

A Self-Contained RF-less HAMVOIP Allstar Node

By WO7T -6/3/2023

I have built a number of RF based Allstar nodes and leveraged various RA-XX interfaces from Masters Communications (<http://www.masterscommunications.com/>) For this build I had a different intention and goals in mind. The use of an RF-free node, solves any issue of antennas, or radio use around sensitive equipment. As such, I could see this RF-free node of great leverage in a highly restrictive housing environment, an elderly care center, a hospital room, an RV campground, a hotel, or even mobile with a cell-phone hot-spot. I leave mine powered on 24X7 and always connected in monitor mode to a node of interest. All this node requires is DC power, DTMF microphone, and a network connection (WiFi in my case). Minus the cost of Raspberry Pi 3B+ the cost for the complete build was around \$120 for this node.

Bill of Materials:

- A Raspberry Pi (3B+, or 3A+) having wifi built in.
- 8GB SanDisk micro-SD card with HamVoip image loaded with your Allstar ID, and config \$5
- 4 ohm – 2"-3" speaker about 1-1/4" tall to fit case \$5
- RL-20 kit (<http://www.masterscommunications.com/products/radio-adapter/rl/rl20.html>) \$25
- Alinco EMS-57 (sourced from online auction site) \$25
- ABS project box (7.87X4.72X2.95 inches) [Box at Amazon](#) \$10
- Pam8406 Mini Amplifier module 5W at 5V [Audio Amp at Amazon](#) \$10
- 8 pin mic socket [Mic Socket at Amazon](#) \$8
- 5-pin micro-USB plugs 10/\$2 (from online auction site)
- 5A adjustable buck converter voltage regulator [Buck Converter at Amazon](#) \$6 < **Recommended** OR
- 5A adjustable step down with digital display [Buck Converter with Display](#) \$15
- 5mm length black nylon circuit board standoffs / screws
- 3mm black plastic LED holders for panel mounting LEDs
- 6 position quick-connect wiring harness plug and socket (optional)
- Hookup wire stripped from old hank of CAT5 network cable (24 ga) point-to-point wiring
- Hank of shielded headphone cable for audio lines. Point-to-point wiring of audio lines

The Required Circuit Boards

The Masters Communications RL-20 interface card was specifically designed to accommodate RF-less nodes. It is a more rigorous form of soundcard interfacing, than hacking a USB sound card into service. The kit for this interface is easy to build with all through-hole parts left to your soldering. It is key to not solder to the board the 9-pin jack, or the LEDs. You can buy the board assembled and tested for another \$30, but I stress the need to NOT have the DB-9 socket or LEDs soldered in place. You will be direct wiring to the PC board at this location on the RL-20 board, and the LEDs get switched around as detailed later. This is a very straight-forward board to solder up. All SMT components are already soldered on the board when you get it. If you've never soldered before, a pre-built board is the way to go. Masters Communication provides with the kit a short USB cable to connect the RL-20 to the Raspberry PI (RPI), as this is how the RL-20 is powered. Do not look for power input pads on the RL-20 circuit board. There are none.

While optional, in constructing my RF-less node I made use of some quick-connector sockets and plugs. They were 6pin. I leveraged SIP sockets and pins to panel mount the LEDs. Orientation of these LEDs matters, but with this plug-in method, it is easy to flip around the other direction with the plug-in to the socket. The buck converter and audio amplifier, each made use of screw terminals for wire connections. Be sure to tin wires first, open the jaws of terminal screw, push in the wire, and tighten down screw. (Note: other model buck converters may require soldering wires to the boards).

With the 5A buck converter, start with the potentiometer screw twisted fully counter-clockwise at least 10 full turns, and then dial up or down to fine tune to exactly 5.0V which is the voltage that the RPI, and the amplifier board both take to operate. Set the voltage before mounting or plugging in any of the boards requiring 5V supply. Insure it is still at 5V, after connecting your loads to it. (Note: Smaller amperage buck converters may not source enough current for the RPI and related boards. Experiment with care.)

The PAM8406 amp is a stereo amp, but only makes use of the left channel input and output since all Allstar audio is mono. The input to this amp, coming from the Pin2 of RL-20 is plugged in via a 3.5mm stereo plug, and wired to the tip of such plug. As always ground is the shield of the plug. I broke off the ring connector on the 1/8" stereo plug before using it in soldering up this plug. (Note: a smaller audio amp may do the job, as I do not have the volume pot advanced hardly at all with this amp. Experiment with care.)

Again, I am using a Raspberry Pi 3B+, with the wireless interface to my home network. My RPI3B+ also has a cooling fan mounted, as well as a reset button, to allow pushbutton shutdown which were all add-ons done before Allstar usage. Worth noting, is I always use SanDisk Class10 micro SD cards of 8GB or 16GB size. Not one of my SanDisk cards failed to date. (Note: Any RPI listed at the Allstarlink.org website will work just fine with the HamVOIP software, but note some of the connectors have been changed on the RPI4 and others so will require appropriate change-over from what the RPI3B+ use)

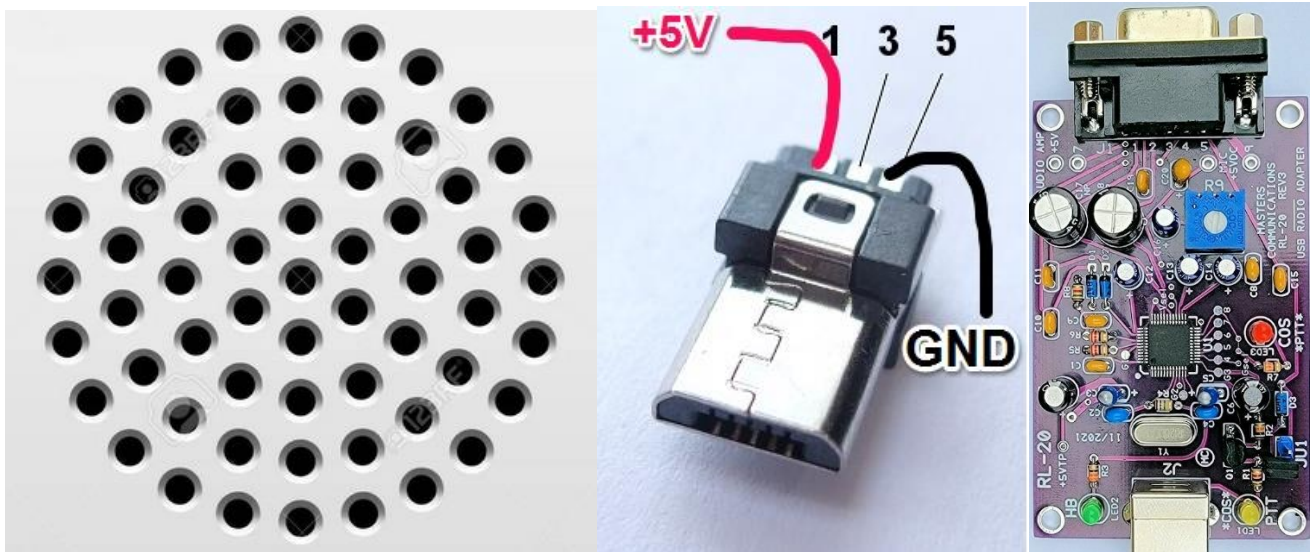
The Case

While you are free to place your RF-less node in whatever cabinet you desire, the ABS case linked in BOM above works well, and provides ample room for all components to mount inside. The case is constructed of two parts with a deep-welled top, and a shallow bottom. Before getting started on circuit board mounting find a template for a speaker grill, size it, print it, and tape to the case, and carefully drill the top in the location that the speaker is going to go. If you do not want to do all that grill drilling for a built-in speaker, you could use a 1/8" panel jack to connect an external speaker out the back of the cabinet. All but the Raspberry Pi 3B+ mount in the deep-welled top. The RPI3B+ mounts on the shallow bottom via Velcro tape. Placement of Pi is such that an end sits over a portion of the speaker. In the photos showing the deeper top, I have used masking tape to identify the area that the RPI3B+ sits in. Two circuit boards are mounted vertical against side walls (Buck Converter && RL-20) utilizing small nylon circuit board standoffs and nylon bolts through the case. The amplifier board is mounted through the front and 3/4" from the top of the deep-welled case top.

Reference the picture below, and your own board mounting hardware to duplicate my layout which is functional on all levels for the referenced ABS box. Inside this box, there are existing plastic posts that aren't used, and some get in the way of mounting the boards. Snip down the obstructing posts in the way to nearly flush, and then smooth flat with a hot soldering iron. Remember to flip over the case to correctly orient left and right on

front panel in my descriptions as I am referencing positions in final assembled operating position. The buck converter is in the back, followed closely by the small 2.5W speaker that I chose to mount with a few dabs of silicone rubber. The front has the audio amp board mounted and held in place with only the front volume shaft nut. The 8 pin mic socket mounts on lower left front. The panel mounted LEDs all are on the right side of the front panel lined up vertically.

Connection from the buck converter at 5V to the RPI3B+ requires a plug wiring of a 5-pin micro-USB plug with small 24 ga wire. The 5-pin plugs I acquired had three solder pads on one side and two pads on the other. The power wiring gets done on the 3 pin side, per following pictorial. Do not short connections on this connector.

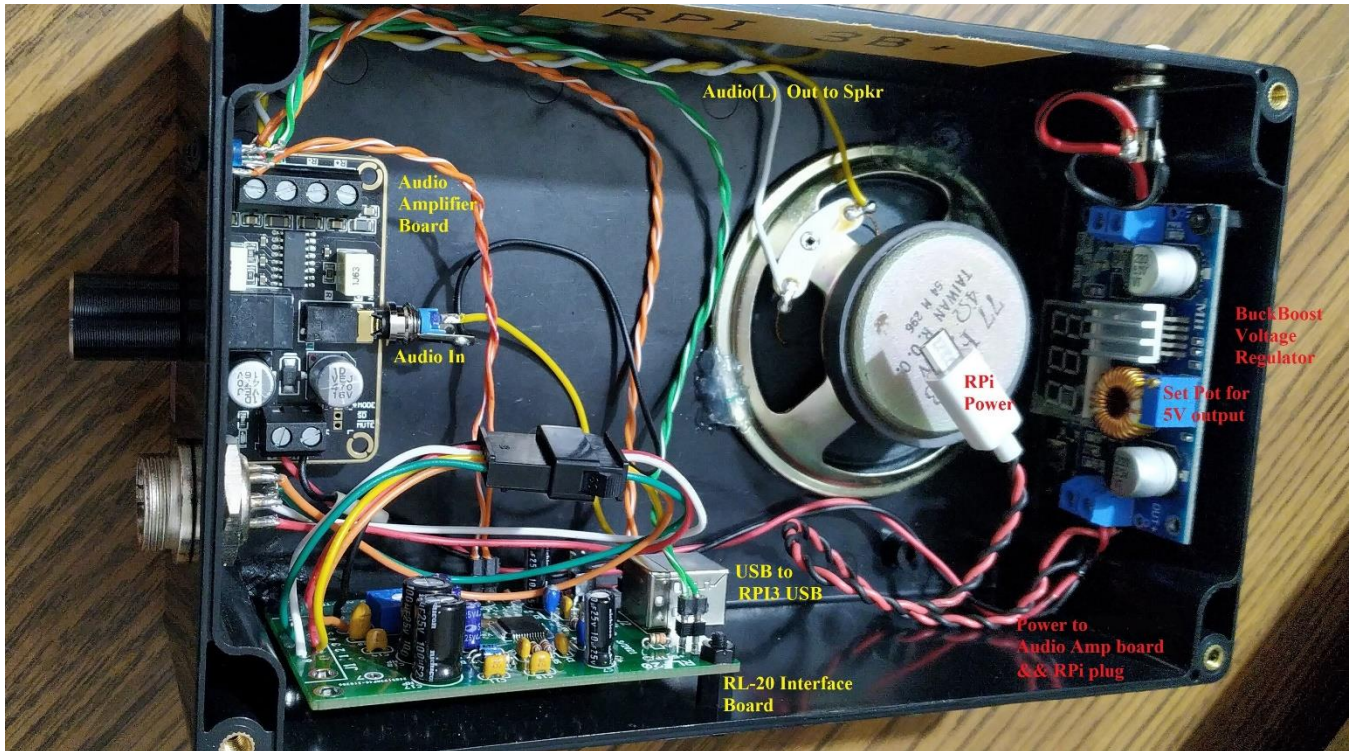


There is no radio in this node, so the concept of a COS, that is triggered by another HT or radio transmitting on the node input frequency of an RF-based node is therefore moot. In this configuration with the RL-20 board, the COS is triggered, when you push the PTT button on the EMS-57 mic. Thus, the COS LED from the RL-20 board, along with a slight required code addition, will be switched to the RED LED to serve as a PTT indication that will track with the EMS-57 PTT button. The heartbeat LED, remains the same flashing GREEN LED, and indicates the node is powered, and alive talking with the RPI3B+ on the network. The yellow LED should light when the node is active in reception. You will direct wire to the PC board where the DB9 connector would have been per the wiring chart and drawings to follow.

I built my RF-less node with REV2 of RL-20 board. Please note that the REV3 board now has convenient solder pads near the DB9 pads to allow for connecting up the 5V needed to power the EMS-57 mic +5V, as well as a point to attach 5V to power the 5V audio amplifier board. Use these pads on the RL-20 to alleviate longer runs to Buck converter power board that may pick up increased noise on longer run wires. The Buck converter supplies 5V to the RPI via the micro-USB plug you wire up, and then the supplied USB cable subsequently feeds power to the RL-20 board and associated circuitry connected to it.

The following picture illustrates ending positioning and was temporarily test fitted throughout construction with measurements taken for each of the mounting points and the requisite wire to reach in point to point fashion

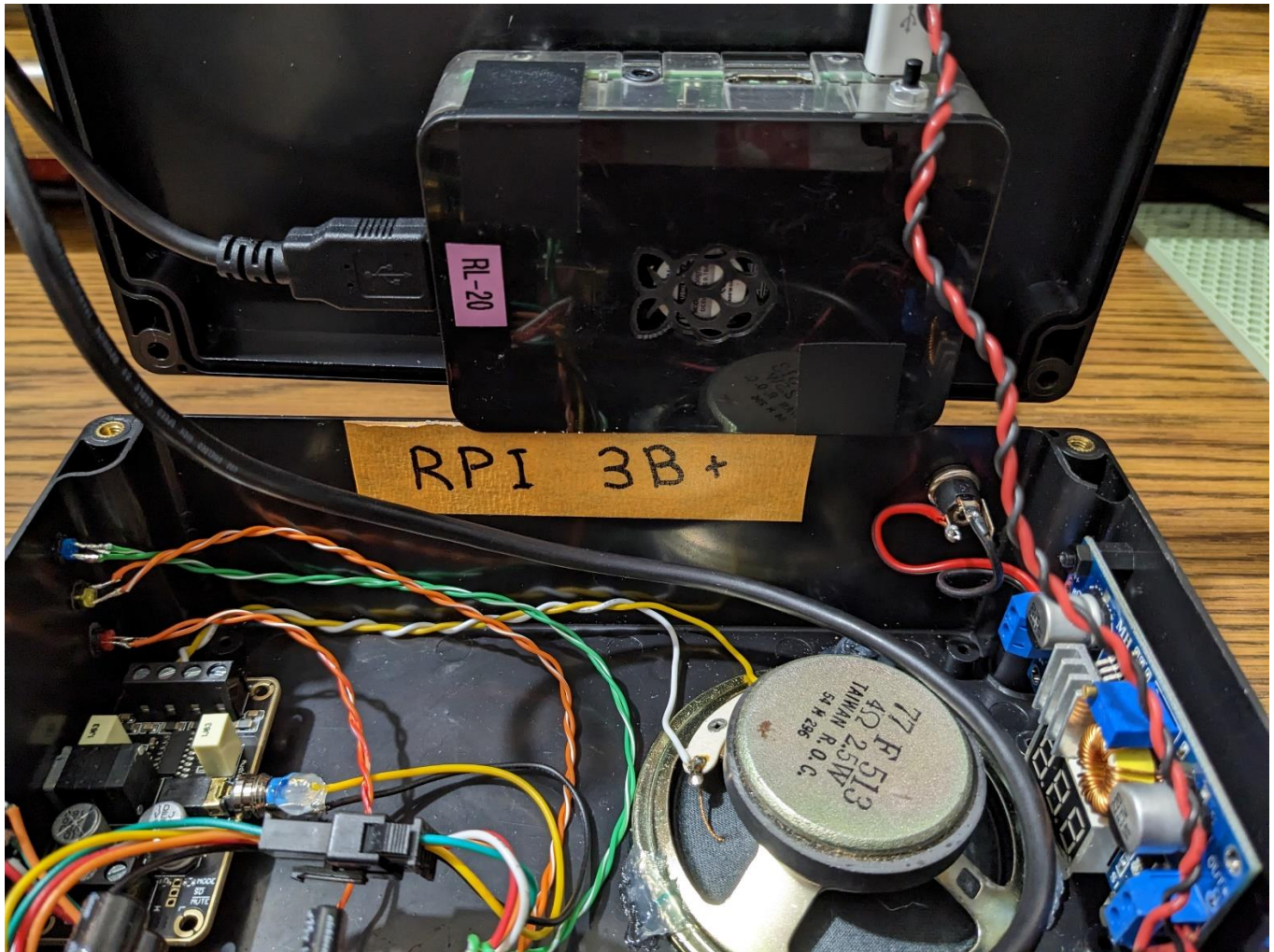
from board to board. I always cut wire a couple inches long before figuring out precisely where it would lay or tuck in, and then trim to exact length to make the connection to the board.



Wiring diagram

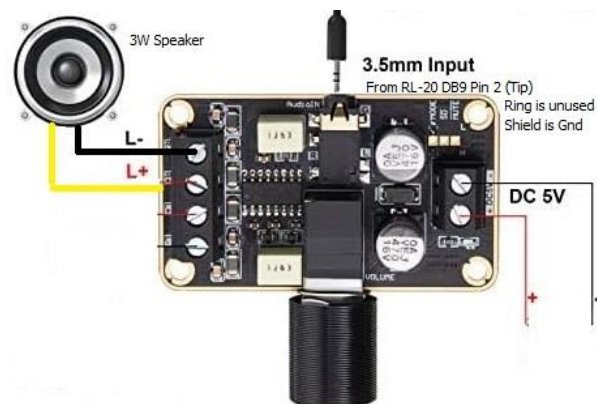
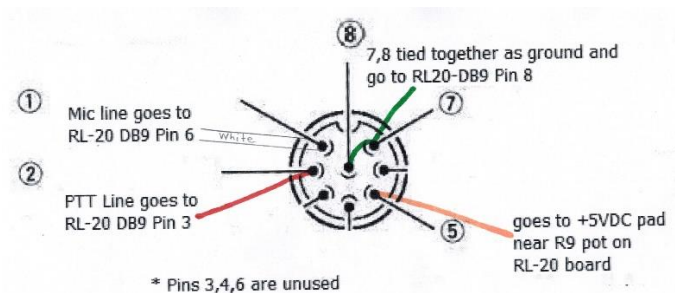
Loosely mount the boards in the case to prevent any shorting of boards/wires. Seen in the photo is the quick disconnect in black that made wiring these lines a little easier to complete then snap together at final install within the case. My chart below is leveraging the colors that came with this 6 wire connector. Red and black twisted wires were 5V power supply wiring to the circuit audio amp board, and the power plug into the RPi. If you blow up the above picture and look to the corner of the RL20 interface board you will see my leverage of DIP Sockets and DIP Pins in order to plug the LEDs in via short twisted pair of network cable wire. If you don't care about seeing LEDs blinking on front panel you may just proceed with mounting LEDs on the board with Yellow and Red swapped for RF-less node. The RL-20 connects to the RPi3 quite simply with a short USB-A to USB_B cord which then powers the interface board. The RL-20 PCB label marks with the *COS* and *PTT* are indicating the connection points for LEDs when building an RF-Less node.

Connection from	Color	Goes to (on RL-20 board @ DB9 end
8P Mic Socket Pin 5 (+5V)	Orange	Mic +5VDC pad on the RL20
8P Mic Socket Pins 8 && 7	Green	DB9 Pin8 on the RL20
8P Mic Socket Pins 3,4,6	Not Used	Left Unsoldered or could be snipped off
8P Mic Socket Pin 1 (Mic Audio)	White	DB9 Pin6 (DISC) on RL20
8P Mic Socket Pin 2 (PTT)	Red	DB9 Pin 3 (COS) on RL-20
Audio Amp -1/8" TRS stereo input	Yellow/Black	DB9 Pin 2 Audio Out (L) Tip && Sleeve only
Audio Amp Output- (L)eft	Yellow/Wht Twisted	Speaker terminals



Plug in the RPI when ready to test, but leave the final screw-tight mounting in project box as one of final steps when everything works on the network.

Note: After build of this node, if repeating another, I would leverage a shielded headphone cord to make the input connection to the audio amp, as well as the line over to the terminal lugs on the speaker. In these tight quarters, I may have even wrapped a few turns of that shielded cable around an RFI ferrite. Additionally, I used a rather fancy buck converter with a digital display on it. Once these things are set, with your multi-meter, they never need touched again, so the digital display is overkill, and in some cases may cause some noise. This unit's cabinet may have been downsized significantly if built-in speaker was left out and a "no-display" buck converter was used. Also, after fully built, and operating the only LED of significance to my daily use is the red PTT



Software Install

On the HamVoip.org website, there are detailed instructions for downloading and building the initial HamVOIP software image onto a Raspberry Pi 3, so I will not repeat those steps here. Follow them, in setting up the node with your Allstar ID number and your configuration for WiFi, with appropriate port forwarding configured for your home network. Also go to the trouble of setting up SuperMon6.2. You will surely use SuperMon6.2 to administer and control your RF-less node from a personal computer. Again, the instructions for setting up SuperMon6.2, are contained at the HamVoip.org website, and will not be duplicated here.

RL-20 Specific Configuration

The following covers the particulars of using the RL-20 board and settings or edits that will be required to run this RF-Less node.

An initial issue for me, was the IP address was not being voice announced on first boot-up of this RF-less node. This appeared to be remedied by editing the file `allstar.env` at `/usr/local/etc` and setting `START_DELAY=12`. I suspect with no RF components in the chain of bootup, the bootup is faster, and this was a timing matter.

Start by setting configurations to match the following in running `simple-usb-tune` menu in the administration menu of your particular node. In testing the audio out of your node it is useful to temporarily turn on the (C) "Toggle Echo Mode" so you can hear your audio play back to you and then get rough setting of good audio after the following is configured. Don't forget to toggle (C) back off when all done.

Setting Name	Set To	Your Settings or Comments
Name	Usb	
rxboost	Yes	Insure set before adjusting R9
PLfilter	Enabled yes	DTMF tones worked after enabled
DE-emphasis	Disabled no	This makes audio worst
PRE-emphasis	Disabled no	This makes audio worst
DCSFilter	Disabled no	Not used – leave no
PTT Mode	active LOW	
COSFROM	Usbinvert	COS is your PTT button push now

CTCSSFROM	No	Not used – leave no
RXONDELAY	0	Note used – leave no
RXAUDIODELAY	8	Eliminated “pop’ on PTT release
RXLevel	800	Insure set before adjusting R9
TX A Level	800	Insure set before adjusting R9
TX B Level	0	This channel not used in node
TX DSP Level	800	Insure set before adjusting R9

Having set the above software config settings, please be aware there is still a physical adjustment on the RL-20 card itself which controls audio level. My setting for the blue R9 POT is turned all the way counter-clockwise, and then adjusted clockwise about 3/8”, (or what I call the 7pm position) which should at least get you heard at another node while testing, as well as being heard back through ECHO, if you toggled ‘C’ on in the simpleusb_tune. If the DTMF tones were not passing through from the EMS-57 mic you may have to fiddle with the driving levels first with the board’s R9 and then simpleusb_tune settings if required in the software.

After insuring DTMF mic control is functional to connect and disconnect from your node, you may need to work with a fellow Ham on a connected node that is familiar with your voice, and audio levels normally, and may have you tweak your RX and TX settings. The above table represents my final settings on my node, and most should do quite well using these settings. Turning R9 further clockwise will increase the audio level of what you are transmitting while pressing PTT button. If you reduce R9 you could reach a point where the DTMF tones no longer make it through and controls do not work.

PTT Indicator

If you swap the LED positions on your RL-20 board, your red LED, indicating keyed microphone is still not going to work until you make some required edits to the rpt.conf file at /etc/asterisk, as well as the file simpleusb.conf also at /etc/asterisk

The details of this change can be found at Masters Communication website, and addendum at end of this document: <http://www.masterscommunications.com/products/radio-adapter/txt/hvconfiguration.txt>

FINAL PRODUCT



Code Change Addendum By Kevin Custer

The following configuration is necessary for COS indication using the Yellow LED on the RL-20. This code has only been tested in HamVoIP.

The COS LED can be driven by software to show the presence of a valid receive signal. This uses bit 8 of the CM119. Using the COS LED or its logic is optional. If you decide to use it you must configure the software to use the bit defined for the COS LED. If the configuration lines are not already installed you must add them.

Here are the lines to EDIT:

In /etc/asterisk/rpt.conf in the node stanza you want to activate the COS LED add the following in the mapping section if it is not already there.

```
events=eventsxxxxxx ;xxxxx is the node number for that stanza, your node number
```

EXAMPLE:

```
[usb]
events=events44067
```

Add the event stanza, if it's not already there. If it's there it will look like this, [eventsxxxxxx] where xxxxx is your node number. This can be located anywhere after the node stanzas. Typically between the [schedule] and [functions] stanza.

```
[eventsxxxxxx]
```

Add the following after the above line. If the lines are already there but commented, remove the ';' semicolon from the beginning of the line.

```
cop,62,GPIO8:1 = c|t|RPT_RXKEYED
cop,62,GPIO8:0 = c|f|RPT_RXKEYED
```

EXAMPLE:

```
[events44067]
cop,62,GPIO8:1 = c|t|RPT_RXKEYED
cop,62,GPIO8:0 = c|f|RPT_RXKEYED
```

If you are typing this in please pay attention to the exact syntax including case or better yet cut and paste from here to the file and edit in your node number

Save the rpt.conf file.

Now you will need to EDIT the /etc/asterisk/simpleusb.conf file.

Add the following to the stanza for the node you want to indicate the COS.

```
gpio8=out0
```

EXAMPLE:

```
[usb]
gpio8=out0
```

Save the simpleusb.conf file.

For these changes to take effect you must restart asterisk, or reboot the box.

RL-20 Node SW Config Addendum

Admin Menu (Option 12) simpleusb_tune_menu

```
lqqqqqqqqqqAdmin Menu List for: RPI3B484151-RF (192.168.0.13)qqqqqqqqqqqqk
x Please select: x
x lqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqk x
x x 1 Perform a system UPDATE (Internet access required) x x
x x 2 Change the ROOT password x x
x x 3 Change the primary NODE number x x
x x 4 Change the system Timezone x x
x x 5 Change the system Hostname x x
x x 6 Configure the Wired Ethernet Networking x x
x x 7 Configure the WiFi Interface Networking x x
x x 8 Change the Secure Shell (SSH) port x x
x x 9 Start Bash shell interface x x
x x 10 Display System Version Numbers x x
x x 11 Run Asterisk CLI client x x
x x 12 Run simpleusb-tune-menu Application x x
x x 13 Restart Asterisk Server x x
x x 14 Power-cycle the USB sub-system x x
x x 15 Reboot this system x x
x x 16 Perform system power down x x
x x
x mqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqq] x
x qqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqq]
x <Run Selected Item> < Exit / Logout > x
x qqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqq]
```

Settings of 'B' through 'N' for the RL-20 RF-Less Node

```
Active simpleusb device stanza: [usb] -----
S) Select active USB device stanza
V) View COS, CTCSS and PTT Telemetry using real-time display
P) Print Current Parameter Values ---- 2) Set Rx Voice Level (using display)
3) Set Transmit A Level ---- 4) Set Transmit B Level
5) Set Tx Audio Level Method (currently LOG)
7) Set Transmit DSP Level
B) Toggle RX Boost Mode (currently Enabled)
C) Toggle Echo Mode (currently Disabled)
D) Flash (Toggle PTT and Tone output several times)
E) Toggle Transmit Test Tone/Keying (currently Disabled)
K) Manually key COS (currently Unkeyed)
F) Toggle PRE-emphasis Mode (currently Disabled)
G) Toggle DE-emphasis Mode (currently Disabled)
H) Toggle PLfilter Mode (currently Enabled)
Q) Toggle DCSfilter Mode (currently Disabled)
I) Toggle PTT Mode (currently active LOW)
J) Change COSFROM Mode (currently "usbinvert")
L) Change CTCSSFROM Mode (currently "no")
M) Change RXONDELAY value (currently "0")
N) Change RXAUDIODELAY value (currently "8")
W) Write (Save) Current Parameter Values
0) Exit Menu
```

Settings of other RL-20 parameter options – Option (P) prints this list

```
Please enter your selection now: p
USB device String:          1-1.1.2:1.0

Card is:                    0
Name is:                    usb
Rx Level:                   800
Rx ondelay:                 0
Rx audio-delay:            8
Tx A Level:                 800
Tx B Level:                 0
Tx DSP Level:              800
preemphasis:               no
deemphasis:                no
plfilter:                  yes
dcsfilter:                 no
rxboost:                   yes

PTT:                        Active LOW
PTT status:                 Un-Keyed

CTCSS (input):              Ignored
COS (input):                CM108/CM119 Active LOW
COS (test):                 Un-Keyed
COS (composite):           Un-Keyed
```

Masters Communication RL-20 Info: <http://www.masterscommunications.com/products/radio-adapter/rl/rl20.html>

HamVoip Initial Install: <https://hamvoip.org/> scroll down about 1/3 of this page for SW download; image card

SuperMon6 Setup : https://hamvoip.org/howto/supermon_howto.pdf
<https://www.youtube.com/watch?v=0WZfl-Ws274&t=20s>