

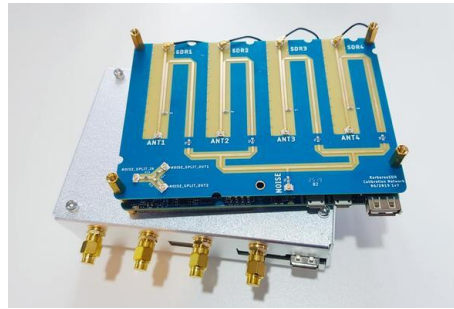


SDR & Flex Radio

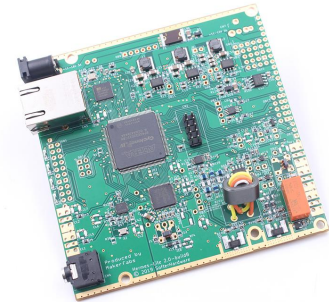
Is It The Future Of Amateur Radio?

By: Jeffrey Bail - NT1K
[Http://www.nt1k.com](http://www.nt1k.com)

About Me



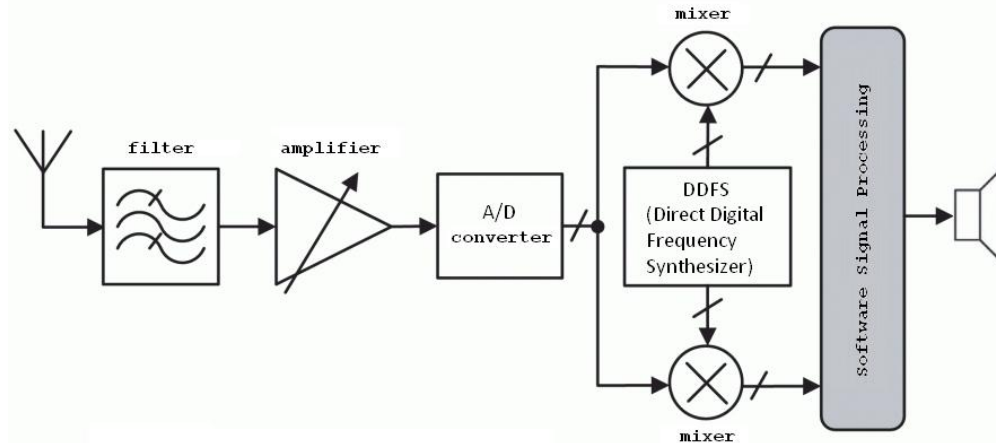
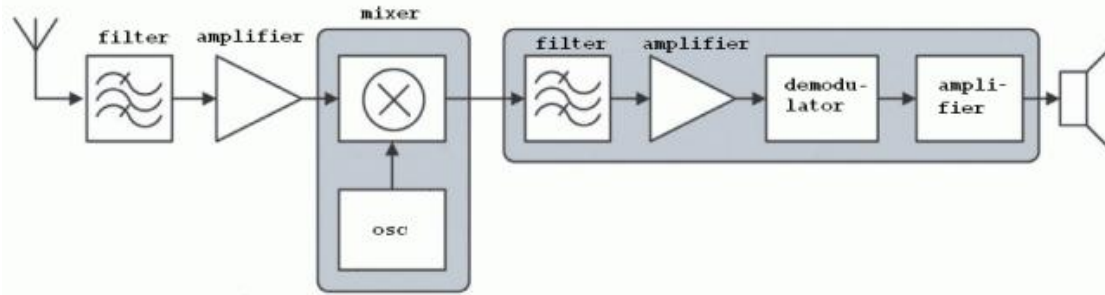
- Been into Amateur Radio since the early 1990's
- Finally licensed in 2001 as KB1GJQ. Quickly changed to N1BMX
- Obtain extra in 2011, changed call to NT1K
- Main interests are contesting, DXCC, antenna and kit building.
- Got into Software Defined Radio in early 2000's
- Started with Softrock, RTL SDR, AFEDRI (IP Based)
- Adapted a FT-950 & Elecraft K3 to use SDR as a pan adapter
- Purchased Flex in mid 2019



What is SDR?

- SDR = Software Defined Radio
- Basically takes an analog signal and converts it to digital for processing.
- Software (either by computer or embedded systems) transforms the digital data to any other form the application requires (SSB, Digital) and will also apply DSP and filtering
- “Digital” Radios were in use since the early 70s
- Term “Software Radio” was used in 1984 to refer to a digital baseband receiver
- SDR type radios were being produced for the Military in the 1990’s for a program called “SPEAKeasy”

Typical Superhet/SDR Block Diagram



SDR Pros (For The Radio Amateur)

- Instantly see band activity (w/ panadapter)
 - Easily focus in on a signal (w/panadapter)
 - Easier to fight in pileups/split (w/pandapter)
-
- Able to adjust filters and apply different DSP algorithms
 - Less distortion = Better Audio
 - Room for development
 - Standalone options available (no need for a computer)
 - FOSS (Open Source) options
 - Update entire radio with only software/firmware upgrades
 - Easier to share (remote) your radio using IP
 - Software could perform multiple tasks (CW/Data decode/encode, logging, station control)
 - Simplified hardware, easier maintenance, less power consumption (on RX)
 - Cheaper prices (Looking at the Icom 7300)... In some cases

SDR Cons (For The Radio Amateur)

- Extensive hardware and software development needed
- Needs processing power (FPGA, PC)
- Some units depend on separate computer - (Not ideal for portable/EmComm use)
- Some units have no display (other than LED indicators) nor any buttons
- Difficulty for home user repair (SMT, Proprietary ICs). Most newer xcvrs also have this
- Possibly need multiple computer monitors
- Difficulty integrating other applications that use audio (WSJT-X, FLdigi)
- Latency issues using IP

Different SDR hardware used by hams

- SDR Receiver Dongles - Either a dongle or puck that connects to your computer VIA USB (RTL, Airtspy, SDRPlay).
- SDR VIA IP - Transfers data using IP instead of USB (AFEDRI, NetSDR, KiwiSDR)
- SDR Kits - Hermes (\$250), Softrock (\$89)
- Standalone SDR xcvr. No computer needed - Elecraft K4, KX3/KX2, Icom 7300, Icom 7610, Flex 6400/M 6600/M, Elad Duo and more coming out.
- Computer dependant SDR Transceivers - Apache labs ANAN, Flex 3k, 5k, 6k (Some models)
- Computer included SDR units - Expert Electronics SunSDR MB1





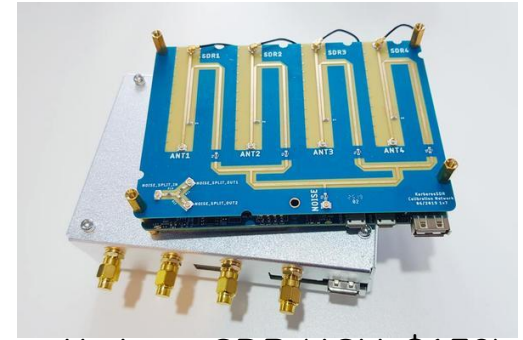
RTL-SDR



RTL-SDR Dongle (\$23)



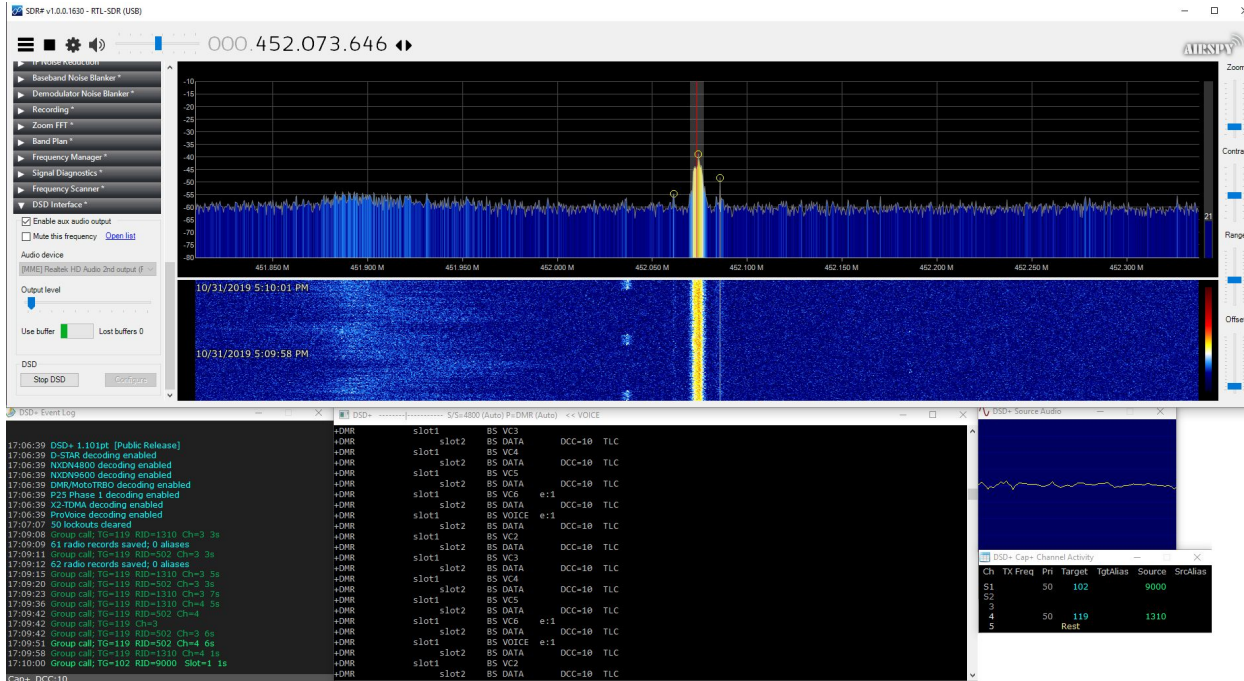
Nooelec NESDR (\$25)



KerberosSDR (4CH, \$150)

- Uses the Realtek RTL series demodulator chip (hence the RTL in RTL-SDR)
- Was originally developed for use in DVB-T (Digital Video Broadcast - Terrestrial) receivers
- Users were able to view the raw I/Q data which allowed for software to be developed to turn the dongle into a wideband SDR receiver. From about 22Mhz to 2200MHz
- Hardware is plentiful and very cheap
- Multiple uses (Police Scanner, Signal Sniffer, ADSB, Pan adapter)
- Due to massive popularity, dongles are now designed with wide band receiving in mind. That means better antenna connections, filters, shielding,
- Best “Intro” SDR for your money. Starts at around \$20 and new stuff is still being developed
- Only downside is the software can be a bit tricky to install because of driver issues
- Possible to modify dongle or purchase available upconverter for HF reception

SDR# & DSD - Digital Decoding w/ RTL



- SDR# has many options including decoding digital modulations
- Uses a plugin called “DSD+” Digital Signal Decoder Plus
- Modes Include
 - D-Star
 - DMR
 - NXDN (4800/9600)
 - P25 P1
 - ProVoice
 - X2-TDMA



SDR# & DSD

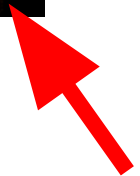
```
17:39:55 Enc Group call; TG=1 RID=1163 Alg=ADP KeyID=1538 1s
17:40:04 Enc Group call; TG=1 RID=3 Alg=ADP KeyID=1538
17:40:21 Enc Group call; TG=1 RID=1032 Alg=ADP KeyID=1538
17:40:22 Enc Group call; TG=1 RID=3 Alg=ADP KeyID=1538 1s
17:40:22 85 radio records saved; 0 aliases
17:40:26 Enc Group call; TG=1 RID=1032 Alg=ADP KeyID=1538 3s
17:40:27 Enc Group call; TG=385 RID=1032 Alg=ADP KeyID=1538 3s
17:40:31 Enc Group call; TG=1 RID=3 Alg=ADP KeyID=1538 1s
17:40:32 19 group records saved; 0 aliases
```

```
Sync:+P25p1 NAC:698 LDU1
Muting encrypted voice

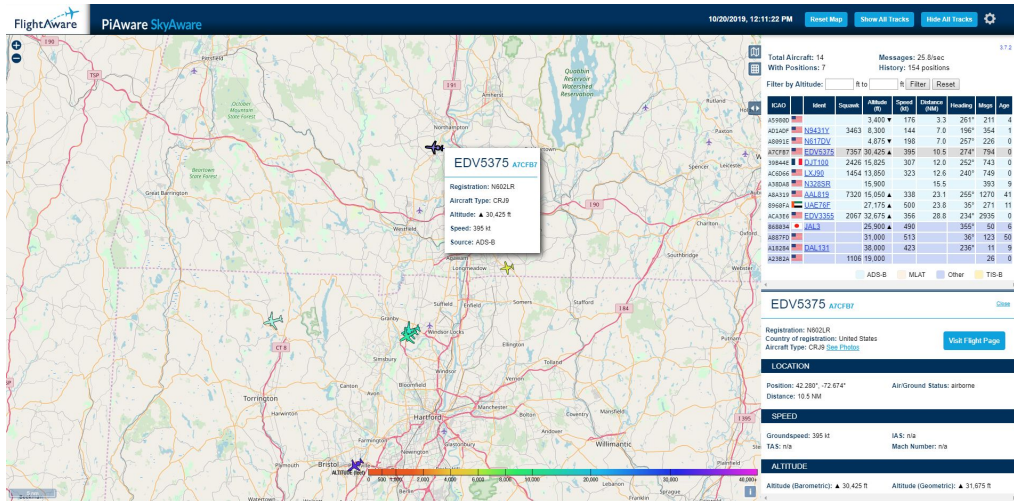
Sync:+P25p1 NAC:698 LDU2
Muting encrypted voice

Sync:+P25p1 NAC:698 LDU1
Muting encrypted voice
```

Does not and cannot decode encrypted communications



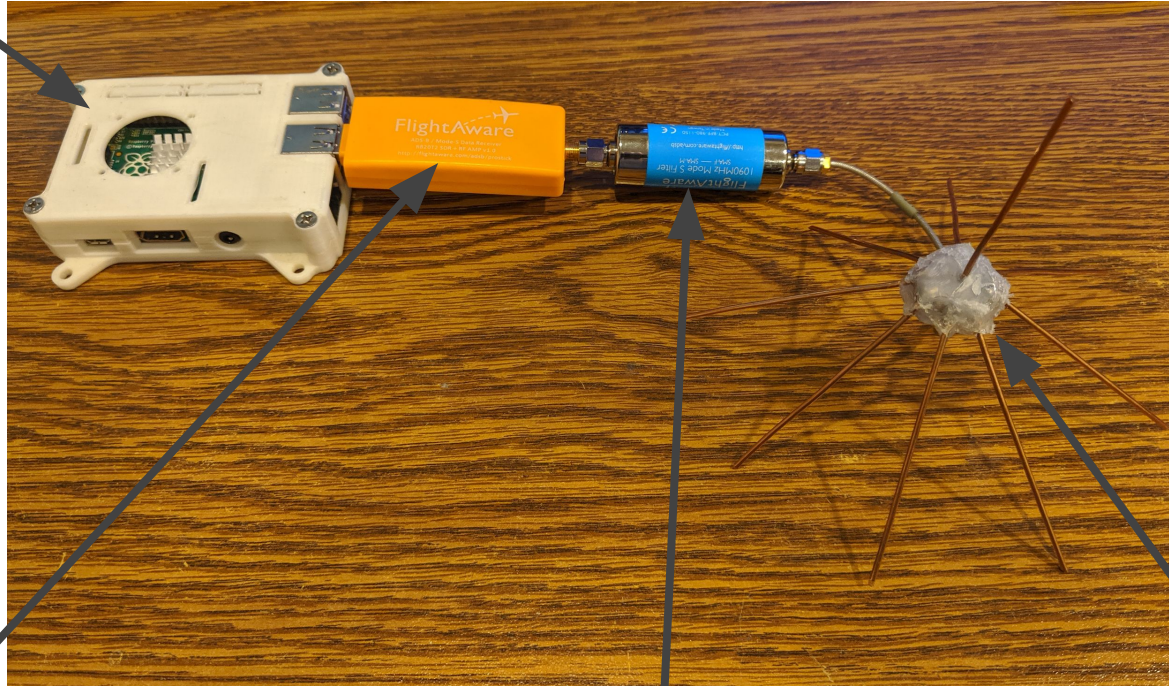
Automatic Dependant Surveillance - Broadcast (ADS-B) Receiving with RTL



DA PLANE! DA PLANE!



Raspberry Pi (\$35)



RTL-SDR Dongle (\$20)

1090Mhz Bandpass Filter (\$15)

1090Mhz
Antenna (FREE)



ADS-B Software

- Most common software is Dump1090 - Available for both linux and windows
- Dump1090 just receives ADSB signals and dumps data to a port
- Need other software like “Virtual Radar Server” to overlay data from Dump1090 onto a map.

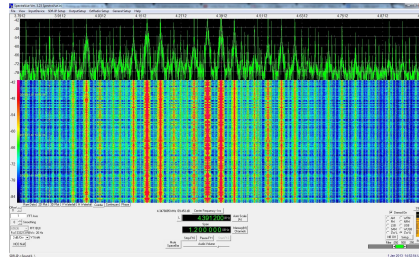
A lot of people feed the data from Dump1090 to websites like Flightaware, Flightradar24 and ADSBxchange. Some websites will give you premium features in return for feeding.

If you are using a Raspberry PI, websites like flightaware offer distribution packages for the raspberry pi (Plaware). This allows inexperienced users to easily setup a site just by writing data to an SD card.

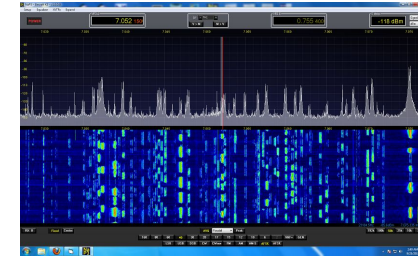
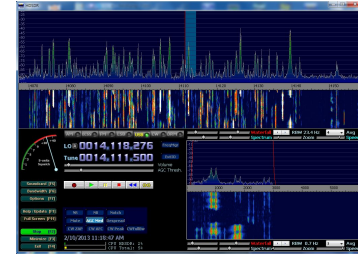
```
C:\Windows\system32\cmd.exe
Hex      Mode  Ssqk  Flight  Alt   Spd  Hdg   Lat      Long     S
-----  -
C01401  S
C06362  S
C0796C  S      5775
030257  S      30000
C05E0D  S      2475
044061  S      36975
C04671  S      12625
C0796D  S      1550
C04811  S      1250
C060B5  S      7700
C0637C  S      9525  253  320  43.478 -79.404
C01150  S      6275  4700
C07F36  S      1063  7725  247  214  43.666 -79.477
C00037  S      300
396505  S      2700
05E3B1  S      2617  6650
C0566F  S      1222  CGTIA  700  71  050  43.611 -79.457
C05857  S      2243  ROU1864 6700 268  189  43.605 -79.437
C02D21  S      6350  265  045  43.723 -79.538
C02E9B  S      11375
```



Other SDR Software



- Too much to list as most software can support multiple devices
- For the RTL-SDR crowd SDR# (SDR Sharp) is the most popular. Many options including RDS, P25, DMR, NXDN, D-Star decoding
- For amateur radio operators, HDSDR and SDR-Radio are very popular.
- For the linux users there is GQ-RX
- For Mac/OSX users... Sorry. I know it's possible to get GQRX and SDR# to work on later versions
- Some hardware has proprietary software that can only be used with certain hardware
- Some hardware (apache labs anan) has multiple software developed for use.



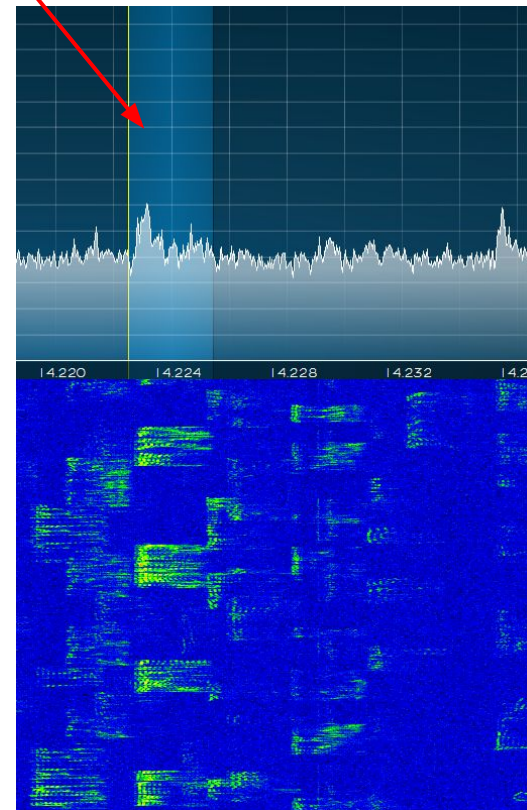


Chasing Waterfalls

- Most amateurs use a waterfall display, spectrograph or a mixture of both
- Displays signals over frequency and time
- Usually displays signal strength (green to red)
- After use and time, Operator can visually see what modes are being used on the bands (AM, USB, LSB, FT8, PSK, etc)
- Also shows any interference going on.

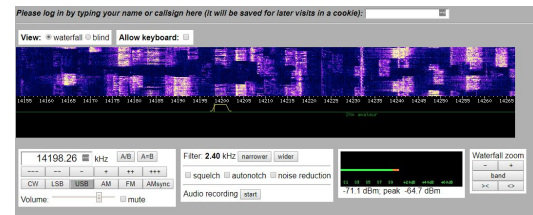
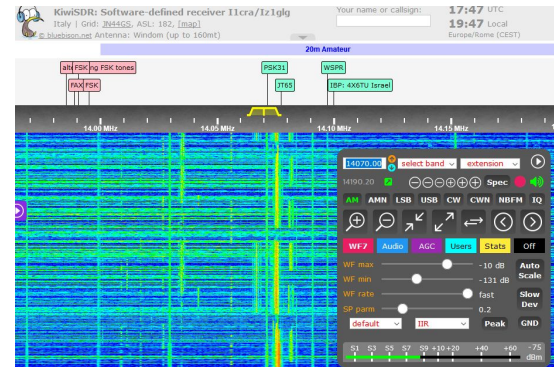
FILTER

FREQUENCY



Try it before you buy it!

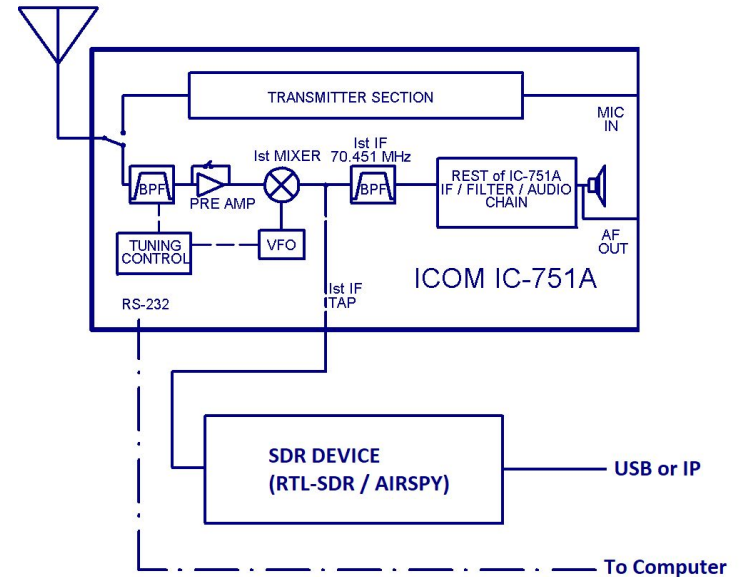
- Before you open your wallet, there are other ways to enjoy SDR... for FREE!
- Hundreds, if not thousands of operators share their SDR units to the general public
- Allows you to listen to amateur radio/shortwave around the world
 - <https://sdr.hu/> - SDR.HU is a popular site using the KiwiSDR receiver
 - <http://websdr.org/> - Another popular site that uses different types of hardware
 - <http://www.remotehams.com> - Site that uses a mix of SDR and SuperHet radios (allows TX)
- You could test to see if your signal is being heard in different parts of the country or different countries.
- Possible to contribute and share your antenna/receiver with the world (high speed fiber preferred).
- If you know of any Flex Radio users, some have the option to share their radio.





Convert your radio into a panadapter

- Possible to convert your superhet radio into an SDR panadapter by tapping into the IF stage of the radio.
- Some radios have an IF output, some have options and some need modifications. Depending on where the tap is, might offer additional filtering to the SDR unit
- Tapping into the IF might involve additional hardware (buffer amp or attenuation) depending on the radio.
- Possible to add a T/R relay (MFJ-1708, QRPkits) and use software (SDR-Radio) to track the SDR with the radio.
- Tune the SDR unit to the IF frequency of the radio and you'll be able to see activity around where your VFO is set
- Most hams use this as a panadapter just to see band/signal activity. Radio is still demodulating the audio. So it's not 100% SDR



The logo consists of a grey quarter-circle on the left and a stylized wave icon made of three black lines to the right of the text.

FlexRadio

- In the market since 2003 (Flex 1000)
- Creators of the original PowerSDR software (Now used with various SDR hardware)
- Competitive price (\$1999 for the 6400) compared to K3S, K4, 7610, Anan and others
- Software continually improving
- Built for the amateur radio operator
- Options available for operators who must need buttons and knobs
- Processing all done in the hardware, PC just acts as a display/controller
- Easily remote. No additional hardware needed. Can connect to your radio from anywhere there is internet using a PC or ipad/iphone. Sorry, no android... Yet!
- Current Models: 6400, 6400M, 6600, 6600M, 6700

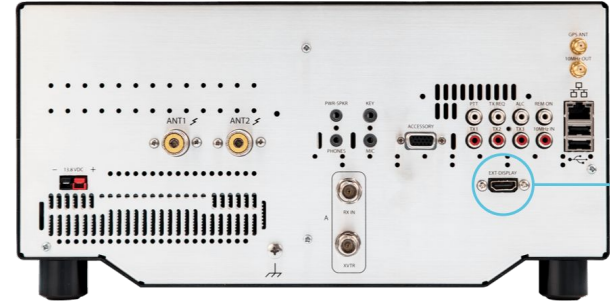


6400 vs. 6600

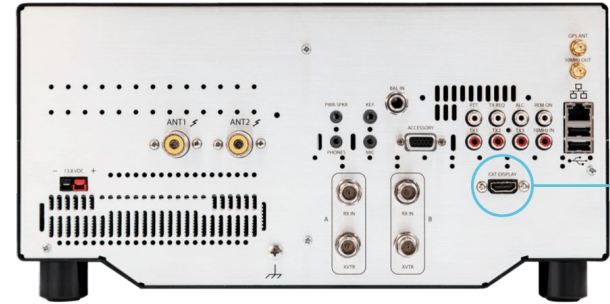
6600 is similar to the 6400 but the 6600 has

- Has 2 SCUs (Spectral Capture Units)
- Better pre-selector (7th order vs. 3rd order)
- Diversity Reception
- 14Mhz of Bandwidth (vs. 7Mhz on 6400)
- ATU built in
- Dedicated XLR/TRS mic input

You're basically getting TWO radios in one with the 6600. This allows for Single Operator, 2 Radio (SO2R) operation with only one radio.



6400 BACK



6600 BACK

Maestro = Knobs and Buttons!



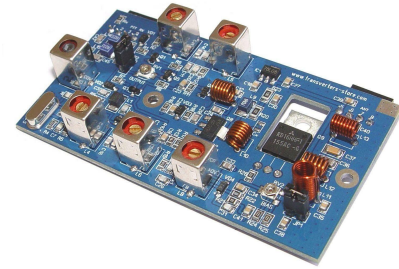
- High Resolution Screen
- Inputs for microphone (RJ45), headset, CW Key, PTT switch and audio line out
- Connects to network using WiFi or Wired connection
- Storage for battery
- Can be used anywhere in the world there is internet to access your radio
- Cleaner Desk!

Why Not Have Both?

- 6400M and 6600M have the Maestro built into the front of the radio
- Perfect for those who want SDR performance in an all-in-one package
- Can hook up an external display
- Great for emcomm, easier to deploy
- No network/internet connections needed for standalone operation



It can also do 2M or other bands... With A Transverter



- Various kits on ebay come assembled or unassembled
- Kits starting at around \$30USD to \$60USD assembled
- Other high performance transverters available
- Uses the transverter port on the back of the flex
- 6600 allows for 2 transverters to be used
- Setup transverters in the PowerSDR software



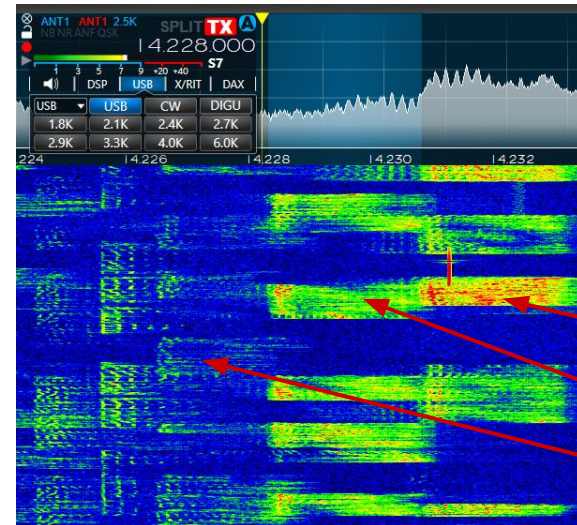
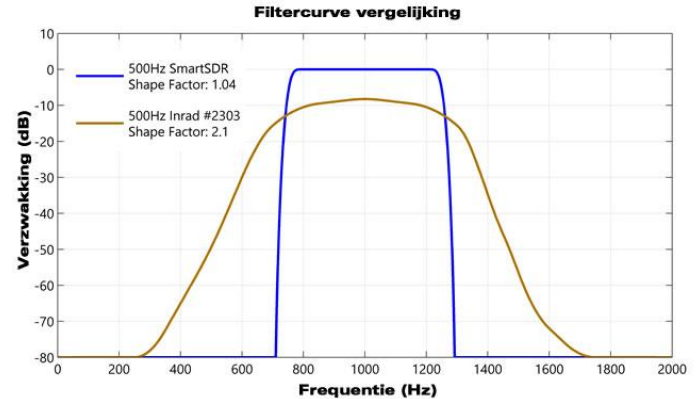
SmartSDR Software



- User interface to control the flex.
- Installed on PC
- Connects to Radio VIA IP Address (locally or internet)
- Full control of the radio
- Change bands, modes, adjust VFO
- Point and click tuning
- RX and TX EQ profiles,
- Filter Adjustments
- Add “Slices”
- Bunch of other features
- Designed by FlexRadio and is only for Flex Radios (closed source)
- Continually updated*

“Brickwall” Filtering. Why Should I Care?

- Doesn't really matter for casual QSOs
- It does matter when there is...
 - A contest
 - Field day
 - Rare stations
 - Pileup situations
 - Emergencies
 - Louder station next to you
- Helps with pulling that station from the noise
- Fully adjustable filters
- Adjustable RX EQ
- More pleasing to the ears = longer on the air



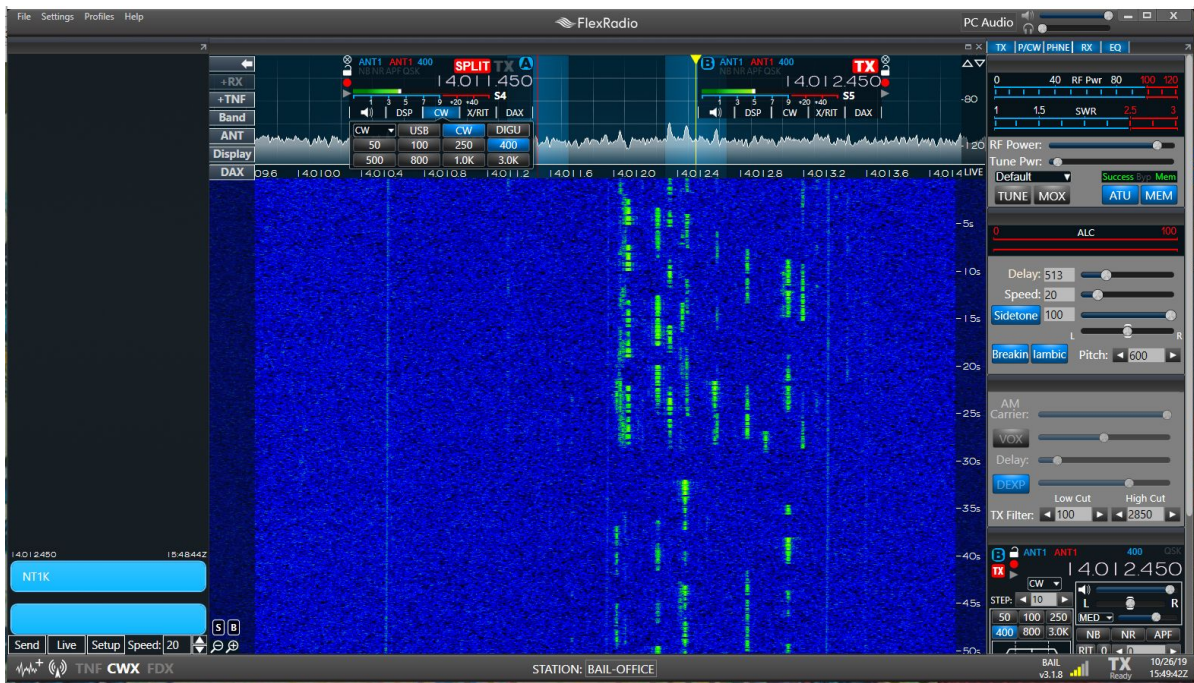
CQWW
SSB
2019

IO50

9A9A

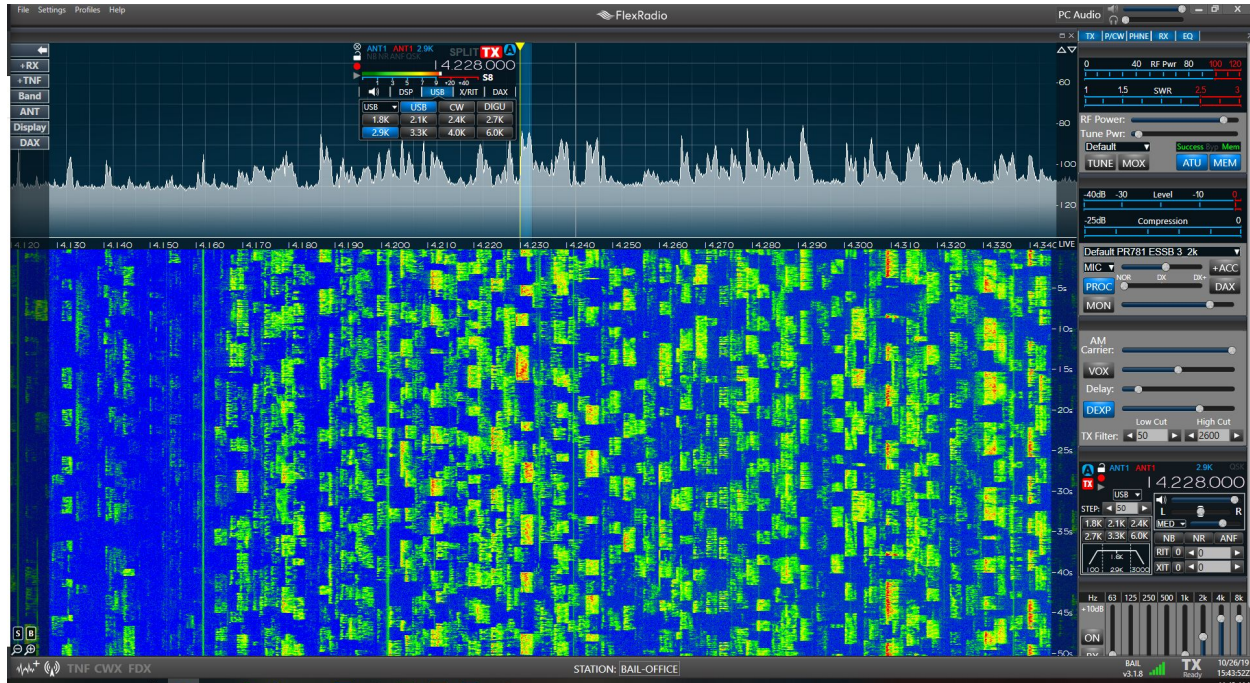
IK2XSL

CW With The Flex



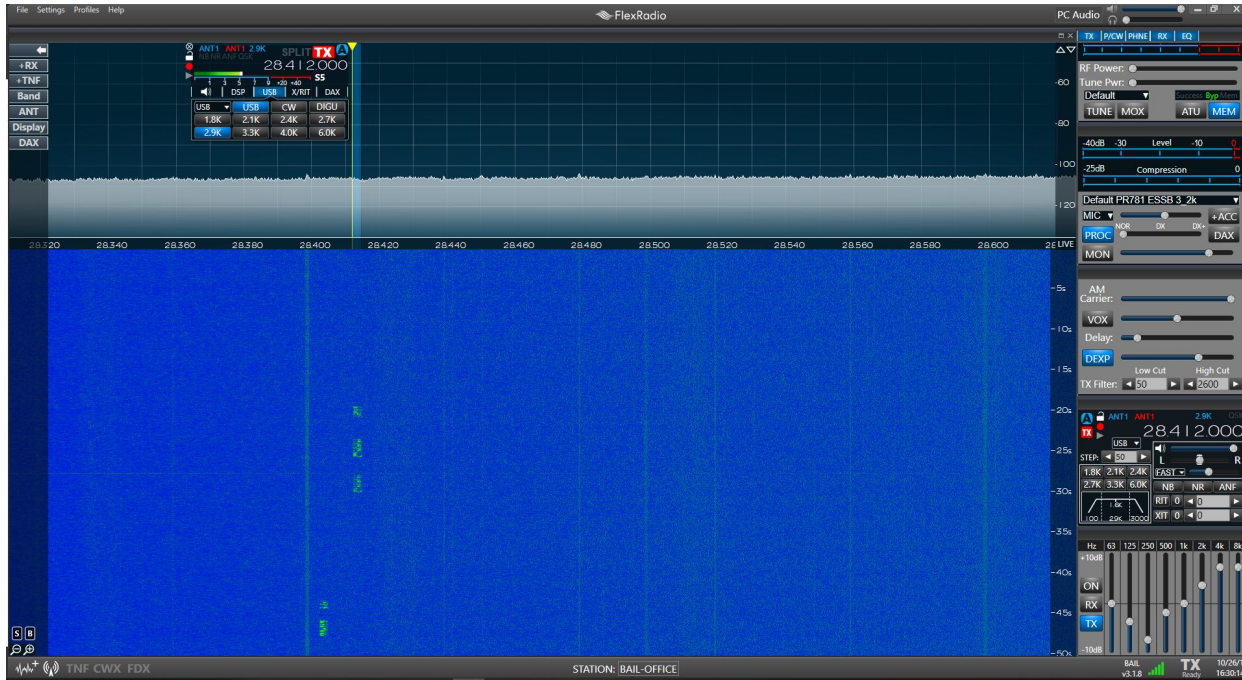
- Easily tune into CW signals and set tight filtering.
- Possible to send CW without a paddle/key using CWX
- CWX helps with remote operations. Can also use winkeyer to use a paddle remotely
- Advantage in pileups where the operator is running split
- Can use CW decoding or skimming software if needed

SSB/Phone With The Flex



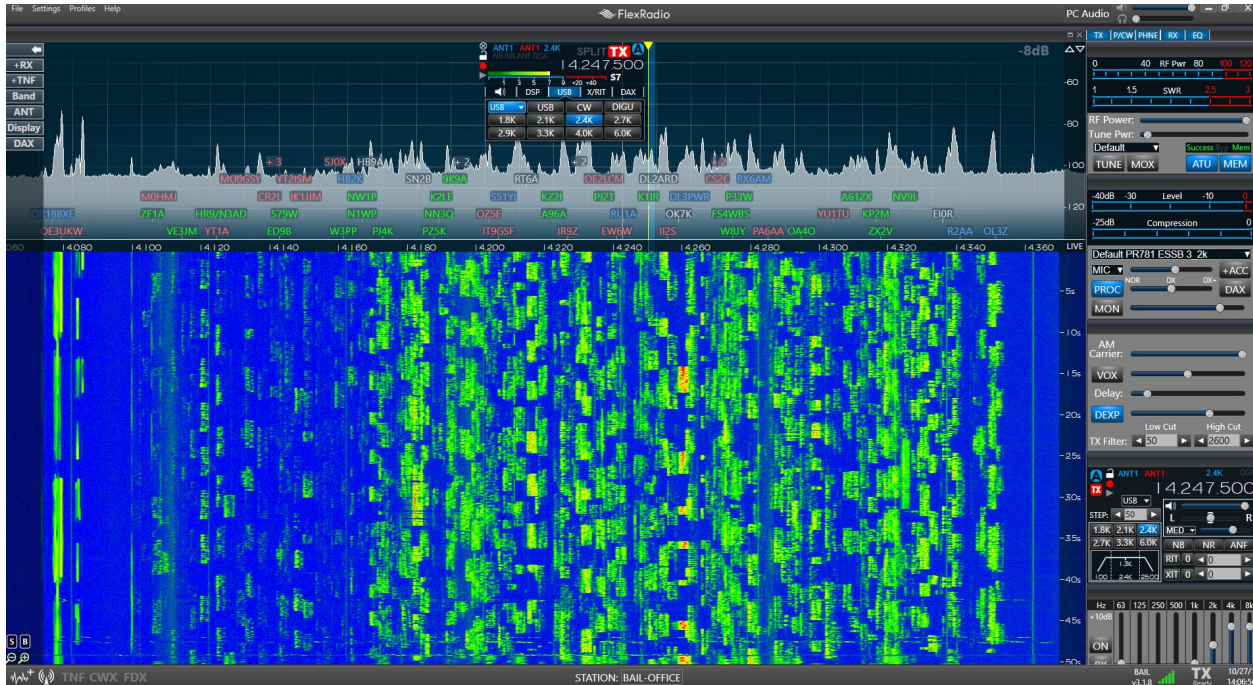
- Instant point and click tuning.
- Can easily see the stronger stations.
- Can tell if a signal is overdriven
- In a crowded band, it can help you find a hole

I See Dead People... Errr Dead Bands



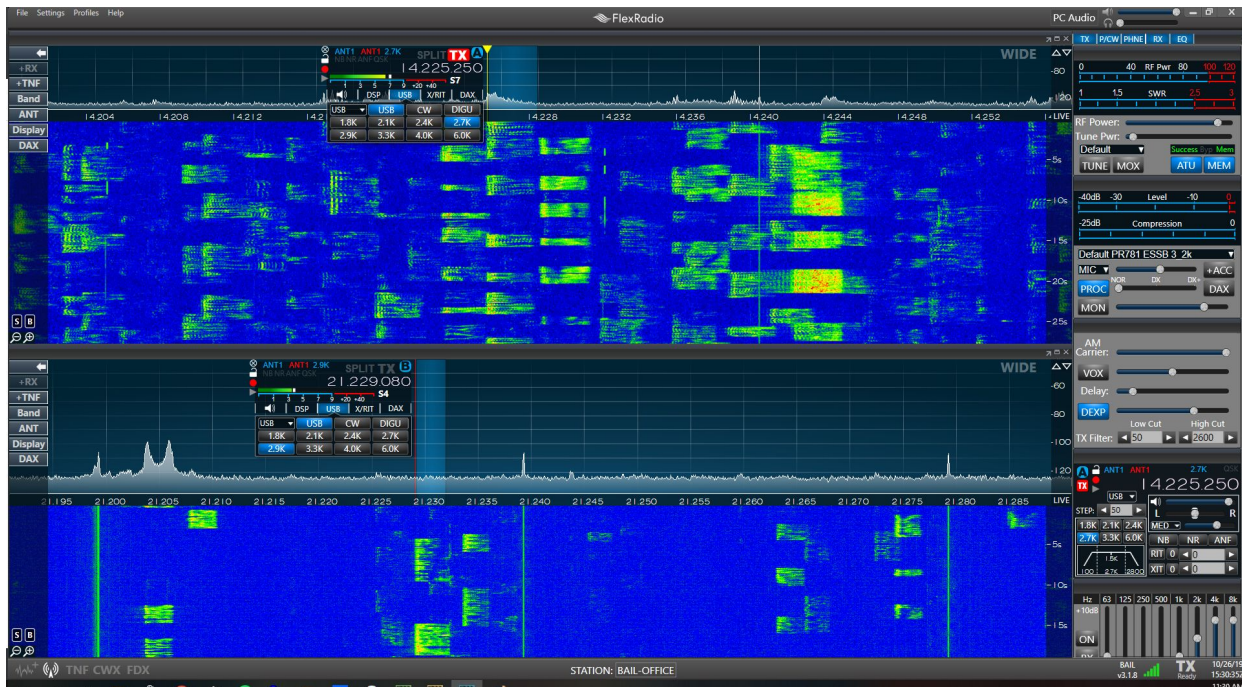
- Instantly tell if a band is dead or alive.
- OR see if there is a lonely station calling CQ.
- In contesting, this can save you time.
- Possible to view in another slice so you don't leave the more populated band

Overlay spots



- Newer versions of SmartSDR allows spots from software like N1MM+, DXlabs Spotcollector and others to display spots from the cluster to the main window
- Just click on a call sign and SmartSDR will tune the VFO to that station.
- Makes S&P Faster!

Multiple Slices



- Can listen to multiple bands at once
- 2 slices with the 6400, 4 slices with the 6600 and 8 slices with the 6700
- Full Duplex operation possible. TX on one slice while RX on the other

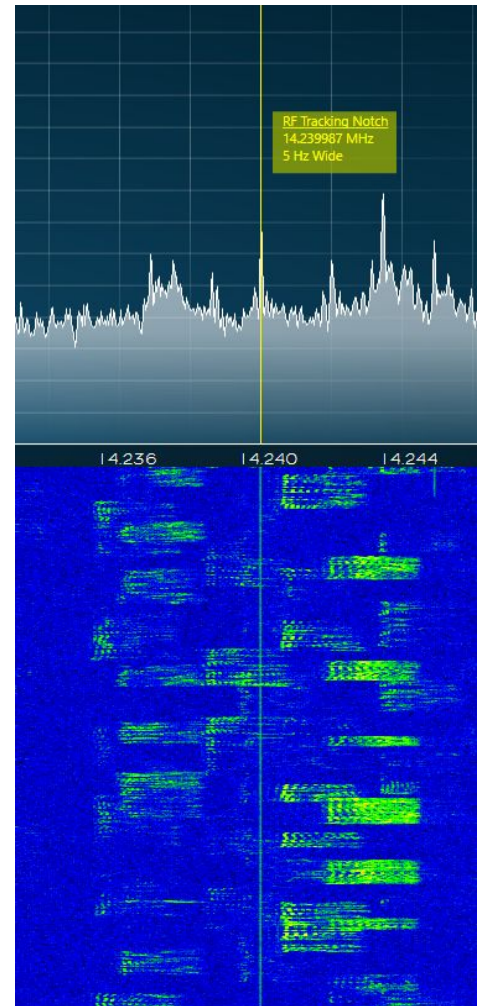


Controlled Envelope Single Sideband (CESSB)

- Increases SSB “Talk Power” by accurately limiting envelope peaks during TX
- Audio quality doesn’t suffer.
- Avg of 2.5dB of increased power. Up to 4dB is possible.
- Not to be confused with Enhanced Single SideBand (ESSB, 4Khz Wide).
- Helps with fighting in pileups.
- Developed by David Hershberger, W9GR
- Details published in QEX (Check out sources at the end of this presentation)

Tracking Notch Filter (TNF)

- SmartSDR software allows for you to “Notch Out” someone tuning up or remove a constant noise or tone.
- No longer have to hear those annoying birdies/tones
- Software remembers where you’ve notched out offending signals.
- You can adjust the notch filter to match the exact width of the signal you don’t want to hear.
- TNF can be toggled on/off with the click of a button.



FT-8/Digital Modes On The Flex

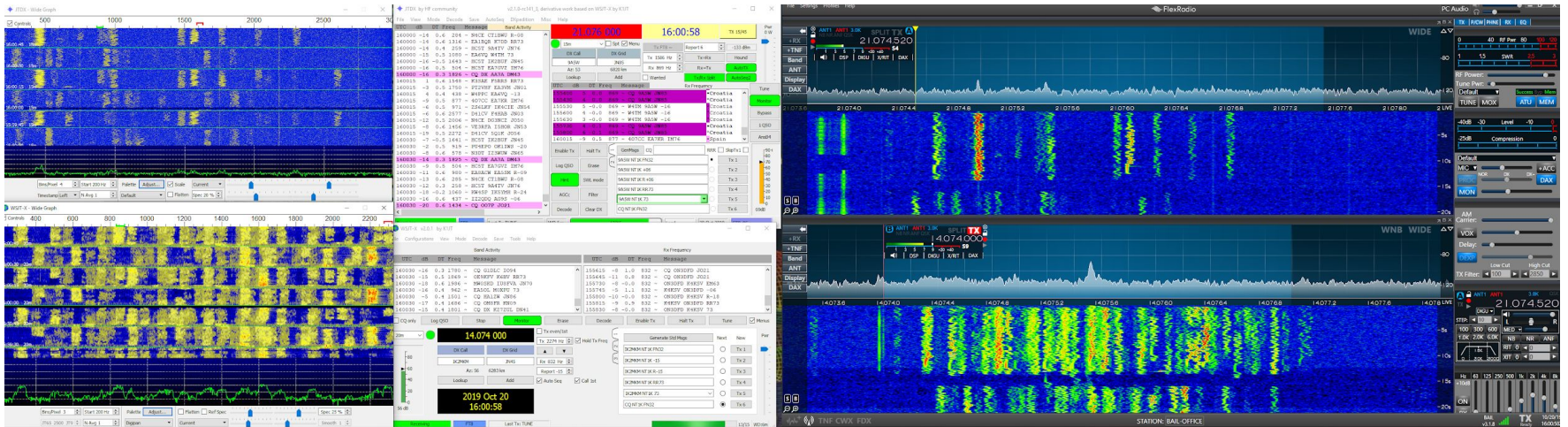
The screenshot displays the FlexRadio software interface with the following components:

- Frequency Display:** Shows 7.074000 MHz with a 3.0K offset.
- Waterfall View:** A spectral display showing signal activity across a frequency range from approximately 7.070 to 7.078 MHz.
- Station List:** A table listing active stations with columns for UTC, dB, DT, Freq, Message, and Band Activity. Active stations include:
 - 224200 Tx 2160 - SVLEDY NT1K FN32 (Greece)
 - 224215 -14 0.3 1794 - N4RID SVLEDY -18 (Greece)
 - 224215 -14 0.3 1802 - CQ WIDNP EM90 (U.S.A.)
 - 224215 -17 0.3 2430 - R6TDC IKLLZF JN44 (Italy)
 - 224400 Tx 2432 - CQ NT1K FN32 (Poland)
 - 224430 Tx 2432 - SQ6WZ NT1K -07 (Poland)
 - 224400 -2 0.3 356 - NT1K SQ6WZ R-17 (Poland)
 - 224400 Tx 2432 - CQ NT1K FN32 (Poland)
 - 224440 -7 0.3 2432 - NT1K IUSR0J JN45 (Italy)
 - 224500 Tx 2432 - IUSR0J NT1K -07 (Italy)
 - 224515 -13 0.4 2432 - NT1K IUSR0J R-17 (Italy)
 - 224515 -13 0.4 2432 - NT1K IUSR0J R-17 (Romania)
 - 224515 -16 0.3 2432 - SV300LDV IKLLZF JN44 (Italy)
 - 224545 -6 0.2 989 - NT1K YO5IAB RN25 (Romania)
 - 224600 Tx 2432 - YO5IAB NT1K -06 (Romania)
- Control Panels:** Includes buttons for 'AGC', 'Filter', 'Decode', 'Clear DX', 'Log QSO', 'Erase', 'SWL mode', 'ASCC', and 'Filter'. There are also settings for 'GenMsgs', 'RRR', 'SplatVx', and 'Tx 1' through 'Tx 6'.
- Right Panel:** Shows 'PC Audio' controls, 'RF Power' (0-100), 'Tune' (Default), 'MOX' (Success, Mem), 'ATU' (MEM), 'Level' (-40), 'Compression' (0), 'AM Carrier', 'VOX', 'Delay', 'TX Filter' (Low Cut, High Cut), and 'TX Filter' (100, 2850).
- Bottom Panel:** Shows 'STATION: BAIL-OFFICE', 'FT8', 'Last Tx: YO5IAB NT1K -06', 'WD 6m', '4/15', 'LogID:3000', '20 Oct 2019', 'FT8 98', and 'v3.1.8'.

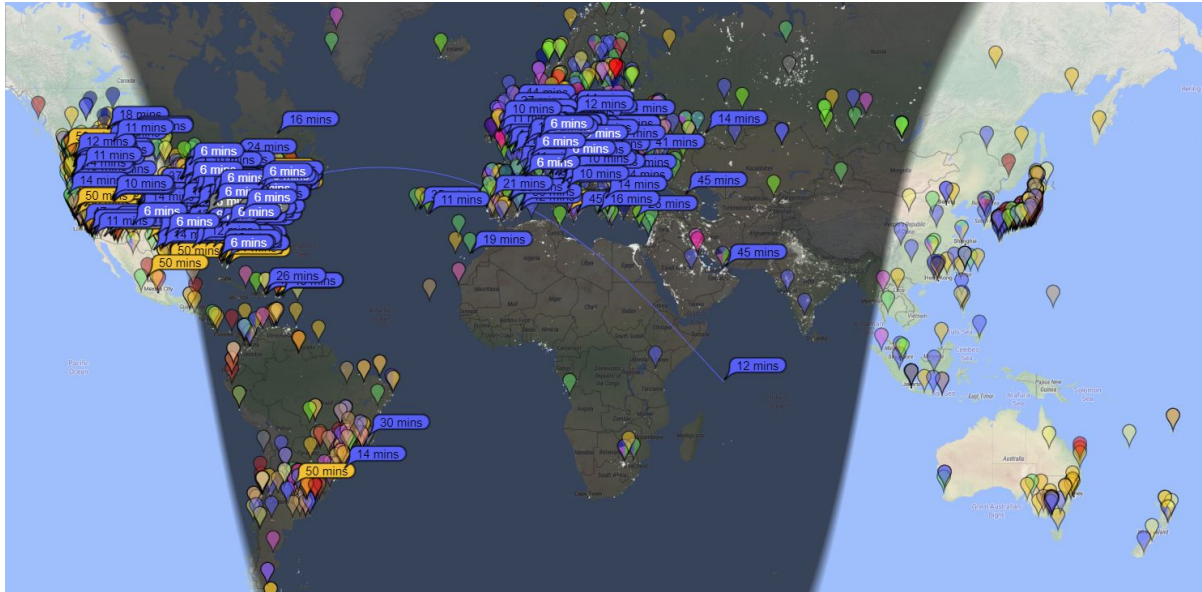
- SmartSDR interfaces with FT8 software using DAX and CAT software
- Easily adjust filters to catch all the action
- Can do FT8 and other digital modes remotely

Multi FT-8 Decoding (15m/20m)

Are you into FT8/FT4? The Flex allows you to decode multiple bands at the same. That way you don't miss out on any action! With the 6600, it's possible to decode 4 bands at once (8 on the 6700).



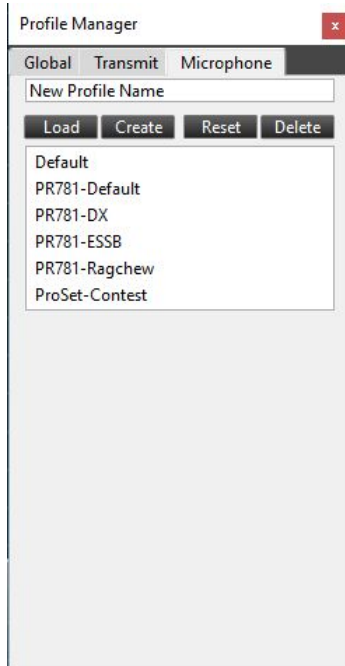
PSK Reporter - Check Yourself



- You can see where you're being heard on certain digital modes like FT8/FT4, JT65, RTTY
- Software reports RX data to websites such as PSKreporter and Reverse beacon network.
- Call CQ a couple times and you should be able to see yourself on a map
- Not related to Flex Radio but worth mentioning



SmartSDR Profiles



- Software allows the user to create and save profiles depending on their operating preferences
- Create different microphone profiles for different modes of operation and for different microphones. (Rag chew, DX, Contesting, ESSB)
- Able to set different Transmit profiles for different power levels for different situations. One for RTTY, One for FT8, One for contesting, One for using amplifiers, etc.
- Global profiles for instant switching (DXing to Digital to Phone)



SmartSDR CAT Controller

- SmartSDR CAT software setups various virtual ports within your computer
- Allows your favorite logging or multi process software to control and receive CAT and other data from the SmartSDR software
- Connect multiple software to SmartSDR at the same time
- No cables!

SmartSDR CAT ... Settings

FLEX-6400
BAIL
NT1K

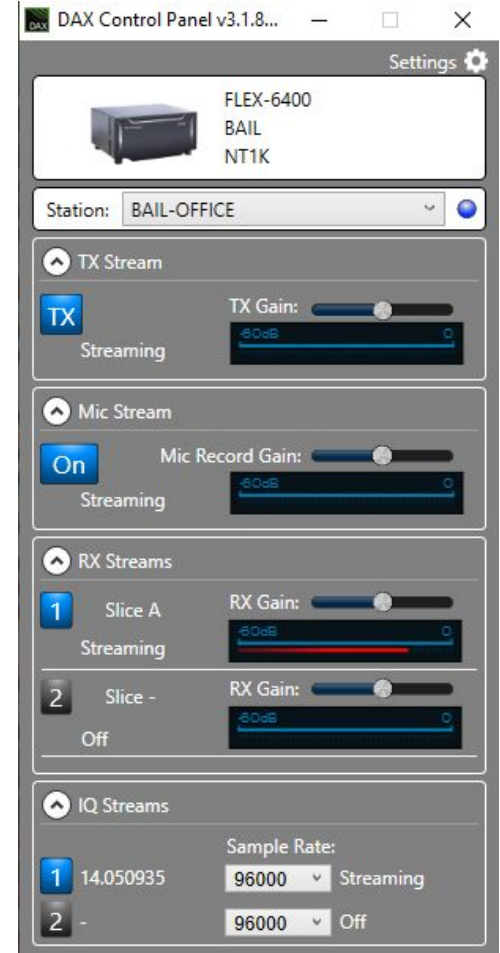
Station: BAIL-OFFICE

C	Serial: COM17 Slice: A Process: (None)	Auto Switch TX
C	TCP: Port 5002 Slice: A	Auto Switch TX
C	WSJT TCP: Port 5003 Slice: A	Auto Switch TX
P	WSJT Serial: COM19 Slice: TX Process: (None)	
C	N1MM Serial: COM13 Slice: A Process: (None)	Auto Switch TX
W	N1MM WK Serial: COM14 Process: (None)	
P	N1MM PTT Serial: COM18 Slice: A Process: (None)	Auto Switch TX
N	N1MMSpot UDP: Port 12061	
P	WSJT-VFOB Serial: COM20 Slice: B Process: (None)	Slice Not Present
C	WSJT-VFOB TCP: Port 5004 Slice: B	Slice Not Present

Add... Edit... Log... Remove

Digital Audio eXchange (DAX) Panel

- Interfaces audio coming in and out of the flex to your computer
- Creates several “Virtual Audio” ports within the computers OS
- This allows you to use various software with the flex radio such as
 - WSJT-X - FT-8, FT-4, JT65
 - FLDigi
 - N1MM+ (For recording/playing voice macros)
 - Ham Radio Deluxe
 - MMTTY
 - And Others
- Can use multiple software at the same time listening to different slices. (6400 has 2 slices, 6600 has 4, 6700 has 8)
- Do not need interface hardware such as Signalink or RigBlaster
- No audio cables. Everything is done through software/OS and CAT





USB devices (Rotor/Amp Control)

USB Cables

Name	Serial Number	Type	Enabled
Steppir		CAT	<input checked="" type="checkbox"/> Enabled
SPE		CAT	<input checked="" type="checkbox"/> Enabled

Edit Log Remove

USB CAT Cable Steppir

Name:

Serial:

Cable Type:

Source:

Auto-report: Enabled

Advanced

Speed:

Data bits:

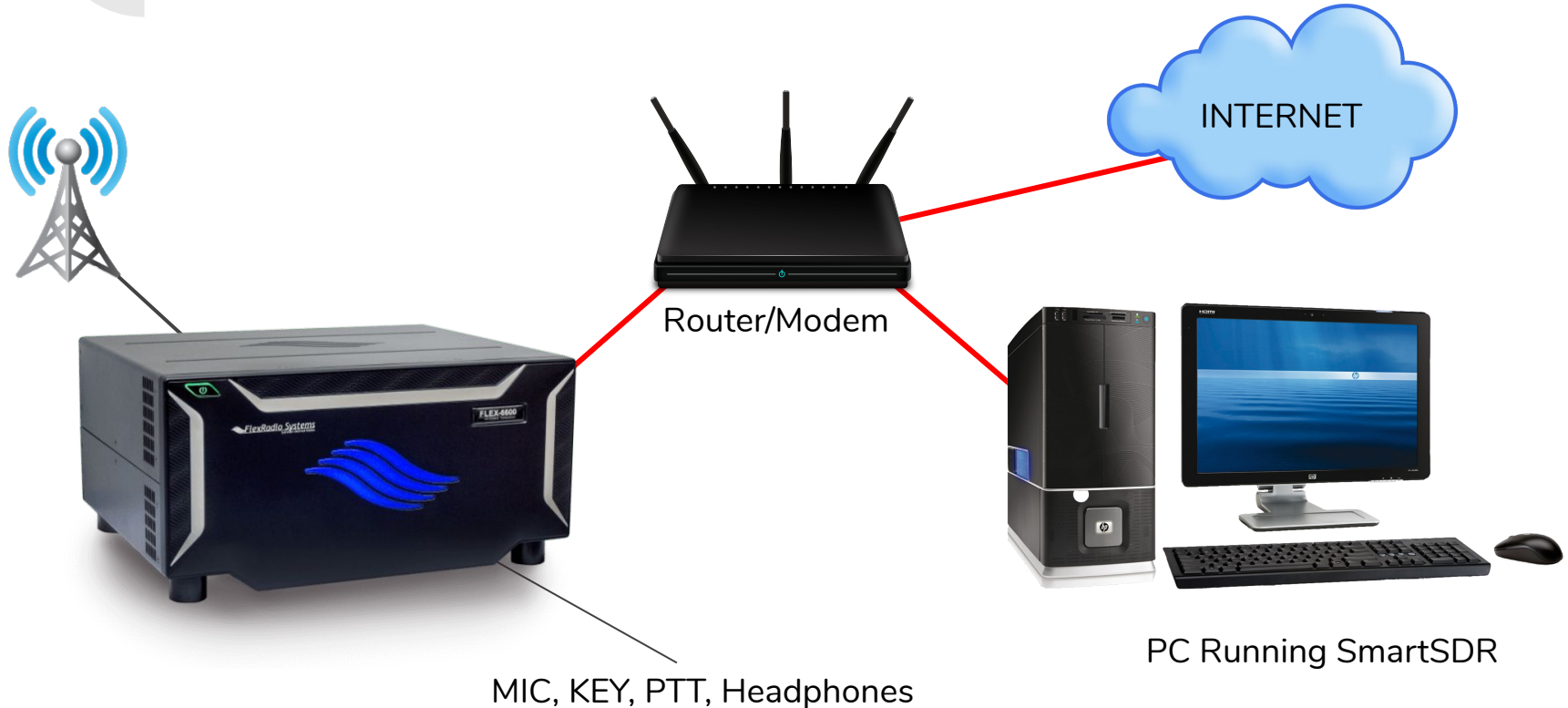
Parity:

Stop bits:

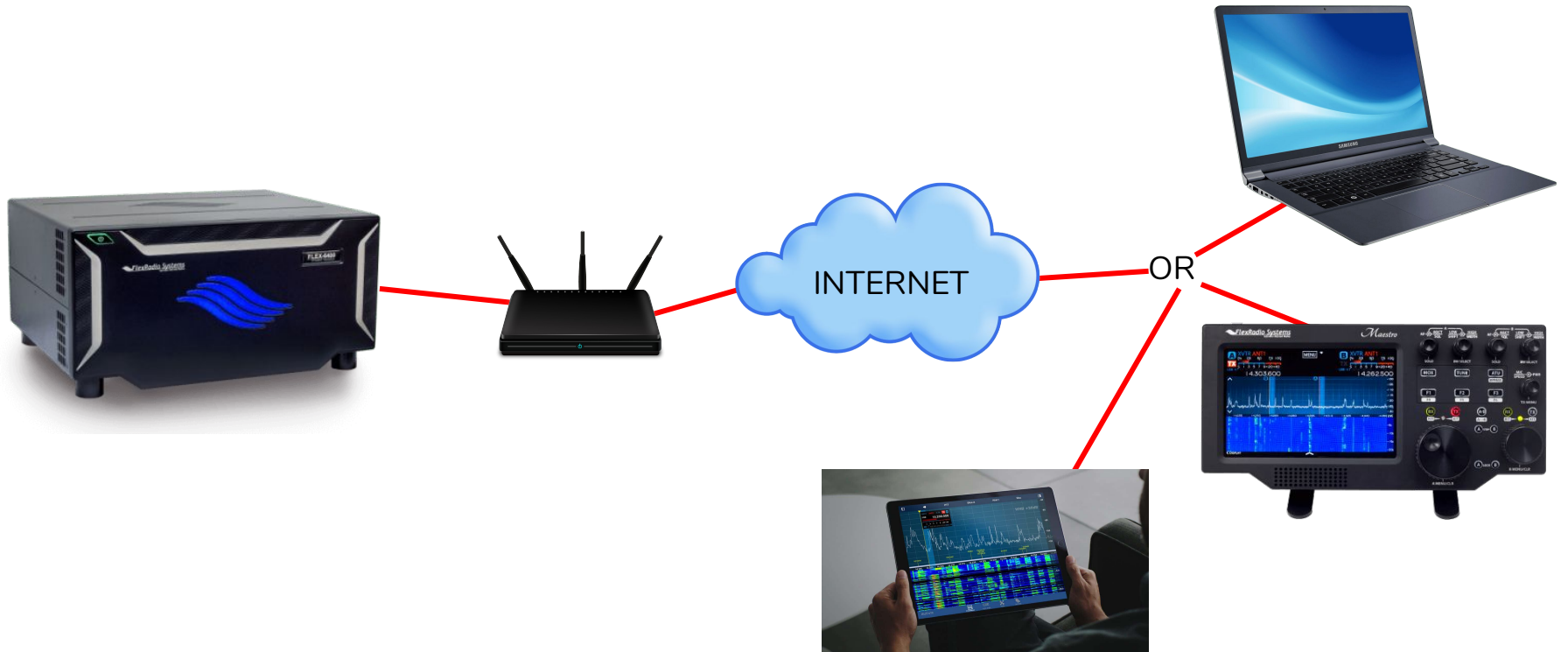
Flow control:

- SmartSDR can feed band data to 3rd party hardware like amplifiers, antenna tuners, antenna controllers and relays using USB (FTDI)
- Supports CAT, BCD or Bit format
- 6000 series has two USB ports. Possible to expand using USB Hub

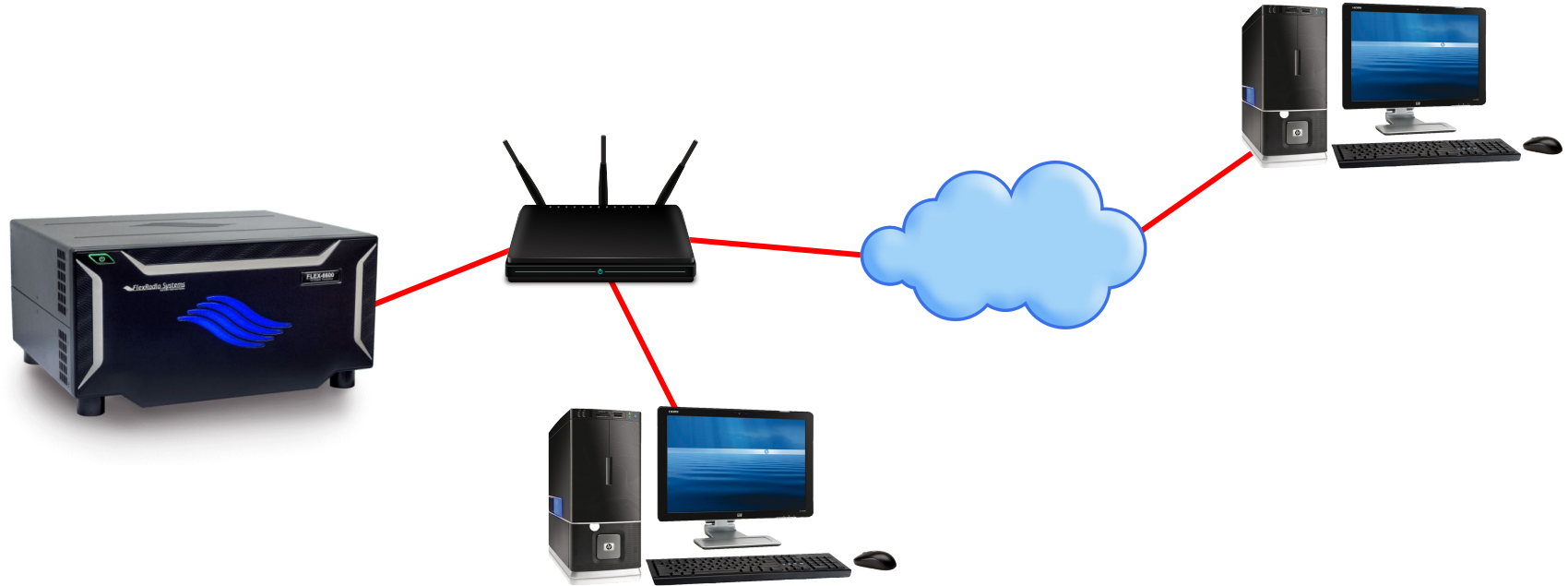
Typical Flex Radio Setup



Operate remotely from anywhere*



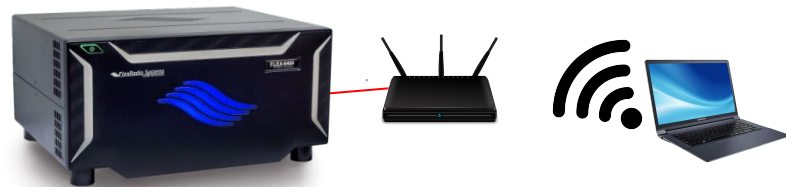
MultiFlex - Multiple operators, 1 Radio



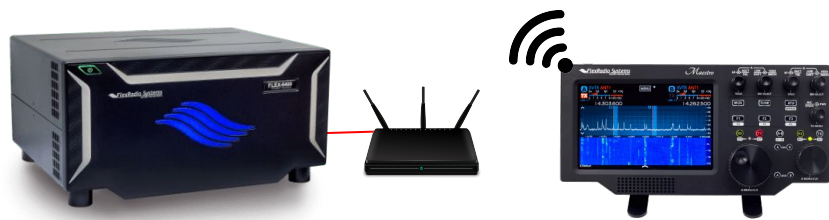
Other Ways To Connect Your Flex



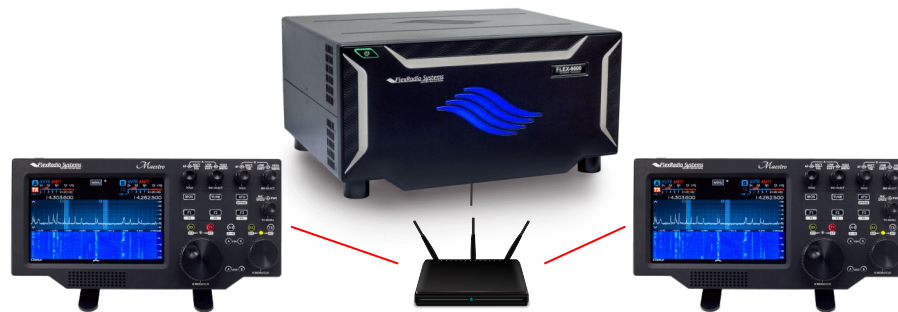
Directly to PC*



Laptop/Tablet/PC Over Local WiFi



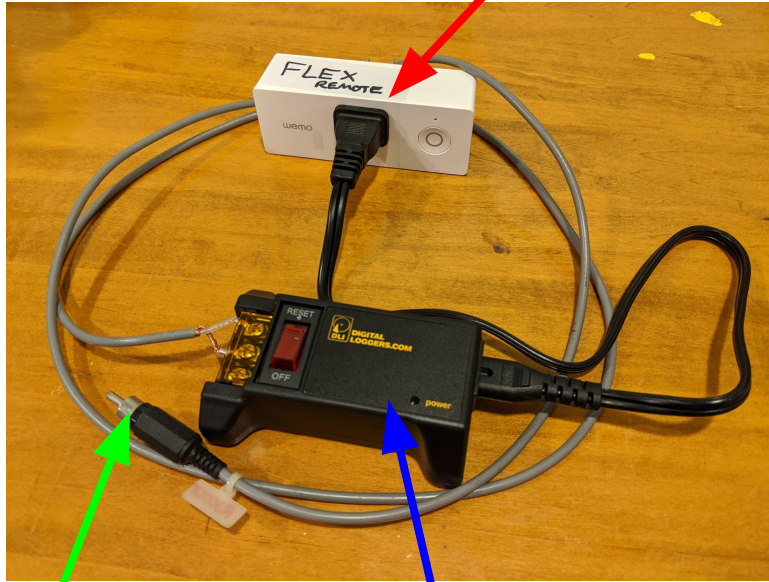
Maestro Over WiFi



SO2R with the 6600/6600M/6700 - MultiFlex

Remote Power On (Option)

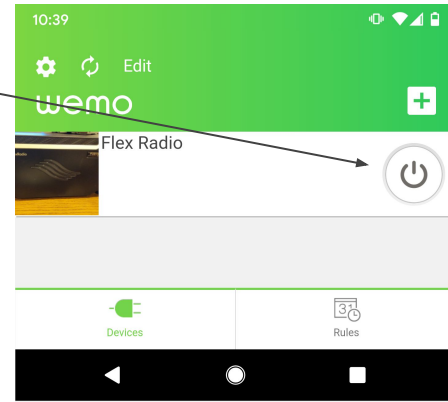
WiFi Switch (\$5+)



TO FLEX "REM" PORT

IoT AC Relay (\$12)

Phone App



- Allows the flex to be remotely powered on or off from almost anywhere in the world
- Consists of Wifi controlled AC on/off switch, NO/NC Relay and cable to radio
- Application installed on phone and PC
- Allows for the radio to be powered off until use



Let's Try Out A Flex!

Since we're doing this over zoom (Nov 2020), we'll use my flex locally

(NT1K) using a Flex 6400 - 3EL Beam @ 45' from West Springfield MA.

And yes... I feel SDR is the future of amateur radio. More and more radios are coming out with some form of SDR. As more development is put into FPGA processing, DSP design and user interface you'll see improvements and cheaper radios.

Hopefully someday there is an all in one amateur radio with filtering on a single IC chip. .

That's it for powerpoint. Let's get hands on!

Sources: In No Order

WebSDR: <http://websdr.org/>

SDR hu: <https://sdr.hu/>

Flex Radio Systems: <https://www.flexradio.com/>

SDR# / Airspy - <https://airspy.com/download/>

SDR Play - <https://www.sdrplay.com/>

ADSBxchange - <https://www.adsbexchange.com/>

Piaware - <https://flightaware.com/adsb/piaware/>

JTDX Software - <https://www.itdx.tech/en/>

PSK Reporter - <https://pskreporter.info/pskmap.html>

Reverse Beacon Network - <http://www.reversebeacon.net/>

CESSB Documentation -

http://www.arrl.org/files/file/QEX_Next_Issue/2016/January_February_2016/Hershberger_QEX_1_16.pdf

NT1K's Website - <Http://www.nt1k.com>