

# John's Tech Blog

Had all I can take, I can't take no more. ~Popeye

## OP25 For Dummies – Or how to build a police scanner for \$30 (Part 1)

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OP25 is a program that decodes P25 Phase 1 and Phase 2 digital radio. Some municipal areas are upgrading to P25 Phase 2 so almost gone are the days that you can track them with a police scanner since P25 is a Trunked Radio system and not just a lone frequency to monitor. The only things that do Phase 2 are hardware scanners and hardware radios and OP25 for software radios. Bear in mind Phase 2 could be encrypted and nothing you can do will decode it.

OP25 is **HARD**. I'm a geek and I messed with it on and off for a year or more and it whipped me more than once. Now that I have it working I find that it is REMARKABLY easy and I'm mad at all the geeks out there who never made a simple tutorial. There are tutorials out there, some good but everybody leaves out the good stuff or the stuff they took for granted.

I'm kind of working on the assumption that you have Linux installed and have your SDR device working. In a pinch I guess the first thing you could do is to install gqrx which would pull in all the necessary RTL stuff you need. Follow the directions [here](#) if you need to. Yeah that's a weird way of doing it but it'll work and probably the easiest thing to do for a newbie.

Installing OP25 is a SNAP. Download from the repository using this command. I'm doing this on Ubuntu 18.04

```
git clone https://github.com/boatbod/op25.git
```

It will make a folder called op25

```
cd op25
```

```
./install.sh
```

It will instruct you to install GNUPLOT following the build and install process

```
sudo apt-get install gnuplot-x11
```

Wait a bit for it to install. It should take care of everything.

Now it is installed but there are three obstacles to overcome.

- How to launch the program with what command to use
- How to set up the file trunk.tsv
- How to set up the file yourcity.tsv

That's basically it. Now my assumption here is that you are using a generic RTL-SDR device. I'm using a V3.



These will set you back about \$30 or so. But you only need one of these to track a trunked radio system.

So plug in your RTL-SDR device and let's get ready to do this thing.

I'm going to demonstrate using my home town of New Bern NC. Lets find the trunked system to follow.

Go to [this page](#) to list the frequencies.

### System Frequencies

**Red (c)** are primary control channels | **Blue (a)** are alternate control channels | Site Map(s): [FCC Callsigns](#) [RR Locations](#)

RFSS	Site	Name	Freqs							
1 (1)	001 (1)	New Bern	854.0625a	856.2625	856.5625a	856.7375	857.2625a	857.7375c	858.2625a	858.7375
			859.2625	859.5125a	859.7375					

This page will not always be spot on. The actual control channel at the moment (they change it sometimes) is 857.2625.

To find the control channel if you don't know which one it is just open a program like GQRX and look and listen for the control channel. It will sound like digital noise. And the signal will be a constant spike. As you can see I found my Control Channel at 857.2625 as stated above.

Now go back to your system and get in the correct directory. Check your path for accuracy.

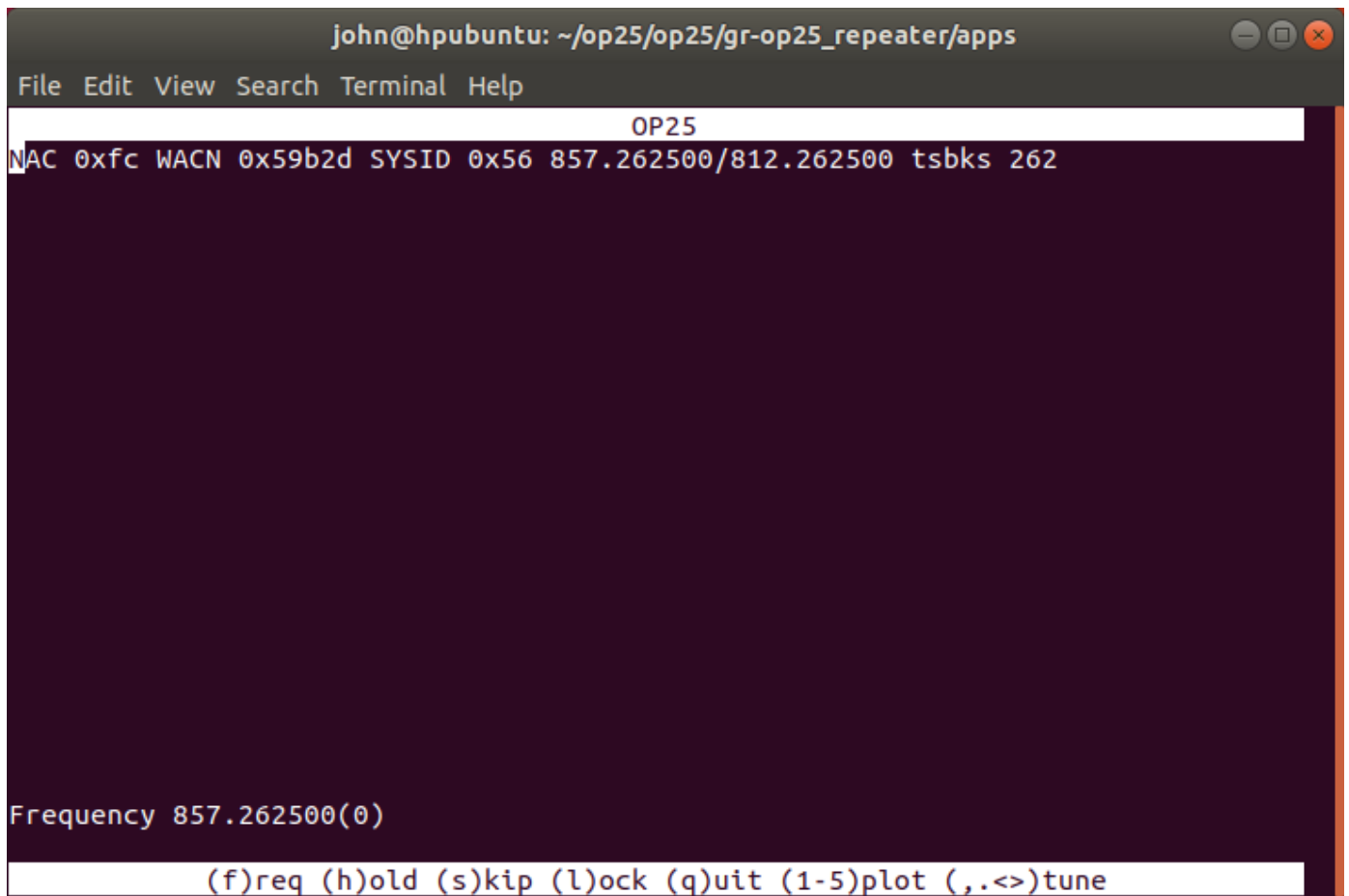
```
cd /home/john/op25/op25/gr-op25_repeater/apps
```

Now try this command **IF YOU ARE SETTING UP A DIFFERENT FREQUENCY FOR YOUR TOWN MAKE SURE TO ADJUST THE FREQUENCY IN THE COMMAND. I ALSO FOUND I CAN DO THIS WITH AN ADALM-PLUTOSDR BY CHANGING THE -ARGS TO 'plutosdr'.**

```
./rx.py --args 'rtl' -N 'LNA:47' -S 2400000 -f 857.2625e6 -o 25000 -q -2
```

If you get a bunch of errors remove the last part of the command (-q -2) It works as above on my V3 SDR but not on my NESDR Smart. You may also have to adjust the -2 number depending on your individual SDR. Have fun with that. To further illustrate my SDR v3 works at -2, my NESDR Smart works with the -q -2 removed (0), and my Adalm-Pluto works at -q 5 (positive 5). You just have to play around until you get your signal centered on the plot.

As per the pic below .....If where it says 857.262500/812.262500 is all zeros then you need to keep adjusting the -q number. On that screen you can start GNUPLOT by pressing the number 1 key. Keep messing with the q number until the signal is centered on the plot.

A screenshot of a terminal window titled 'john@hpubuntu: ~/op25/op25/gr-op25\_repeater/apps'. The window has a menu bar with 'File', 'Edit', 'View', 'Search', 'Terminal', and 'Help'. The main display area is dark purple. At the top, 'OP25' is written in white. Below it, a line of text in red and white reads 'NAC 0xfc WACN 0x59b2d SYSID 0x56 857.262500/812.262500 tsbks 262'. At the bottom left, 'Frequency 857.262500(0)' is shown in white. At the bottom right, a command prompt '(f)req (h)old (s)kip (l)ock (q)uit (1-5)plot (.,.<>)tune' is displayed in red and white. The terminal window has standard Ubuntu window controls (minimize, maximize, close) in the top right corner.

```
john@hpubuntu: ~/op25/op25/gr-op25_repeater/apps
File Edit View Search Terminal Help
OP25
NAC 0xfc WACN 0x59b2d SYSID 0x56 857.262500/812.262500 tsbks 262
Frequency 857.262500(0)
(f)req (h)old (s)kip (l)ock (q)uit (1-5)plot (.,.<>)tune
```

Something like the box above should pop up. There won't be any sound but take note of the NAC. In my case it is **0xfc**. We're going to need that. Copy your NAC for your frequency. **YOU WILL ONLY GET THE CORRECT NAC IF YOU ARE TUNED TO THE CONTROL CHANNEL YOU WANT TO MONITOR.**

Now you should still be in the apps directory. Double click on the file named trunk.tsv and open it with LibreOffice. Make sure the file looks like this and has these settings. (I've already modified my file, so ignore the difference.)

**Text Import - [trunk.tsv]**

**Import**

Character set: Unicode (UTF-8)

Language: Default - English (USA)

From row: 1 - +

**Separator Options**

☐ Fixed width ☒ Separated by

☒ Tab ☐ Comma ☐ Semicolon ☐ Space ☐ Other

☐ Merge delimiters String delimiter: " ▼

**Other Options**

☒ Format quoted field as text ☐ Detect special numbers

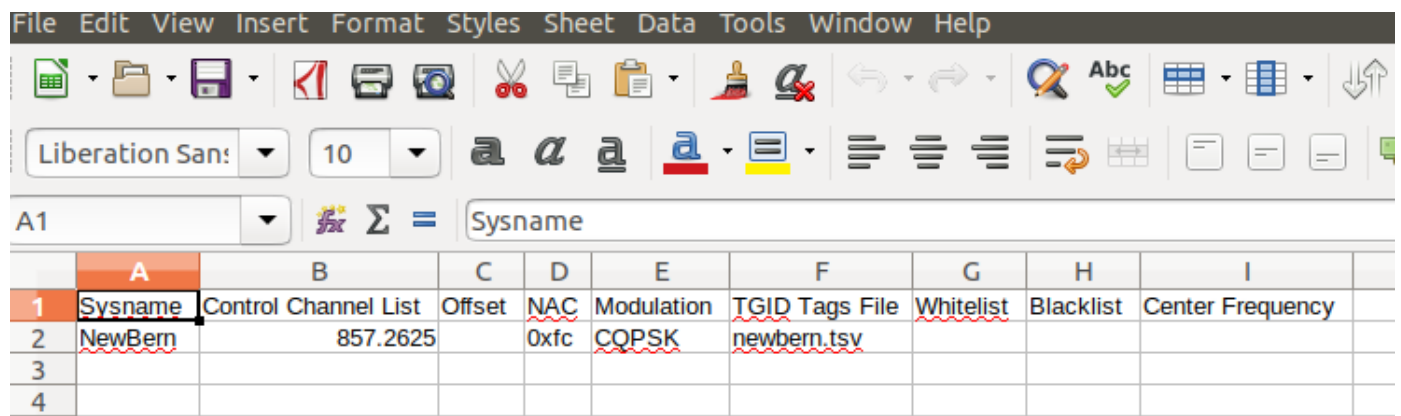
**Fields**

Column type:

	Standard	Standard	Standard	Standard	Standard	Standard
1	Sysname	Control Channel List	Offset	NAC	Modulation	TGID
2	NewBern	857.2625		0xfc	CQPSK	newbe

Help OK Cancel

Now take note of the way I changed the file. I made the SysName = NewBern, then put my control channel frequency in, put the NAC I copied earlier in, and then told it the tag file was named newbern.tsv Under modulation there are only two types, CQPSK or C4FM. If one doesn't work, try the other. Save this and exit. Save it as the "Use Text CSV Format"



	A	B	C	D	E	F	G	H	I
1	Sysname	Control Channel List	Offset	NAC	Modulation	TGID Tags File	Whitelist	Blacklist	Center Frequency
2	NewBern	857.2625		0xfc	CPSK	newbern.tsv			
3									
4									

Now open the file tompkins.tsv. It looks like this. Make sure the settings are the same as depicted above.

File Edit View Insert Format Styles Sheet Data Tools Window Help									
Liberation Sans 10									
A1 $\Sigma$ = 1									
	A	B	C	D	E	F	G	H	
1	1	Range Test							
2	2	Range Test							
3	7	Range Test							
4	55001	Fire/EMS							
5	55002	TC Fire Disp							
6	55003	Ithaca FD							
7	55004	MED A							
8	55005	MED B							
9	55050	Hosp Multi							
10	55051	CMC							
11	55052	CRMC							
12	55075	Ithaca FD/FG							
13	55100	All Call							
14	55101	Brooktondale							
15	55102	Speedsville							
16	55103	Salterville							
17	55150	All Call							
18	55152	West Danby							
19	55175	All Call							
20	55177	Etna							
21	55178	Freeville							
22	55179	Varna							
23	55180	McClean							
24	55201	Groton							
25	55202	Enfield							
26	55203	Newfield							
27	55204	Trumansburg							
28	55205	CayugaHeight							
29	55206	Lansing							
30	55250	EmrgAllCall							

Delete all the filled in fields in here and go back to the radio reference.com page where all the New Bern frequencies were.

**New Bern EMS Talkgroups** ▶

DEC	HEX	Mode	Alpha Tag	Description	Tag
500	1f4	D	NBEMS DISP	New Bern EMS Disp	EMS Dispatch
501	1f5	D	NBEMS DISP2	New Bern EMS Dispatch 2	EMS Dispatch

**New Bern Fire Talkgroups** ▶

DEC	HEX	Mode	Alpha Tag	Description	Tag
100	064	D	NB FIRE DISP	New Bern Fire Dispatch	Fire Dispatch
101	065	D	NB FIRE TAC1	New Bern Fire Tac 1	Fire-Tac
102	066	D	NB FIRE TAC	New Bern Fire Tac 2	Fire-Tac
111	06f	D	NB FGROUND1	New Bern Fireground 1	Fire-Talk
112	070	D	NB FGROUND2	New Bern Fireground 2	Fire-Talk
113	071	D	NB FGROUND3	New Bern Fireground 3	Fire-Talk

**New Bern Police Talkgroups** ▶

DEC	HEX	Mode	Alpha Tag	Description	Tag
200	0c8	D	NBPD DISP	New Bern Police Dispatch	Law Dispatch
204	0cc	D	NBPD AC	New Bern Police Animal Control	Law Dispatch

**New Bern Public Works Talkgroups** ▶

DEC	HEX	Mode	Alpha Tag	Description	Tag
300	12c	D	NBPWS	New Bern Public Works	Public Works
304	130	D	NBPWS	New Bern Public Works	Public Works
400	190	D	NBPWS	New Bern Public Works	Public Works
401	191	D	NBPWS	New Bern Public Works	Public Works
403	193	D	NBPWS	New Bern Public Works	Public Works
600	258	D	NBPWS	New Bern Public Works	Public Works
700	2bc	D	NBPWS	New Bern Public Works	Public Works

**NOTE: TO EASILY INPUT TALK GROUP DATA GET A PREMIUM MEMBERSHIP AT [RADIOREFERENCE.COM](http://radioreference.com) (\$30 per year) AND YOU CAN DOWNLOAD SPREADSHEETS AND JUST CUT AND PASTE THEM INTO YOUR TSV FILES BELOW. I MERGED TWO TAG CELLS TOGETHER TO GET MORE DESCRIPTIVE INFORMATION, ESPECIALLY ON THE VIPER SYSTEM THAT HAS OVER 2000 ENTRIES. HOW'D YOU LIKE TO HAND ADD 2000 ENTRIES?**



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Last Updated: June 12, 2016, 2:20 pm

[Home](#)[Downloads and Reports](#)[NC Trunking](#)[Submit](#)[Admin](#)

## New Bern Public Safety - Downloads and Reports

You can download information directly into your radio by using a scanner programming software application that supports the RadioReference.com *Web Service Direct Download* feature. Please see the following page for information on how to get started using this feature:

[Programming Your Scanner with the RadioReference Web Service](#)

### Pre-Defined Report Downloads

[Download CSV File of All Sites and Frequencies for Trunked System: New Bern Public Safety](#)[Download CSV File of All Talkgroups for Trunked System: New Bern Public Safety](#)[Download Printable PDF File of Trunked System: New Bern Public Safety](#)[Download Printable PDF File of Trunked System: New Bern Public Safety \(All talkgroups sorted\)](#)

### Data Downloads

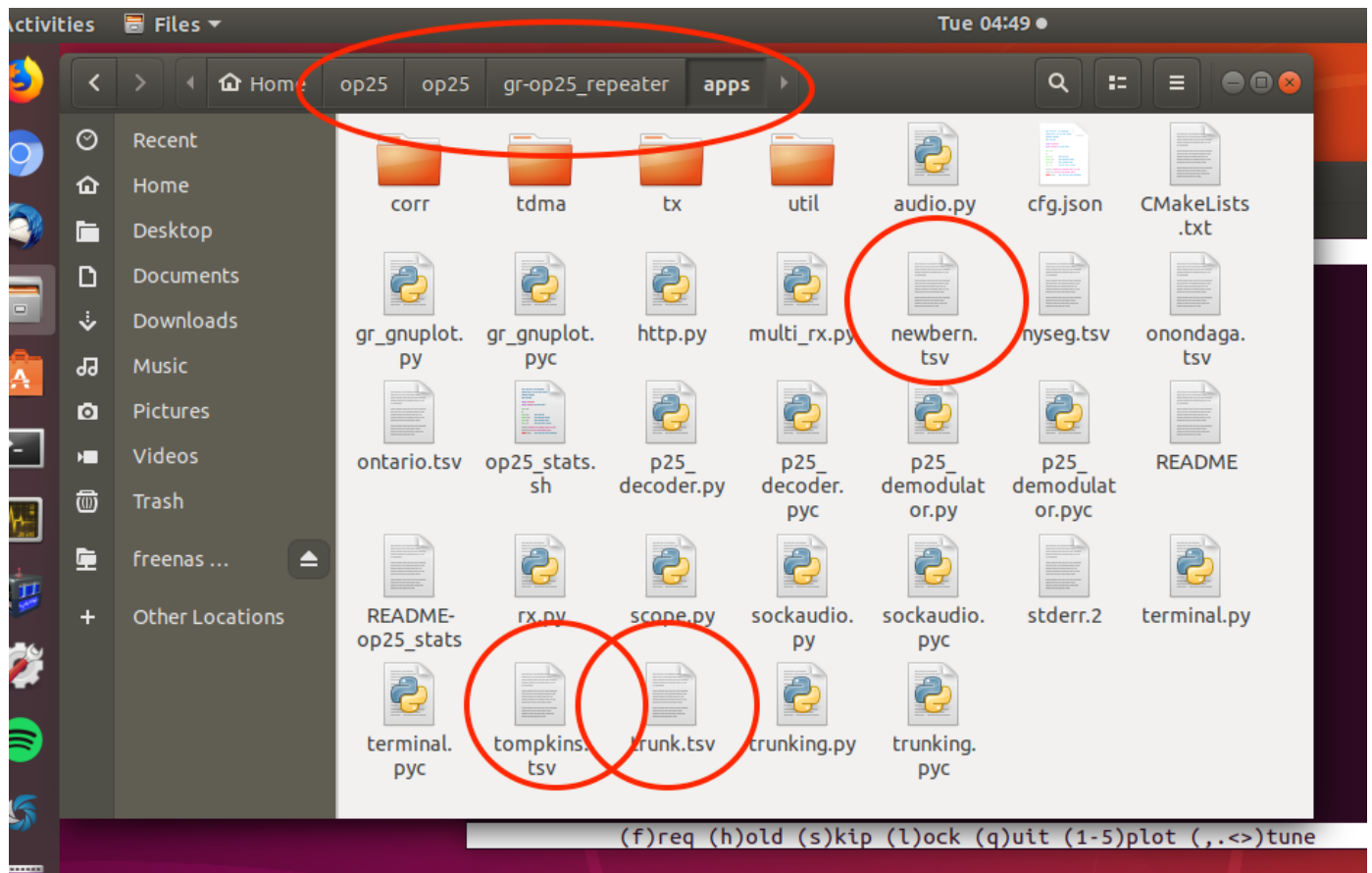
[Download DSD Formatted Sites Data File for Trunked System: New Bern Public Safety](#)

Now go to the tompkins.tsv file that you cleared and type in column A the numbers in the DEC column (i.e. 100, 101, 102, etc.) Then in column B insert in the tag (i.e. Law Dispatch, Public Works, etc.).

Sorry mine are not in order. Sue me.

	A	B	C	D	E
1	200	Law Dispatch			
2	204	Law Dispatch			
3	100	Fire Dispatch			
4	101	<u>Fire-Tac</u>			
5	102	<u>Fire-Tac</u>			
6	500	EMS-Dispatch			
7	501	EMS-Dispatch			
8	111	Fire-Talk			
9	112	Fire-Talk			
10	113	Fire-Talk			
11	300	Public Works			
12	304	Public Works			
13	400	Public Works			
14	401	Public Works			
15	403	Public Works			
16	600	Public Works			
17	700	Public Works			
18					
19					

Do a “Save As” and name the file newbern.tsv (remember that field in the other file you named newbern.tsv). Make sure this file is also saved in the same format as above and also in the apps directory where the tompkins.tsv file was.



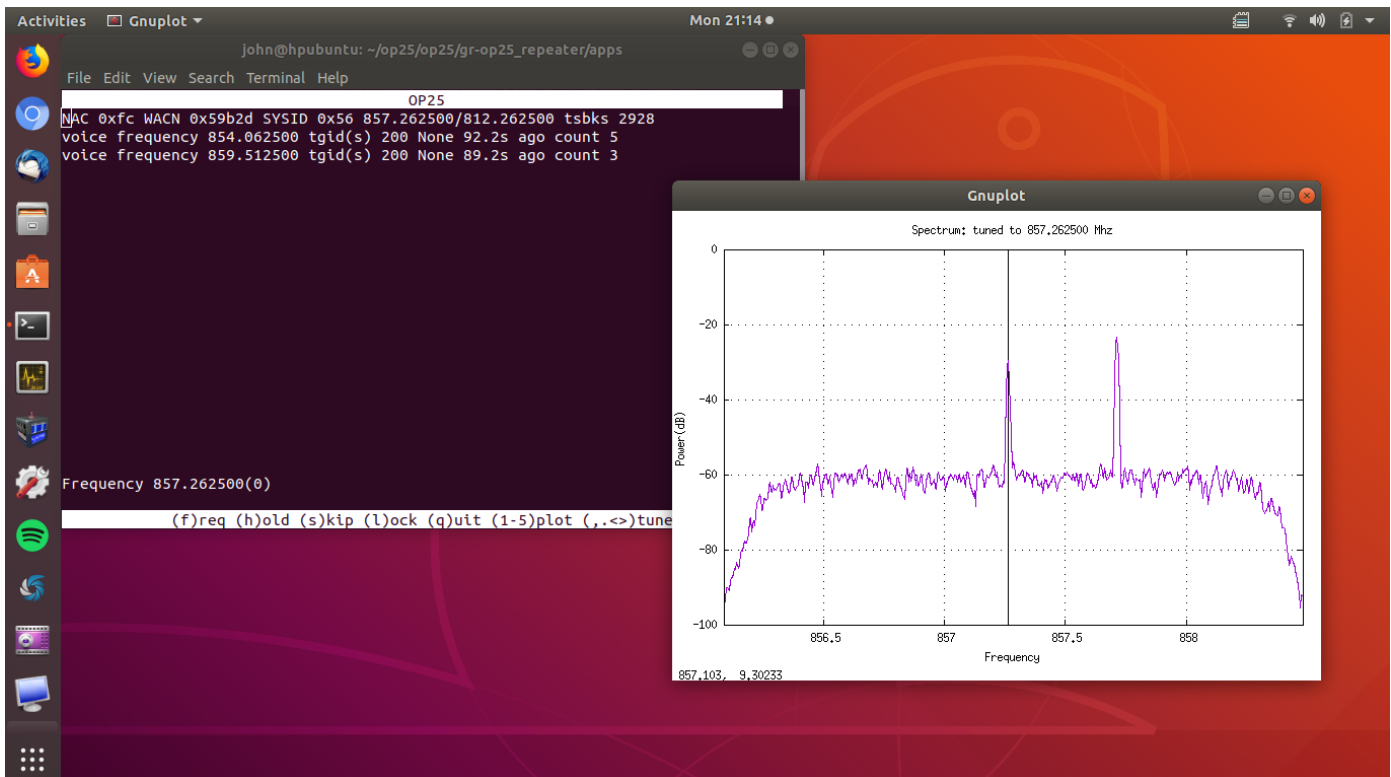
Okay open your terminal. cd to the apps directory /op25/op25/gr-op25\_repeater/apps and do this command:

```
./rx.py --args 'rtl' -N 'LNA:47' -S 2400000 -f 857.2625e6 -o 25000 -q -2 -T trunk.tsv -V -2 -U 2>
stderr.2
```

Again you may have to remove the -q -2 or adjust it depending on your SDR

```
john@hpubuntu: ~/op25/op25/gr-op25_repeater/apps
File Edit View Search Terminal Help
john@hpubuntu:~/op25/op25/gr-op25_repeater/apps$ ./rx.py --args 'rtl' -N 'LNA:47'
-S 2400000 -f 857.2625e6 -o 25000 -q -2 -T trunk.tsv -V -2 -U 2> stderr.2
```

When OP25 launches hit the number “1” on your keyboard to open GNUPLLOT



And now when there is a transmission on the Control Channel, OP25 will track it to the correct frequency and even display the talk group that is currently active.

Now lets make a little script file so we aren't forever typing long commands.

```
cd
```

```
cd op25
```

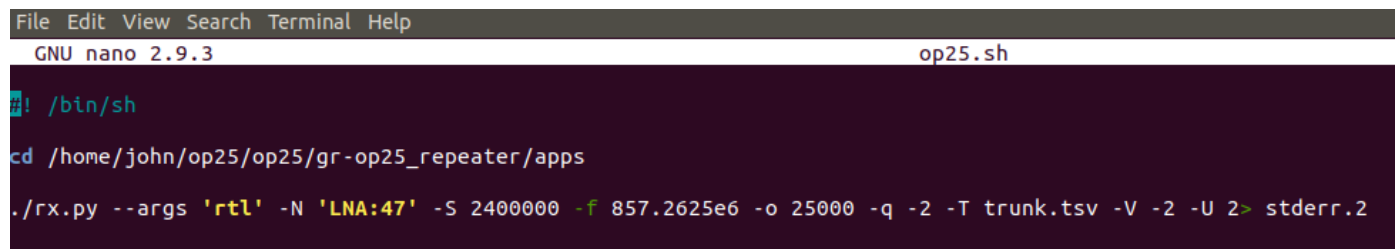
```
sudo nano op25.sh
```

Paste in the following data in the file **(MAKE SURE YOUR PATH IS CORRECT AND DON'T FORGET ABOUT THE -q -2 part if you have problems):**

```
#!/bin/sh
```

```
cd /home/john/op25/op25/gr-op25_repeater/apps
```

```
./rx.py --args 'rtl' -N 'LNA:47' -S 2400000 -f 857.2625e6 -o 25000 -q -2 -T trunk.tsv -V -2 -U 2> stderr.2
```



```
File Edit View Search Terminal Help
GNU nano 2.9.3 op25.sh

#!/bin/sh

cd /home/john/op25/op25/gr-op25_repeater/apps

./rx.py --args 'rtl' -N 'LNA:47' -S 2400000 -f 857.2625e6 -o 25000 -q -2 -T trunk.tsv -V -2 -U 2> stderr.2
```

Hit CTL + the X key then Y to save the file. Now make it executable.

```
sudo chmod +x op25.sh
```

Now to launch the file simply be in the directory that script file is in and type:

```
./op25.sh
```

It will cd to to the right directory and run the command to start OP25.

That's it. I hope I made this easier for someone.

Here's OP25 in action:

And lastly here is a video of me using OP25 to track 2 Control Channels simultaneously. You'll hear the transmissions echo in the video. That is my screencast software recording both from the microphone and speakers and not the way OP25 sounds.

On a final note just for fun I installed OP25 on a Raspberry Pi 3 B+. It works like a champ. I installed GQRX first which pulled in most everything OP25 needs and plus I use GQRX a lot anyway. OP25 takes a while to build on a Pi but it does build. If you look at the pic below the CPU usage is 40% however to get this picture I was running a VNC server as well so some of that usage is almost certainly the VNC session.

```

pi@raspberrypi3bplus: ~/op25/op25/gr-op25_repeater/apps
File Edit Tabs Help
OP25
NAC 0xfc WACN 0x59b2d SYSID 0x56 857.262500/812.262500 tsbks 261492
voice frequency 854.062500 tgid(s) 101 None 315.2s ago count 415
voice frequency 856.262500 tgid(s) 101 None 309.2s ago count 437
voice frequency 856.562500 tgid(s) 101 None 704.3s ago count 514
voice frequency 856.737500 tgid(s) 200 None 8.7s ago count 426
voice frequency 857.737500 tgid(s) 200 None 5.2s ago count 433
voice frequency 858.262500 tgid(s) 200 None 2.0s ago count 476
voice frequency 858.737500 tgid(s) 101 None 723.9s ago count 509
voice frequency 859.262500 tgid(s) 101 None 712.6s ago count 488
voice frequency 859.512500 tgid(s) 101 None 312.1s ago count 484
voice frequency 859.737500 tgid(s) 101 None 708.9s ago count 501

Frequency 858.262500(0) Talkgroup ID 200 20053
Law Dispatch NB
(f)req (h)old (s)kip (l)ock (q)uit (1-5)plot (.,.<>)tune

```

This is a living document (for a while). If you find something I should add feel free to go to my contact page and email me.

This entry was posted in Linux, SDR, Software on July 17, 2018

[<https://www.hagensieker.com/wordpress/2018/07/17/op25-for-dummies/>].

16 thoughts on “OP25 For Dummies – Or how to build a police scanner for \$30 (Part 1)”

Pingback: [Tutorial on Setting up OP25 for P25 Phase 2 Digital Voice Decoding - rtl-sdr.com](#)



Gene

July 22, 2018 at 2:05 pm

Thank you. Runs great on a Tinkerboard. Monitoring Louisville Metrosafe. Used the standard RTL install procedures then I used `sudo apt-get install gqrx-sdr` and then `sudo apt-get install libvolk1-bin` and ran `volk_profile`. Then I followed all of your steps. And just for info the `-n` option in OP25 somewhere near the beginning of the will block the encrypted squeals that can cause loved ones to vote you off the island. I'm not sure why but this system has a better sound than others that I use and like.



Thanks again, have finally found a use for this SBC that I had written off months ago. As an additional note my V3 is running off a powered USB adapter, not the Tinkerboard usb power.

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Pingback: [OP25 on a Raspberry Pi \(part 3\) | John's Tech Blog](#)



**John Ossi**

August 8, 2018 at 4:09 am

Can you point me for assistance on getting Unbuntu 18 onto a Pi?

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**John Hagensieker**

Post author

August 8, 2018 at 9:14 am

<https://ubuntu-mate.org/raspberry-pi/>

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**Brian**

August 12, 2018 at 3:43 am

Thanks for great tutorials. Not only got op25 phase 2 running on my laptop under Ubuntu, but also got it working on my Raspberry Pi 3 perfectly!

I have a question, I am using the -n switch to silence the encrypted stuff (works fine), but is there a way to block them completely? I find sometimes the encrypted "silenced" talkgroups, over ride the non-encrypted ones and I miss some of the information. I listen to the fire departments in my area, but the police who are encrypted are on the same control channel and I will sometimes miss the dispatch of a fire call because a "silenced" talkgroup is active. Is there a way around this by chance?

Thanks again for taking the time to put this information together in a easy to understand format!!

---



**John Hagensieker**

Post author

August 12, 2018 at 10:15 am

In your .tsv file you can set Priority but you'd have to know which talk groups the encrypted stuff is generally on. Set a low priority for it.

---

**Brian**

August 13, 2018 at 1:21 am

ah, OK. I'll give that a go then. I am getting a pretty good idea of which talk groups are the busiest and those will be my priority first.

Thanks for the reply!

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**Matt R.**

September 21, 2018 at 11:34 pm

The "blacklist" field in trunk.tsv tells op25 to skip a talkgroup completely and keep listening for other talkgroups; I have been putting the encrypted talkgroups on the local system in that field and it seems to work OK. See my reply further below for the details.

(Even with a talkgroup in the blacklist, if somebody transmits on that talkgroup, you will still see the talkgroup near the top of the screen, where op25 lists the last 5 frequencies it heard things on – you just won't hear the audio for that talkgroup.)

I hope this helps!

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**PiScanner**

August 17, 2018 at 4:51 pm

I see all the comments about getting this going on RasPi 3 B+, but not the details on it. So could you please post the RasPi 3 B+ portion of the tutorial. A couple SDR dongles and a PI 3+ would still be cheaper than a \$600 P25-P11 scanner, or a \$3K P25 P11 radio and hoping you can keep it unaffiliated and unstunned.

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**John Hagensieker**[Post author](#)

August 17, 2018 at 10:06 pm

Check the later posts on my blog. I did just that.

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**David Dobson**

August 29, 2018 at 7:26 pm

First time link user (ubuntu18-04) how and where can I check my build to ensure all is their and what not and something to compare to

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**Gared**

September 5, 2018 at 12:00 am

I am linux stupid, but this tutorial helped me out a lot thank you. I am having trouble with setting up the whitelist I can't seem to find it ( if you have it and I skipped it i'm sorry my brain is still fried from the commands )

Do you have to setup a new line with the nac and the whitelist every time? Or just in the whitelist box you can have many many entries?

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**Ashleigh**

September 14, 2018 at 8:54 pm

Thanks for the tutorial. It saved me days of work. I had this working great for a few weeks but then i got a software update thru ubuntu yesterday and now its broken. I run op25.sh and it stops at setting gain LNA to 47

Any ideas how to fix it?

---

fox



September 21, 2018 at 1:22 am

I suggest you check some forums, lots of help there.



Matt R.

September 21, 2018 at 11:30 pm

Thanks for the write-up! I got an RTL-SDR a few years ago, when P25 decoding was not as far along as it is now. I started playing with it again recently and now I have a scanner – thanks!

Some notes on how I set it up:

I found I could copy the text of the tables on Radio-Reference and paste it into LibreOffice. LibreOffice treats the paste like importing a text file, and breaks it up into columns and rows pretty much how you would expect. You can then cut it down to just the talkgroup ID (first column) and whatever you want to use for the description (second column), for the .tsv file that describes the system you want to listen to.

I used the “Description” field from Radio-Reference as the description in my .tsv file. The “Tag” field there is pretty generic; the “Alpha Tag” is a little better, but still kind of cryptic – especially on a system like the one near me, which has 800+ talkgroups. (On the other hand, “Alpha Tag” probably matches what the “official” system users actually see on the front of their radios.)

When you are first listening, you might want to have a text file or a piece of paper handy. You will probably hear some encrypted talkgroups; note their talkgroup IDs. Then, add those channels into the “blacklist” field in trunk.tsv – you can put more than one talkgroup in that cell, separating them with commas. If you wanted to ignore talkgroups 1001, 2002, and 3003, that cell would look like this:

1001,2002,3003

Save trunk.tsv and restart the scanner program and op25 will then skip those talkgroups. (There is an -n option to rx.py to ignore encrypted channels, but if you use that, op25 will still stop on an encrypted talkgroup for as long as someone is transmitting on that talkgroup. Putting the talkgroup in the blacklist makes op25 skip it immediately and keep checking for other transmissions.)

Thanks!

