filament has approximately 330 meters of filament.
- After I finish development I will place the *.stl files on [thingiverse](https://www.thingiverse.com) as V2 for those that want to print it.

The toughest part of this project is getting the housing

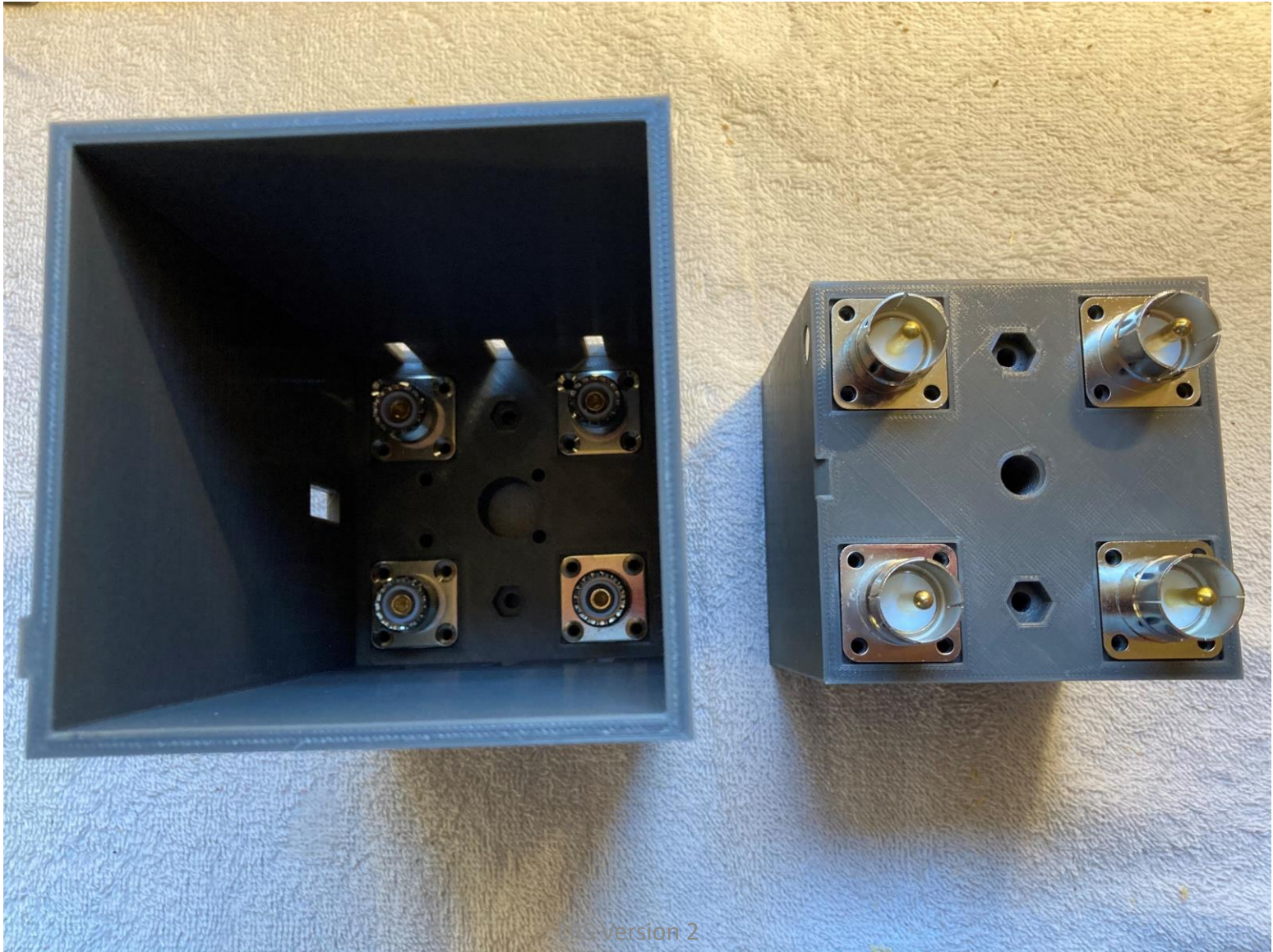
Assembly Isometric V2:



Assembly (Motor):



Assembly Inner PL259, Outer SO-239 V2:



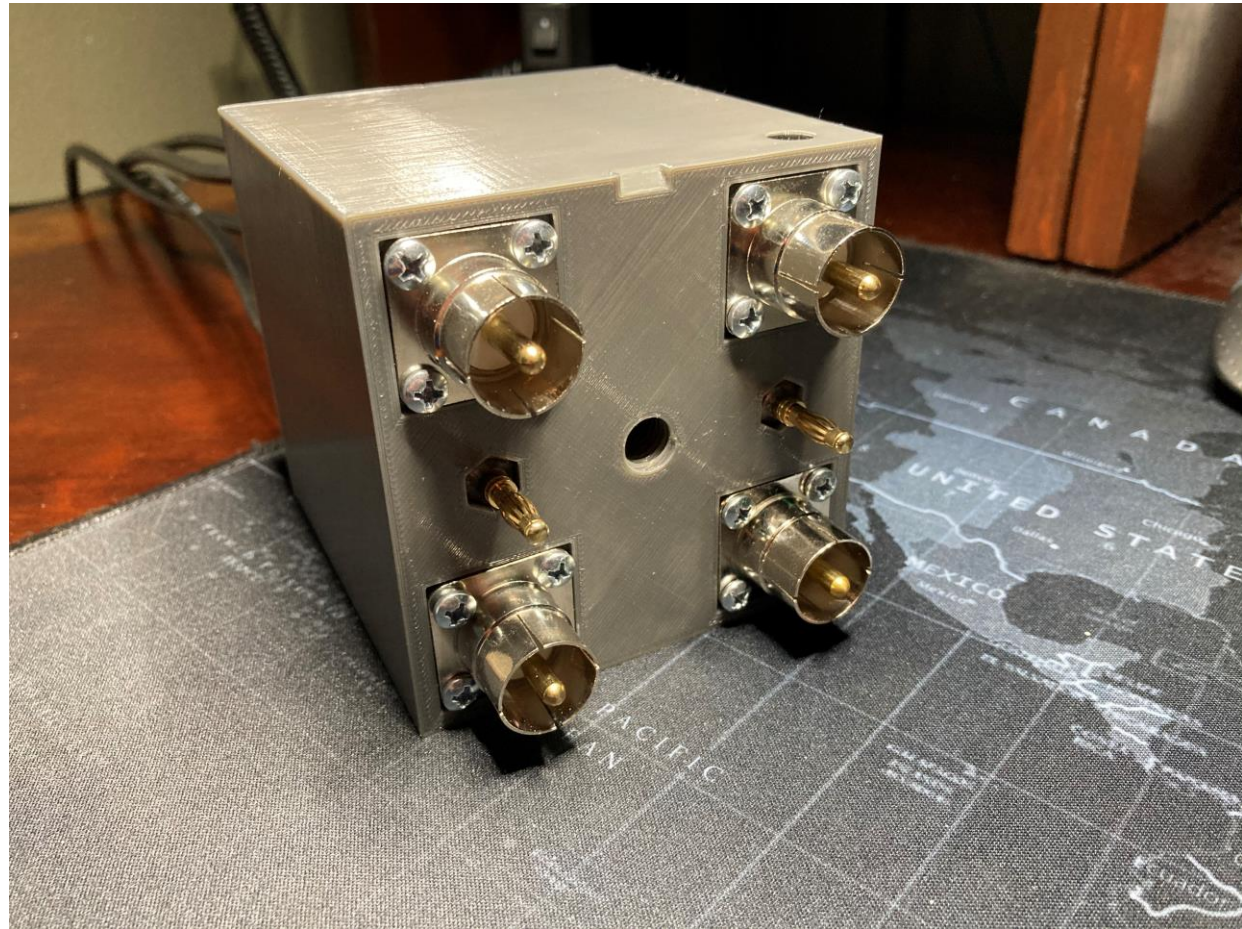
Assembly inner/outer box V2:



Assembly inner box (ground lugs) V2:



The banana plug must be aligned on the screw axis
Use a lathe or drill press to align and solder



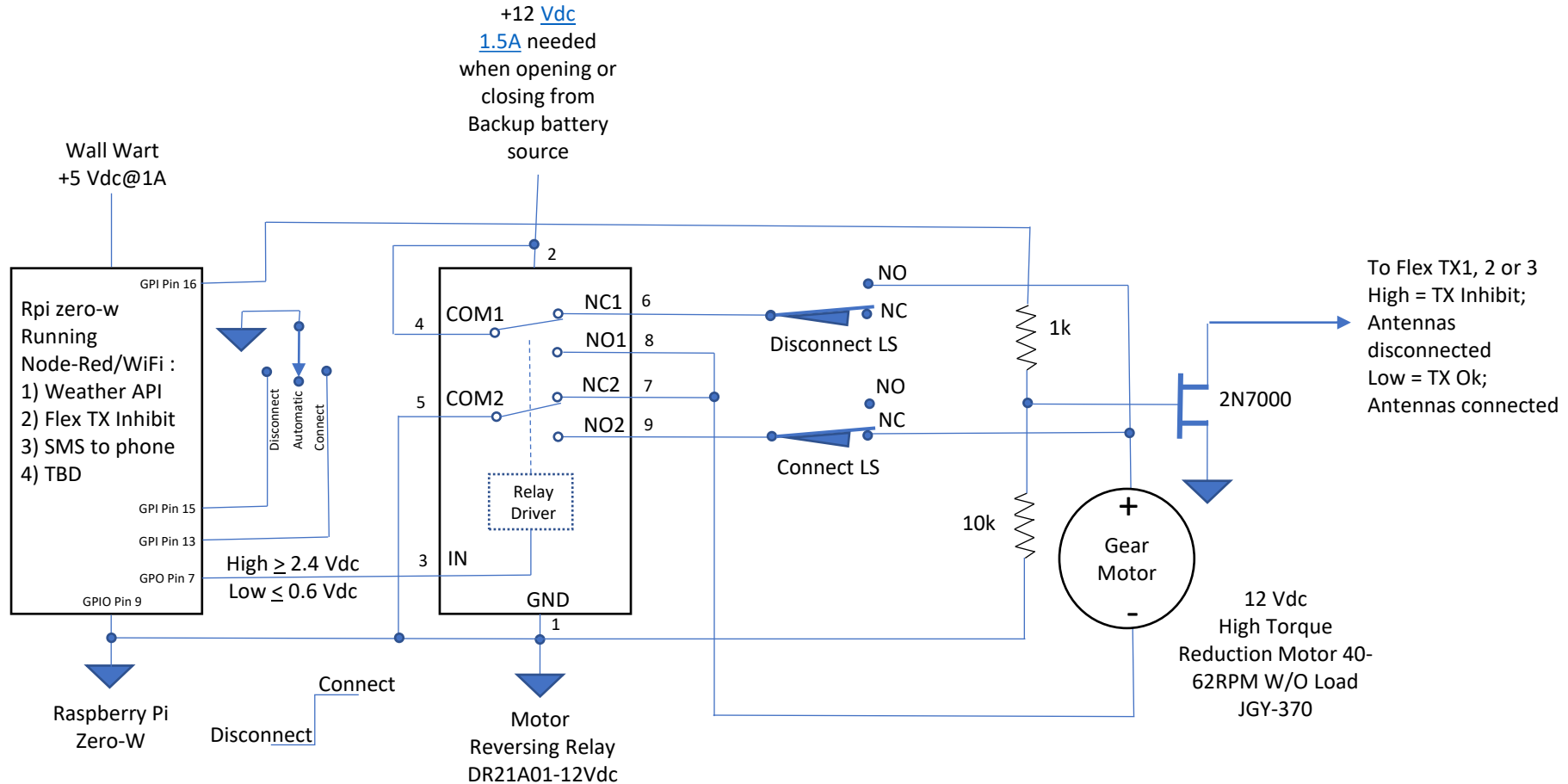
Assembly outer box (Grn Lugs):



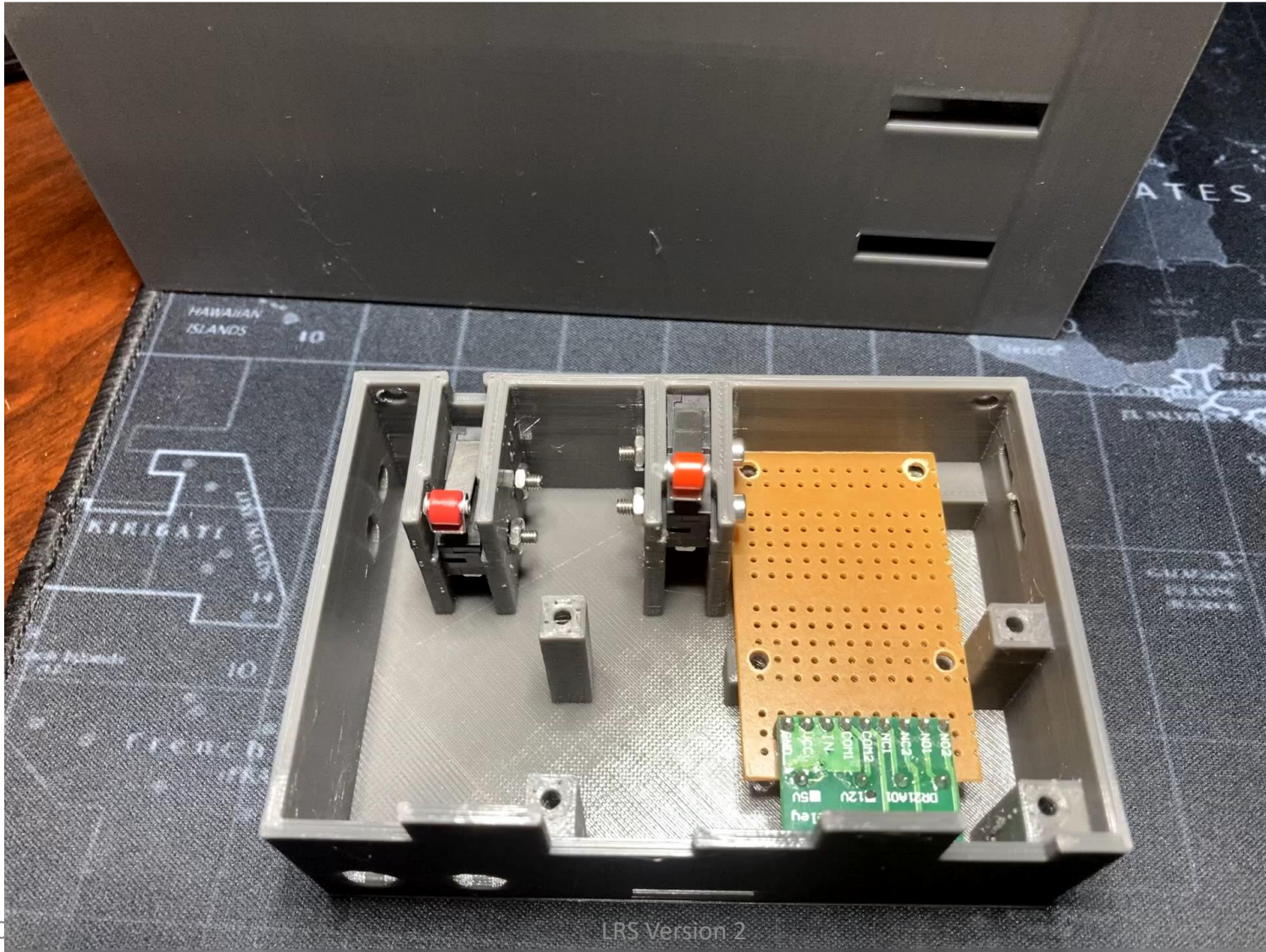
The banana plug must be aligned on the screw axis
Use a lathe or drill press to align and solder



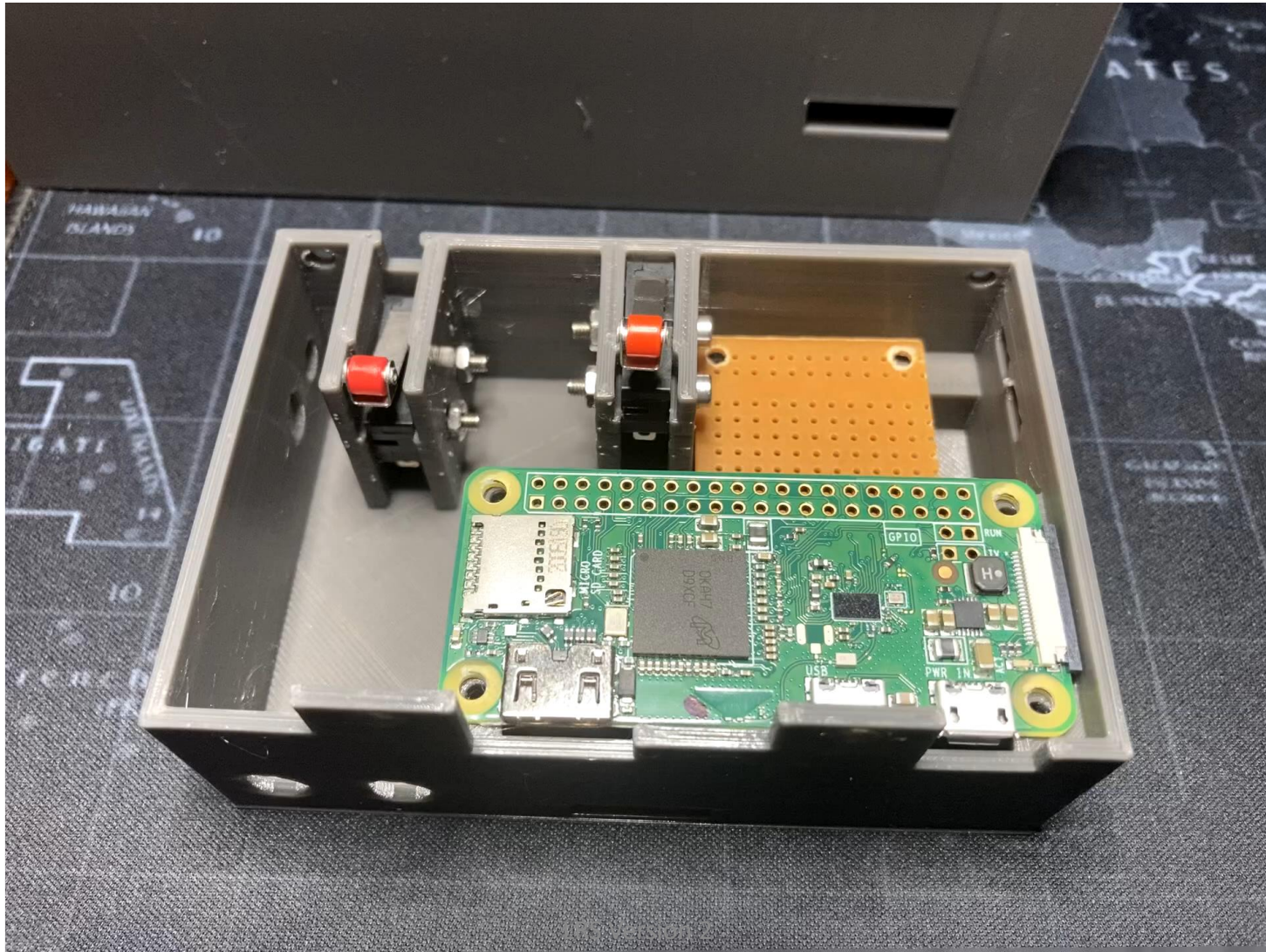
Schematic V2 with no encoder:



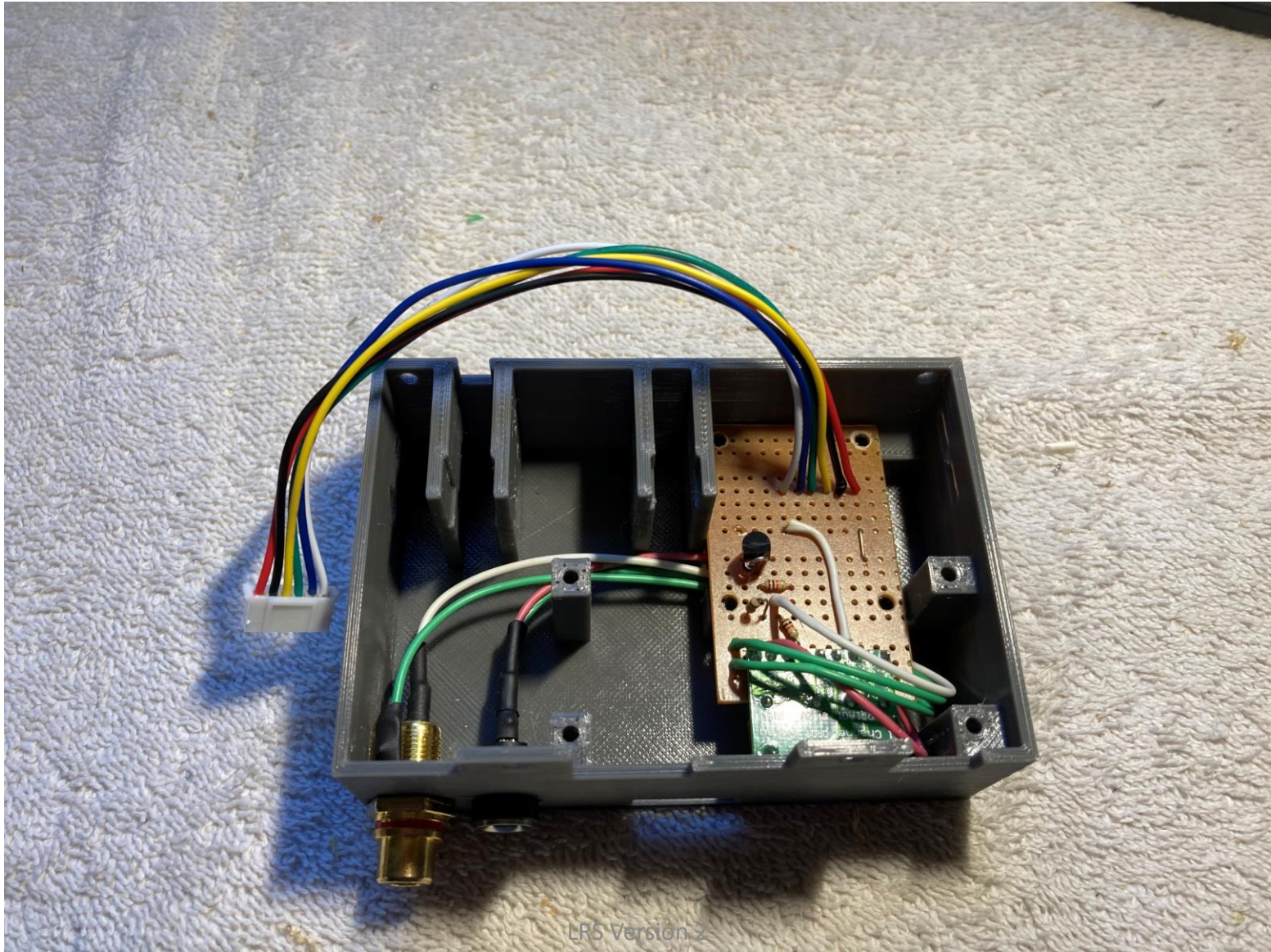
Assembly Electronics Box V2:



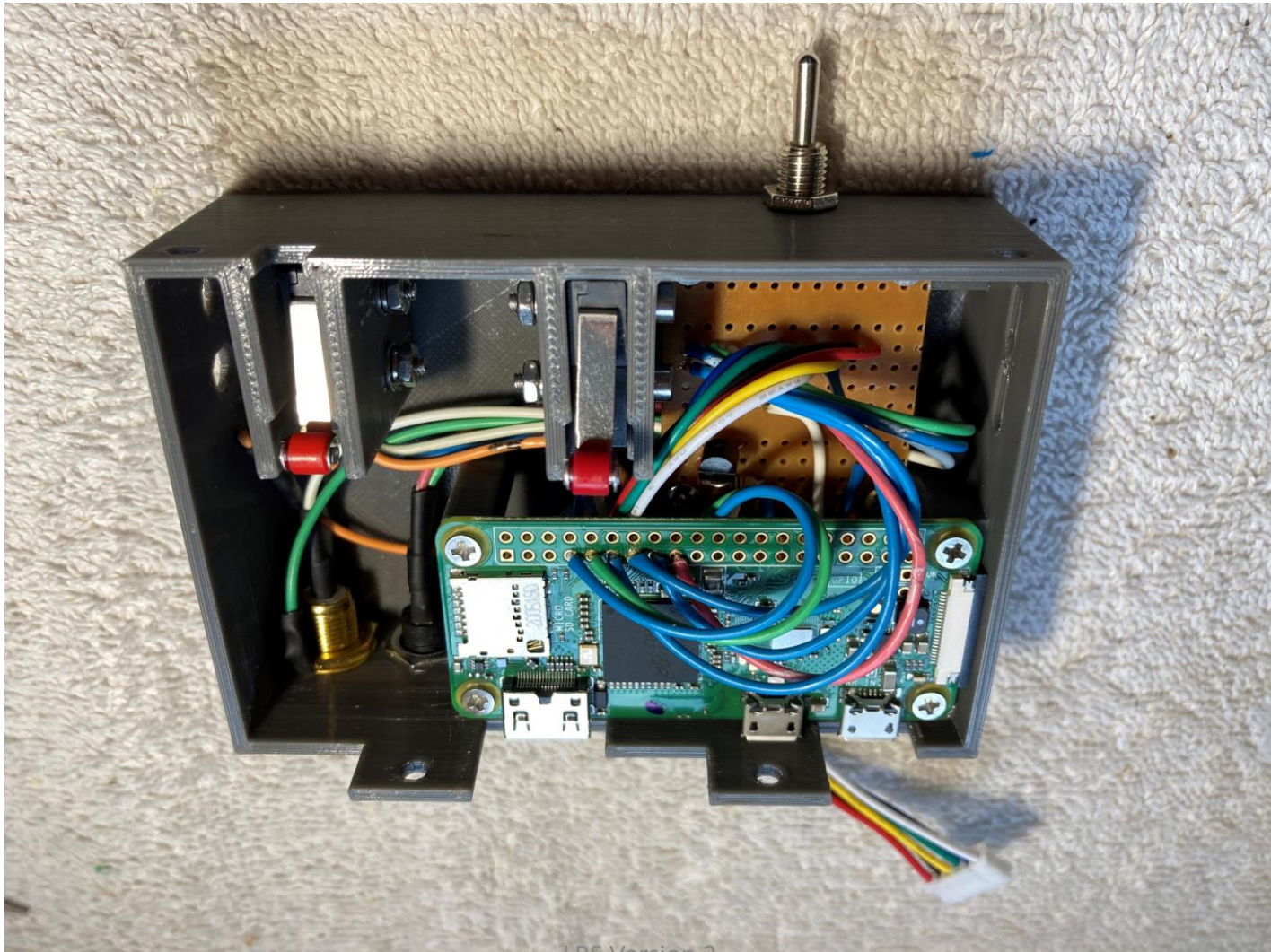
Assembly Electronics Box V2:



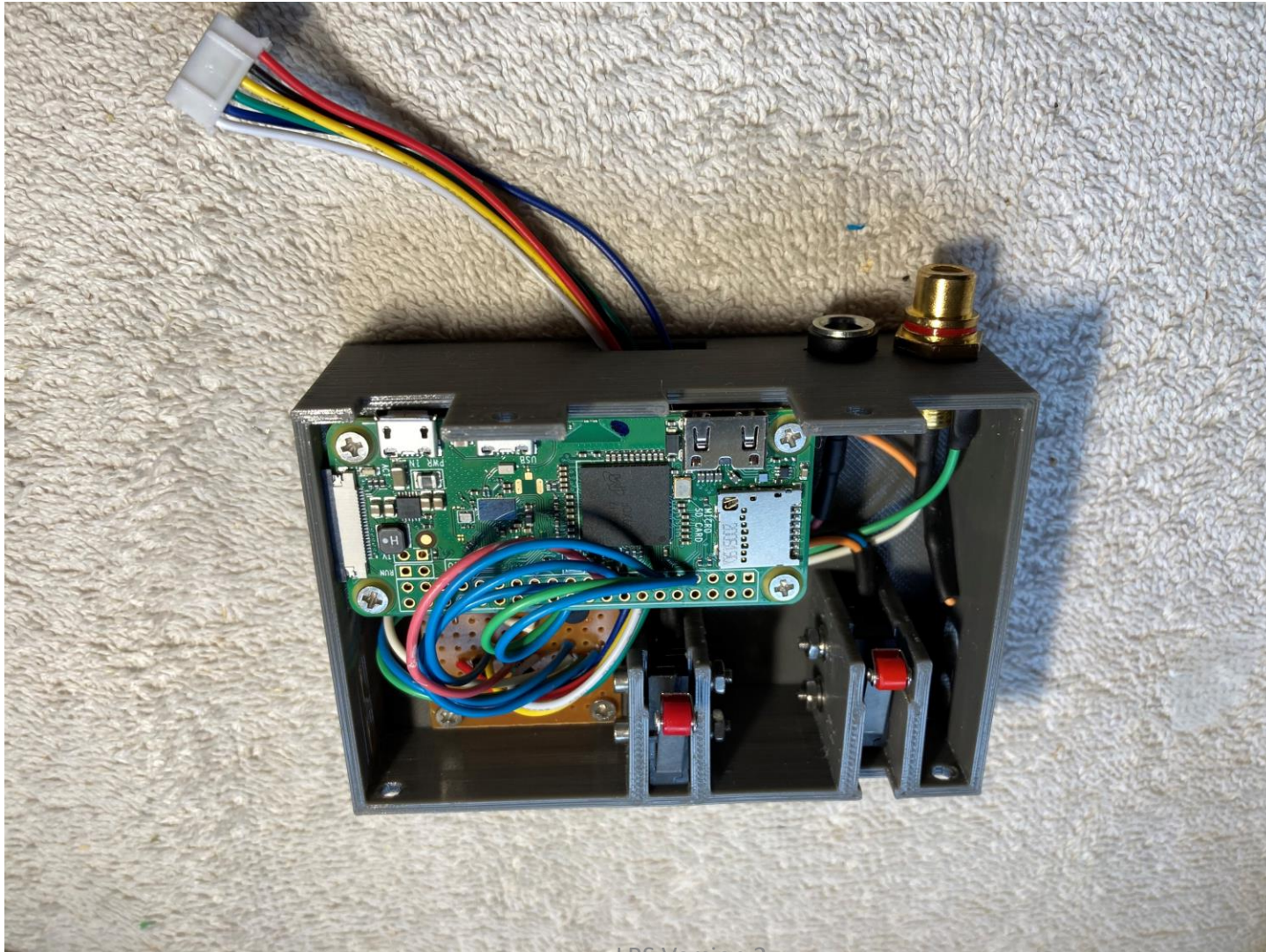
Assembly electronics V2:



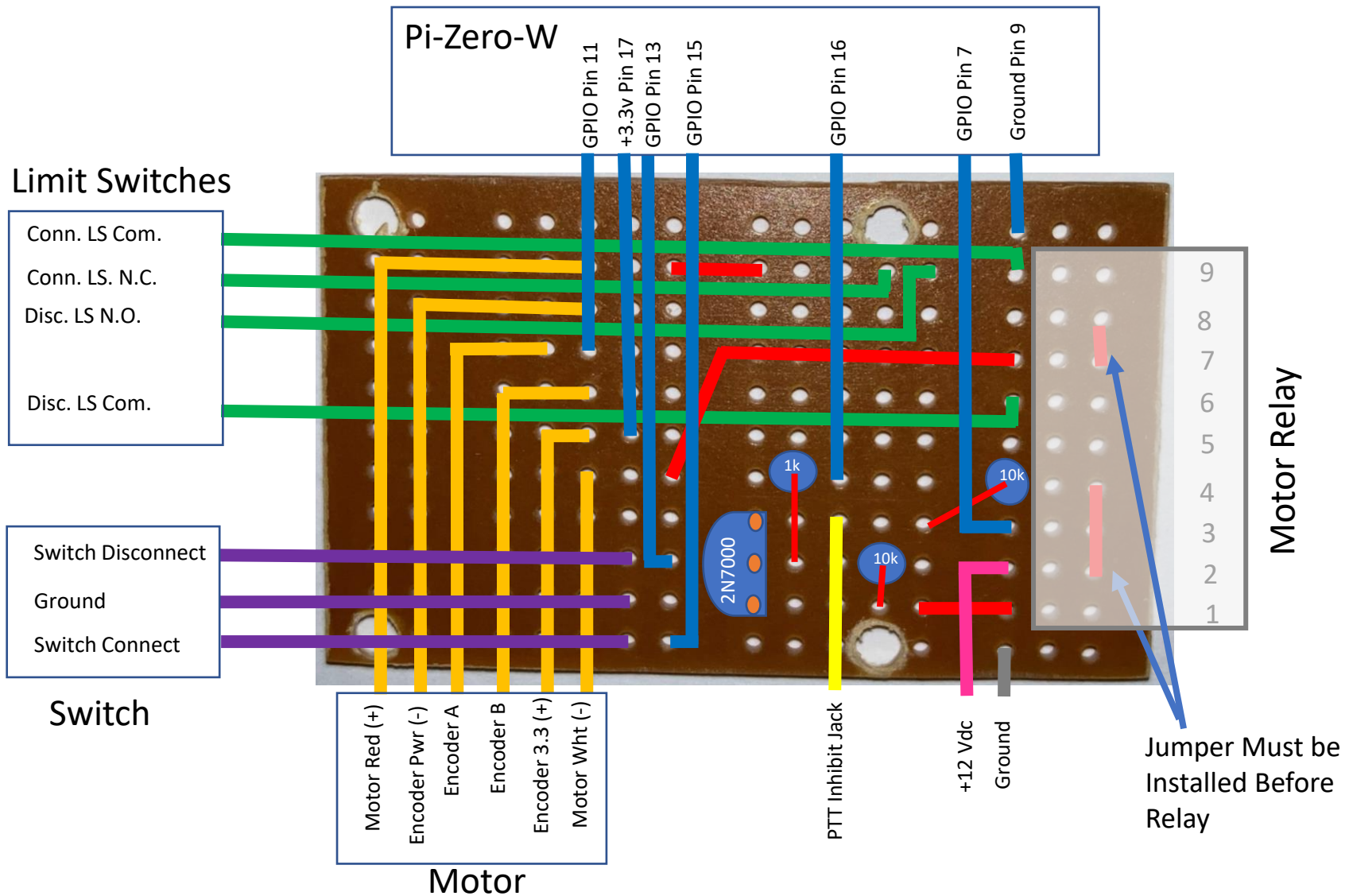
Assembly electronics V2:



Assembly electronics V2:

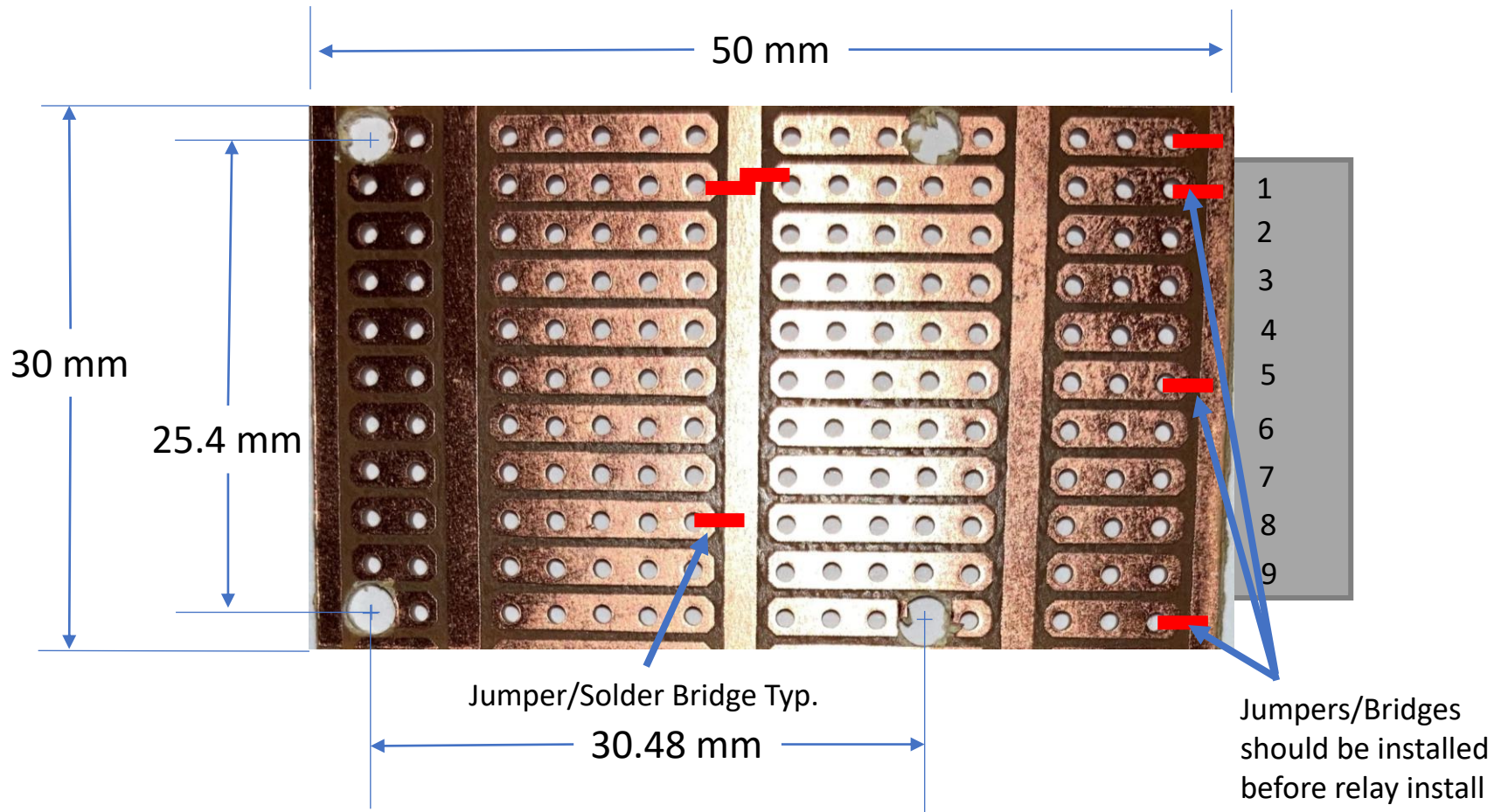


V2 Electronics Board Top View:



Note: Motor +/- are the only ones really needed.
The others are for my development purposes only

V2 Electronics Board Bottom View:

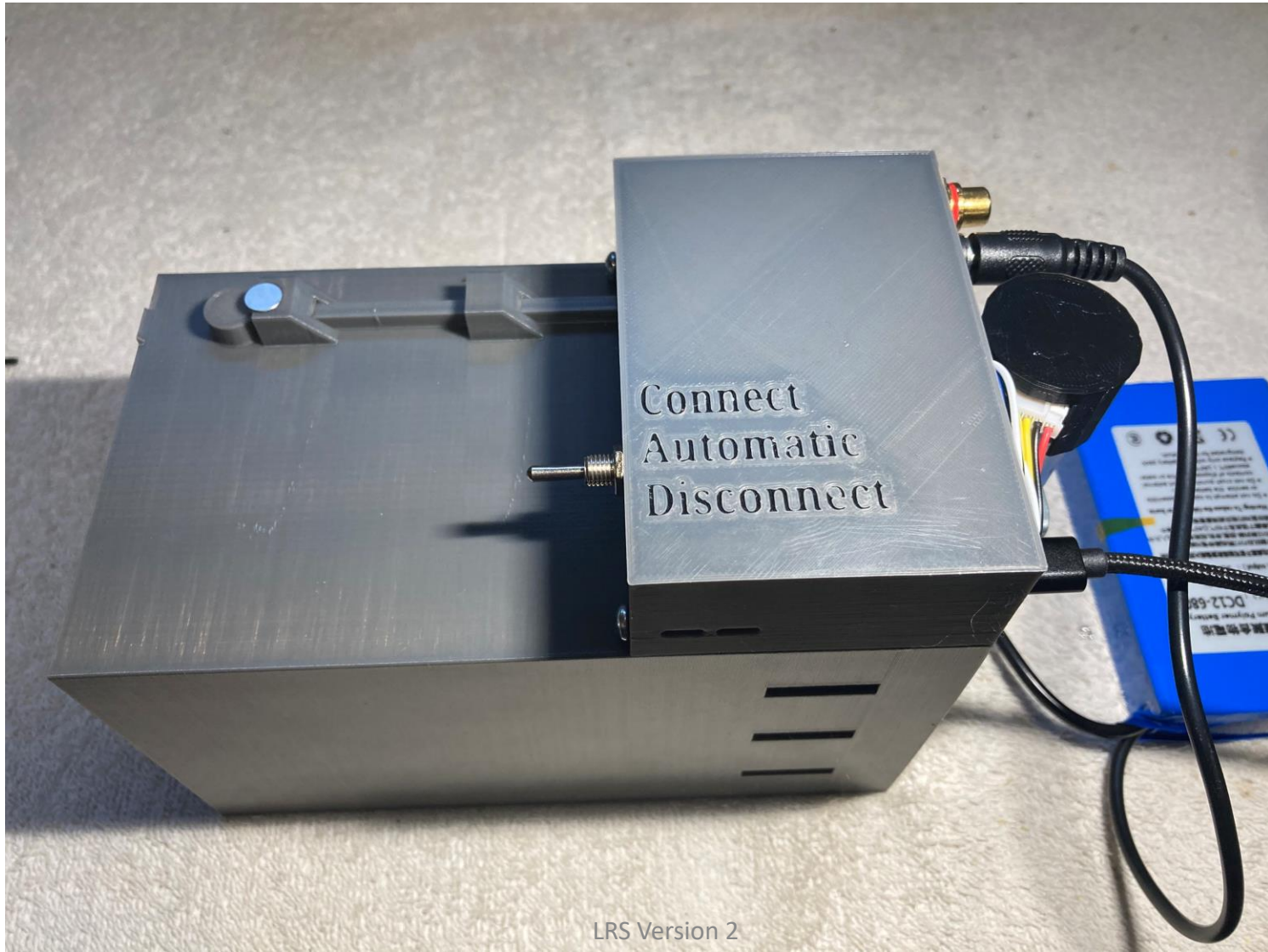


Pi-Zero-W Pin Outs:



Power	3V3	1	2	5V	Power
SDA I2C	GPIO2	3	4	5V	Power
SCL I2C	GPIO3	5	6	Ground	
	GPIO4	7	8	GPIO14	UART0_TXD
	Ground	9	10	GPIO15	UART0_RXD
	GPIO17	11	12	GPIO18	PCM_CLK
	GPIO27	13	14	Ground	
	GPIO22	15	16	GPIO23	
Power	3V3	17	18	GPIO24	
MOSI	GPIO10	19	20	Ground	
MISO	GPIO9	21	22	GPIO25	
SCLK	GPIO11	23	24	GPIO8	CE0_N
	Ground	25	26	GPIO7	CE1_N
I2C ID EEPROM	ID_SD	27	28	ID_SC	I2C ID EEPROM
	GPIO5	29	30	Ground	
	GPIO6	31	32	GPIO12	
	GPIO13	33	34	Ground	
	GPIO19	35	36	GPIO16	
	GPIO26	37	38	GPIO20	
	Ground	39	40	GPIO21	

Assembly complete V2:



Hardware future:

- If there is enough interest see if we can get an injection molded inner/outer and electronics box made. This could be expensive unless we find a Ham in the industry that would be willing to help.
- Make a PCB with interconnects for easier assembly
- TBD

Lots of improvements possible if the hive contributes

Software:

- I am not much of a programmer so I got some ideas and help from Marty Boroff WD9GYM and Alan Blind WA9WUD (on the FlexRadio community). Their Node-Red weather flows got me started programming in Node-Red for this project.
- With their permission I got the critical code snippets (flow) to get a Thunderstorm warning from OpenWeatherMap API (free).
- To load Node-Red on the RPi-Zero-W follow the following steps
 1. Load the RPi OS via the instructions in this link: <https://www.raspberrypi.org/downloads/raspberry-pi-os/> Any of the versions should work. You don't really need the desktop version unless you want a GUI.
 2. Next load Node-Red via this link: <https://nodered.org/docs/getting-started/raspberrypi>
 3. Next install the OpenWeatherMap from within Node-Red:

Node-Red is simple once you understand it...LOL

Software:

- Go to OpenWeather.com to sign up for a free API account (<https://openweathermap.org/api>). Write down your API Key. You will need it to setup the Weather Node in Node=Red
- Install the OpenWeatherMap in Node-Red
- Sign up for a gmail account (free) so you can text yourself notifications
- Install the email node in Node Red
- Import the flows I will supply and start filling in all the nodes that have red triangles.
- You can manually connect and disconnect the antenna via the three position switch
- Note; with the RPi-w turned off the antenna will always disconnect.

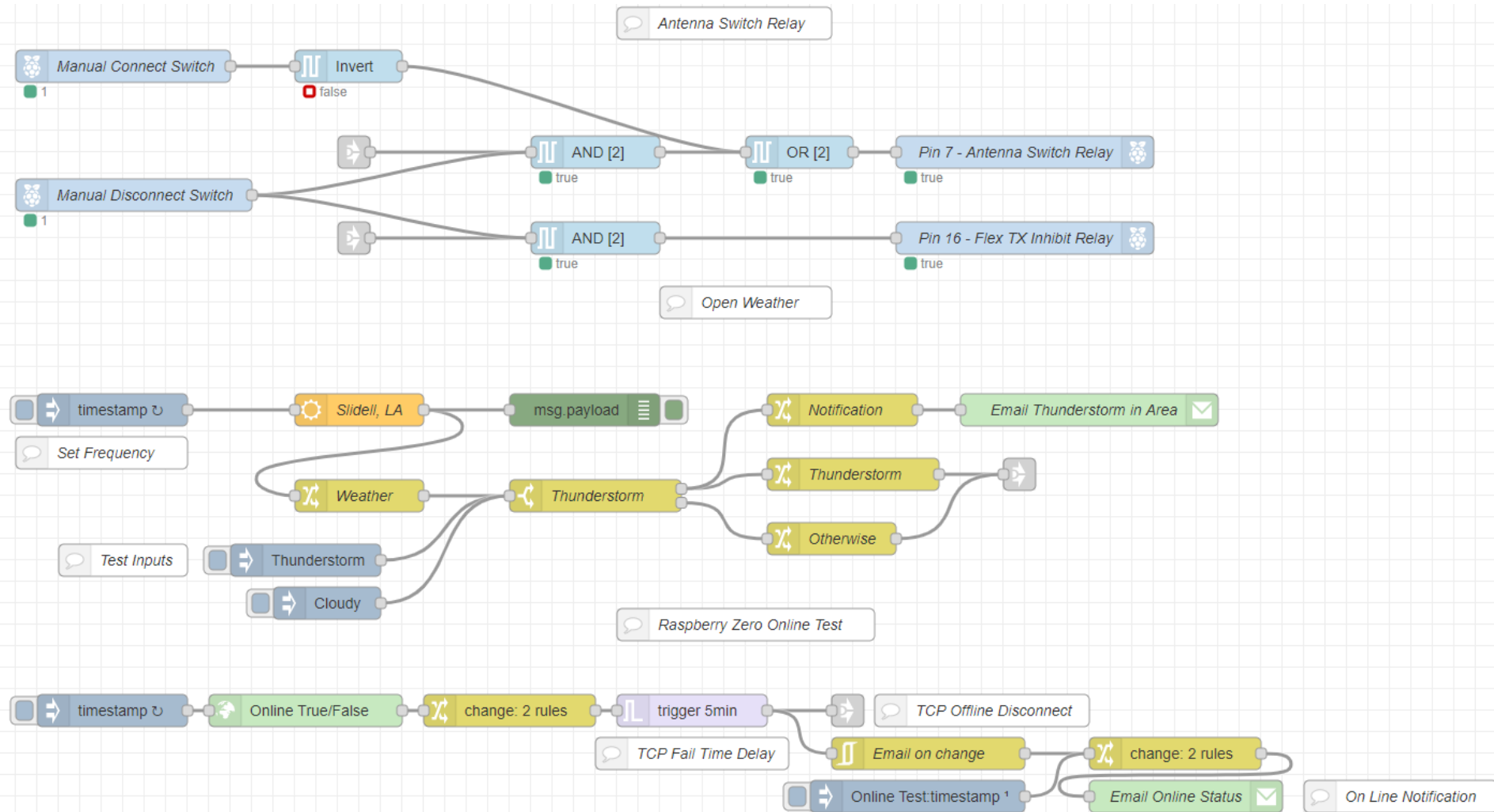
Node-Red is simple once you understand it...LOL

Software:

- The software checks the weather API every ten minutes and if it sees the words “Thunderstorm” it will disconnect the antennas. If it sees anything else it will connect the antennas
 - If someone wants to buy the Pulse Lightning API (very expensive) they can use it verses the Thunderstorm weather warning (free). This will give a more accurate lightning in the area alarm. You can look at this incorporated on the WeatherBug app.
 - You could also buy a Personal Lightning detector and wire it into the RPi; however, I do not know how these will react to high power RF.
- The s/w checks to see if the internet is online, If not, it will disconnect the antennas
- If RPi power (house power) goes out it will automatically disconnect the antennas using the battery backup 12Vdc supply and the failsafe wiring of the Motor reversing relay.

This is a must for remote controlled radio systems

Software (example flows):



Software future:

- Incorporate this flow in one of the many Node-Red Remote Control GUI programs on the FlexRadio Community (Done by Alan Blind, WA9WUD)
- Convince [Earthnetworks Pulse Lightning API](#) to be free for Ham Radio Operators.
- Incorporate WiFi Switches for power disconnect
- TBD

Lots of improvements possible if the hive contributes