An Introduction to
Software Defined Radio
W0TLM
Amateur Radio Club
April 2023
SDRplay
Presenter:
Steve Brightman KI5ENW

Agenda

- The Basics
- Applications
- Hardware
- Software
- Panadapters
- Support & Information Sources
- Q&A

What is an SDR?

- A radio communication system where many components that have been traditionally implemented in ***hardware***…

  (e.g. mixers, filters, amplifiers, modulators/ demodulators, detectors, etc.)

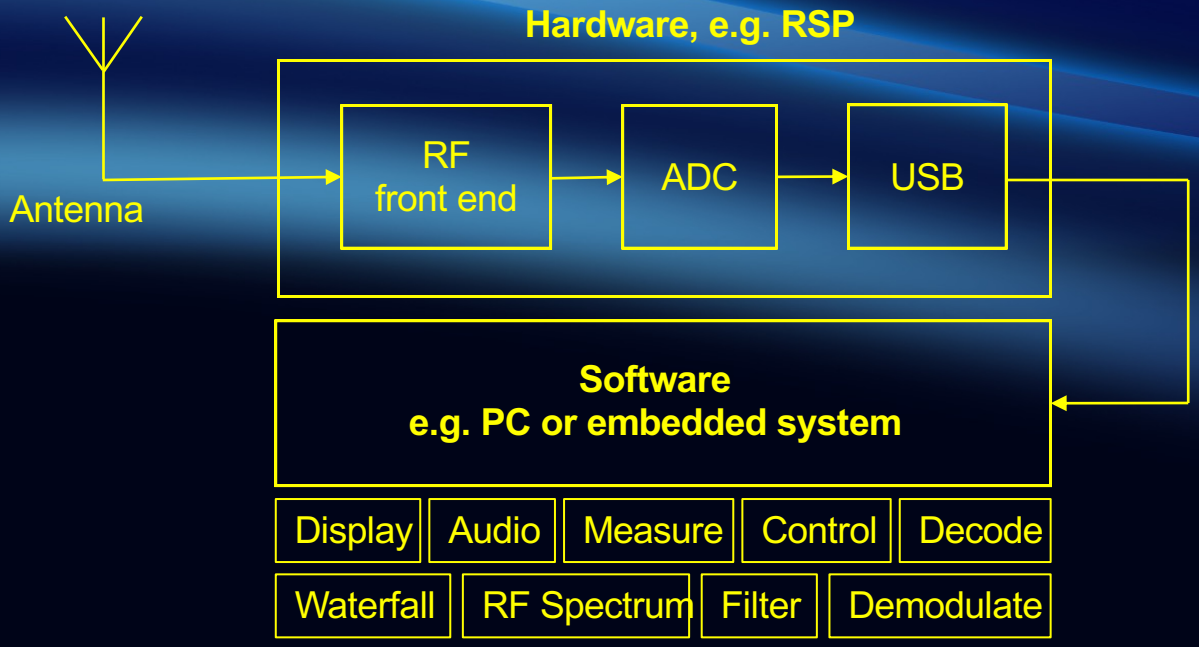
  …are implemented by ***software*** on a PC or embedded system.

- The hardware portion consists of pre-selection filters, possibly some IF filtering and a Analog-to-Digital Converter

- SDR is a technique, the actual implementation will vary by application:

  e.g. Receivers tend to concentrate on wide bandwidth, Transceivers on narrower bandwidth at a specific frequency

Simplified SDR Receiver Block Diagram



Example implementation

Why do I want an SDR Receiver?

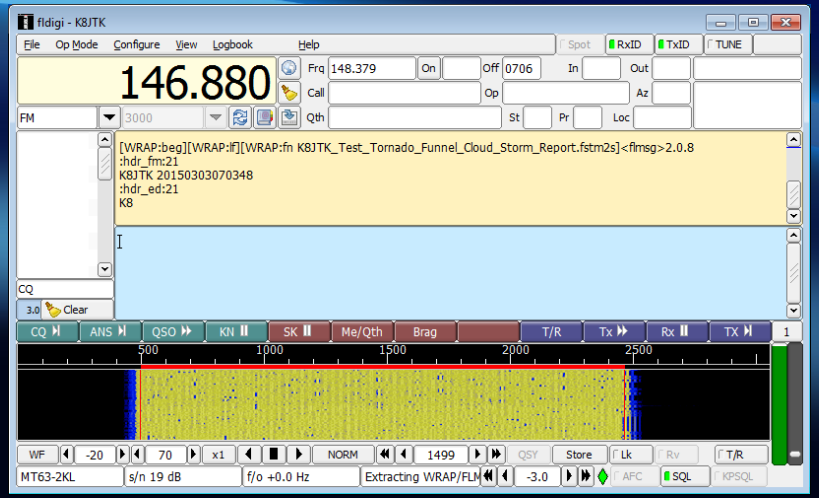
Top Ten List

1. True general coverage
2. Work one frequency and still monitor the entire band (or another band!)
   - Panadapter (suddenly your eyes can do 1000X what only your ears could do previously, one signal at a time!)
3. Audio and IF Digital Signal Processing (DSP)
4. Filters! (brick-wall envelopes… improving all the time with s/w upgrades)
5. Harness the power of your existing Computer
6. Multiple VFOs and/or virtual receivers
7. Schedule and Record large bandwidths of the spectrum and tune later!
8. Record/playback of audio from a specific signal
9. Allows you to explore new applications:
   - Digital modes, WX satellites, radio astronomy, aircraft monitoring, digital stations, TV, DAB, Ionosondes etc etc
10. Can you ever have too many receivers?

Application Examples

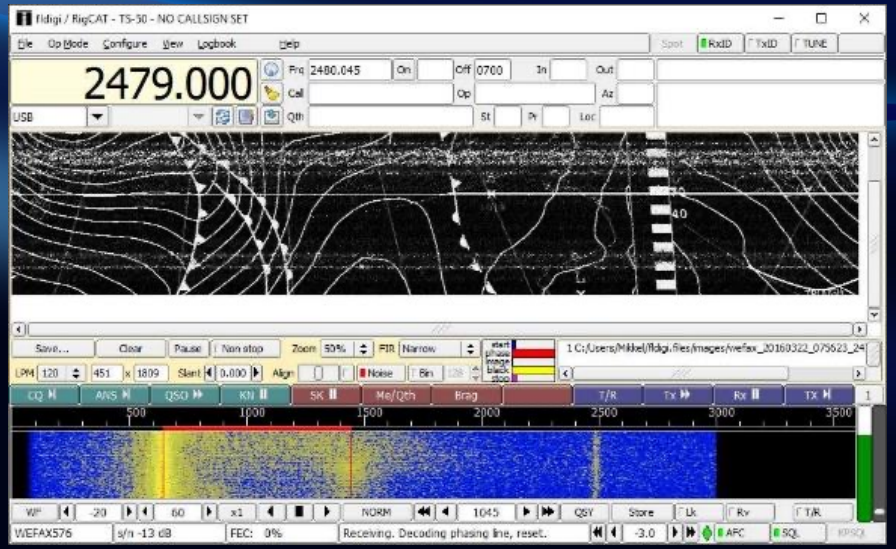
Fldigi Digital Decoding

Fldigi NBEMS (Narrow Band Emergency Messaging System)



Credit: Jeff Kopcak, k8jtk

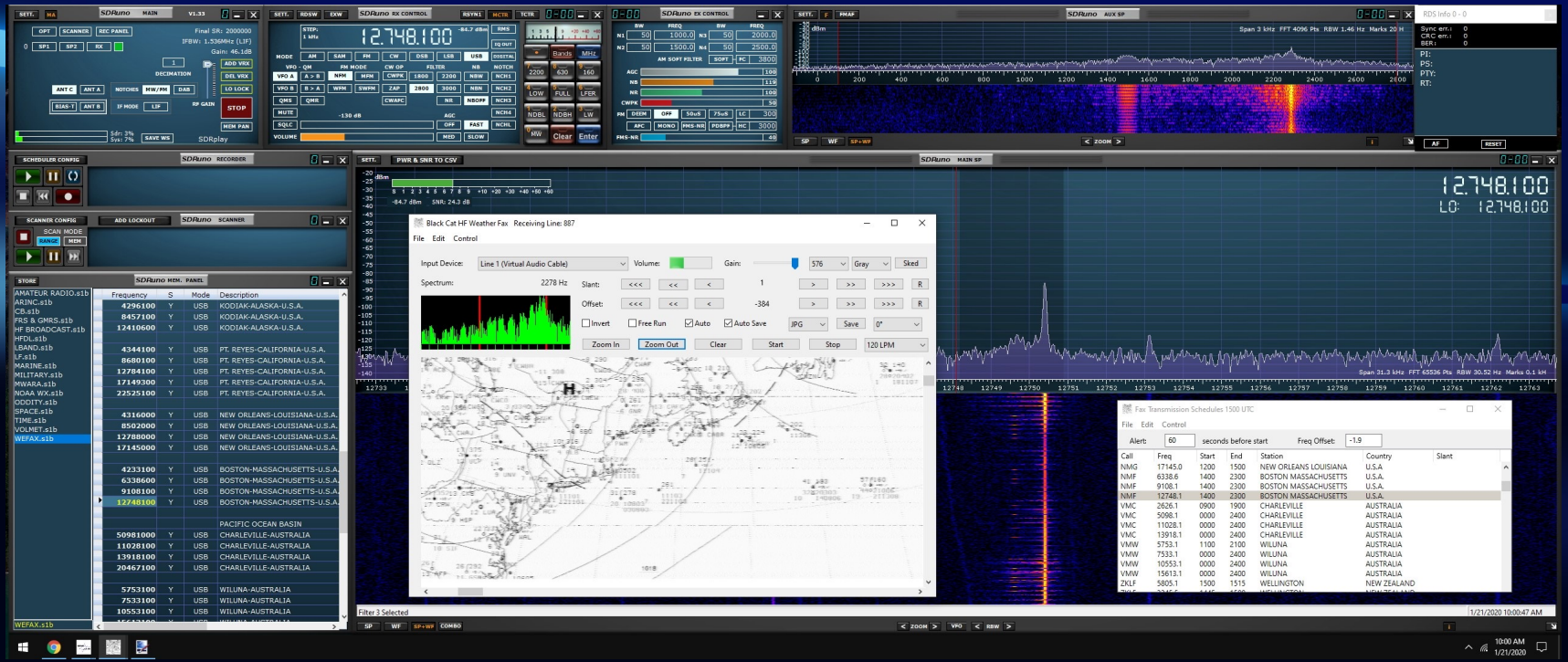
…and WEFAX Decoding



Credit: Erik Mikkel Wied

Fldigi:
http://www.w1hkj.com

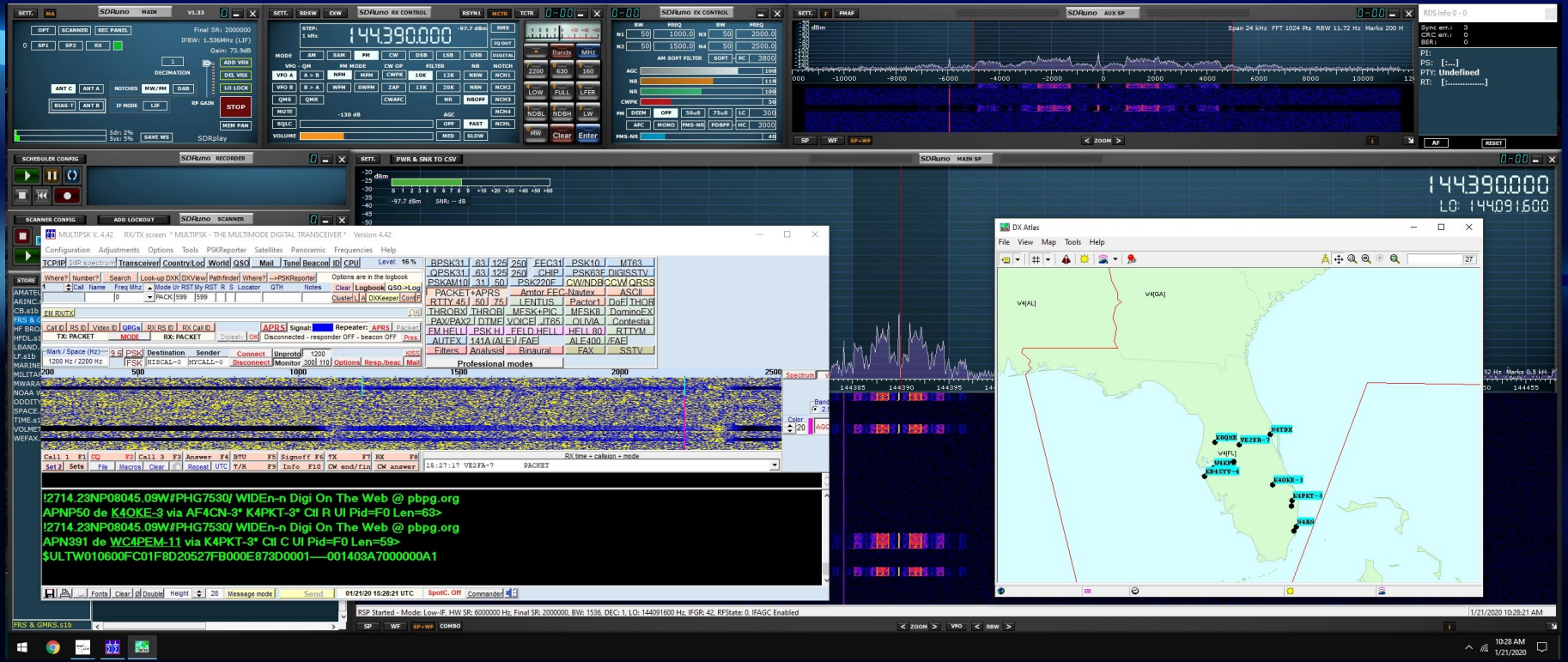
HF Weather Fax



Black Cat Systems:
https://www.blackcatsystems.com

Credit: Mike Ladd, KD2KOG

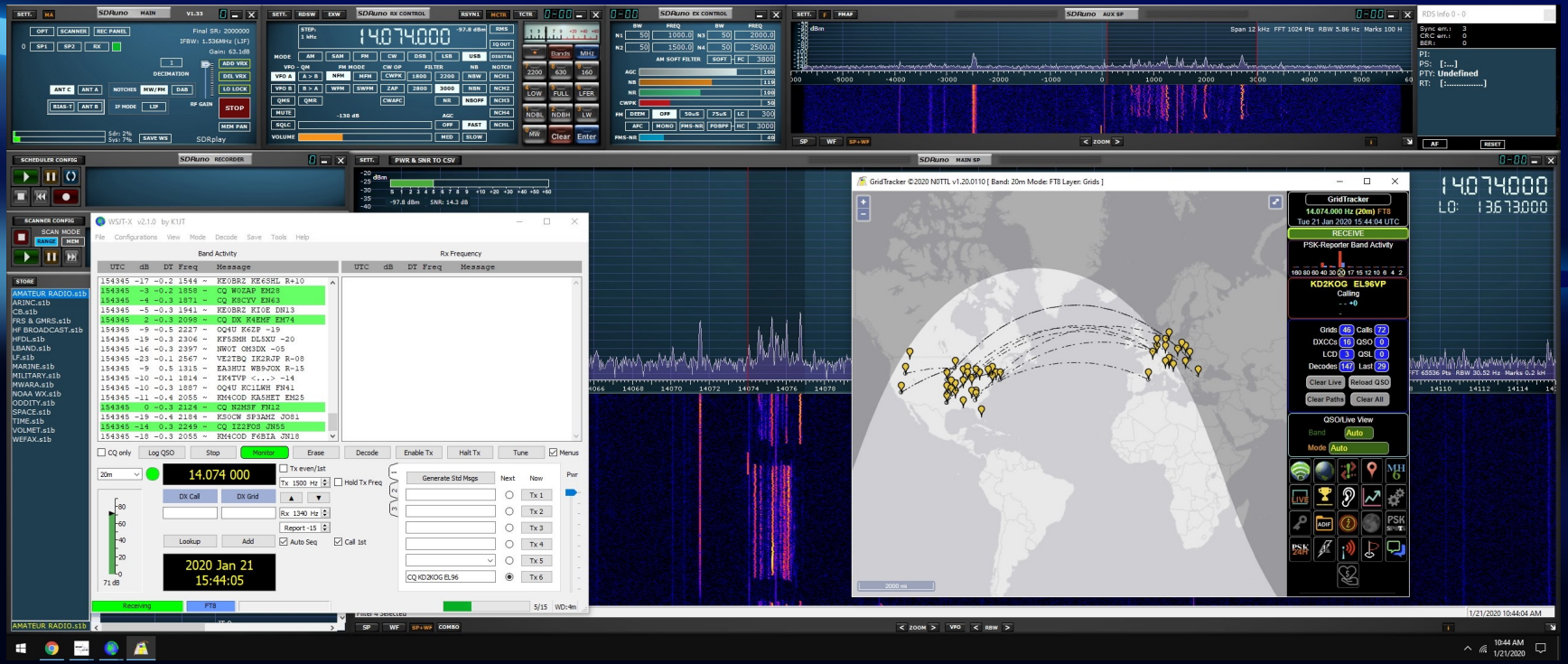
MultiPSK



MultiPSK:
http://f6cte.free.fr/index_anglais.htm

Credit: Mike Ladd, KD2KOG

WSJT-X and GridTracker



WSJT-X: https://physics.princeton.edu/pulsar/K1JT/wsjtx.html

GridTracker: https://tagloomis.com/grid-tracker/

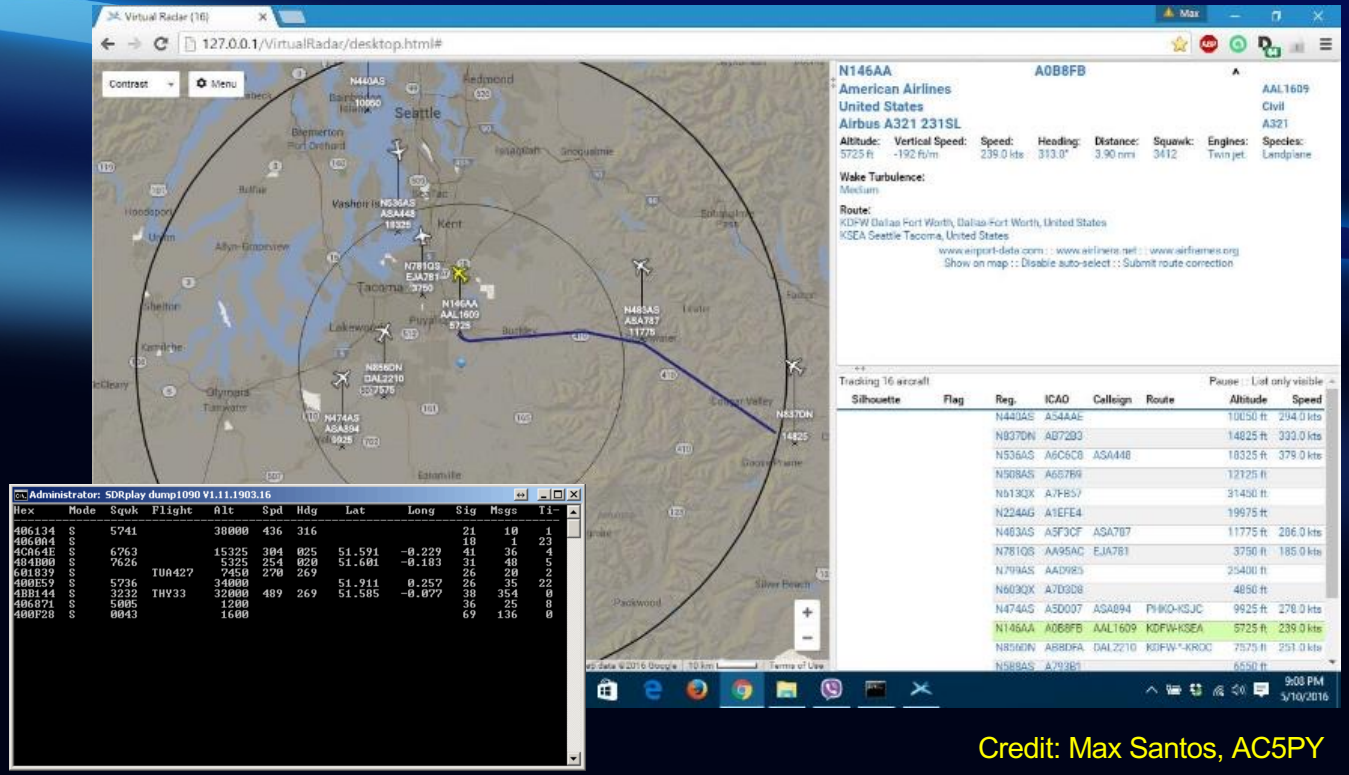
Credit: Mike Ladd, KD2KOG

CSV Userlist Browser

CSV User List Browser: https://www.df8ry.de/htmlen/home/welcome.htm

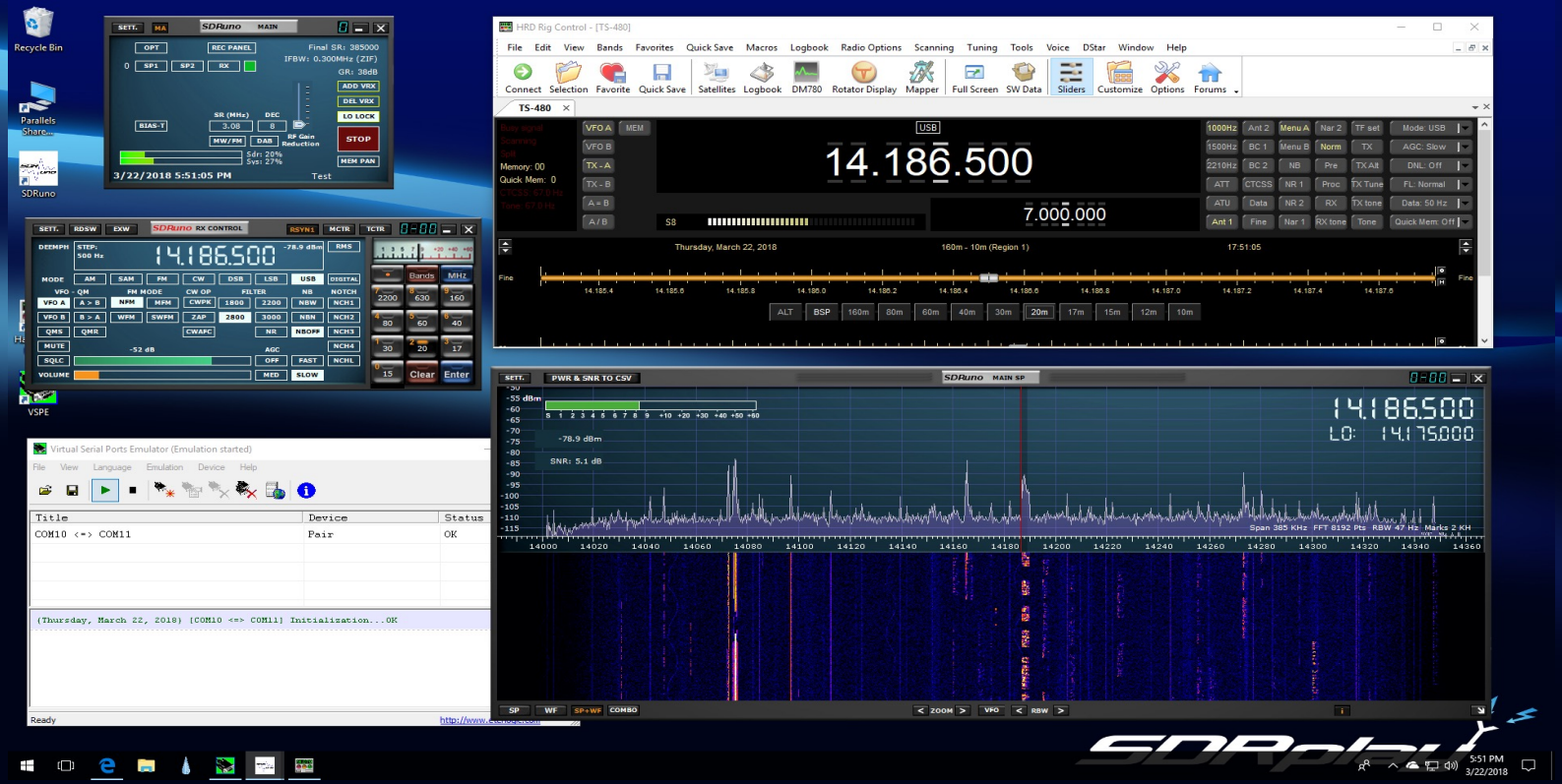
Credit: Mike Ladd, KD2KOG

ADS-B decoding example using Dump1090 and VRS



Credit: Max Santos, AC5PY

Ham Radio Deluxe (including DM-780 and Logbook)



Ham Radio Deluxe:
https://www.hamradiodeluxe.com/

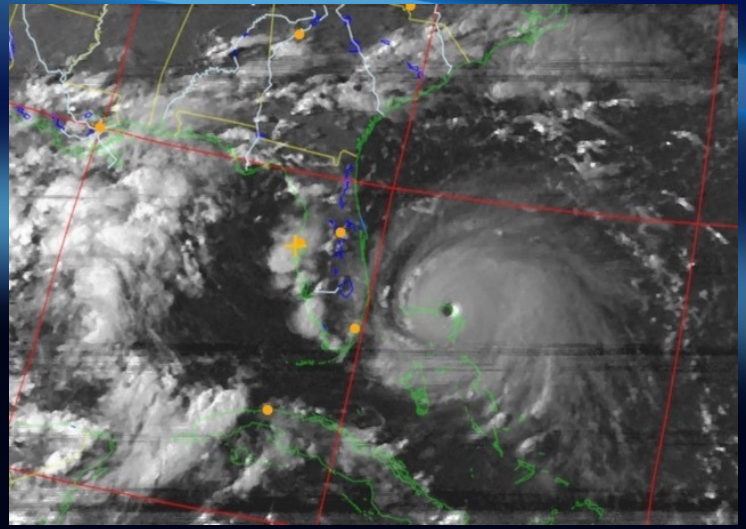
Credit: Steve Brightman, KI5ENW

www.sdrplay.com

Satellite working

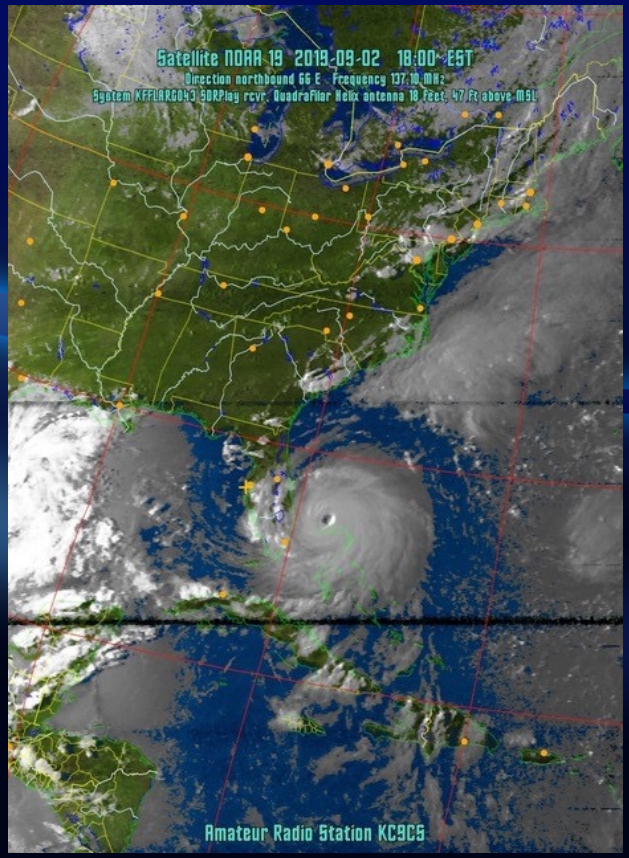
WD9EWK VHF crossed dipole
& Tablet + RSP for telemetry

NOAA Weather satellite (137 MHz) - Wxtoimg (RSP1)



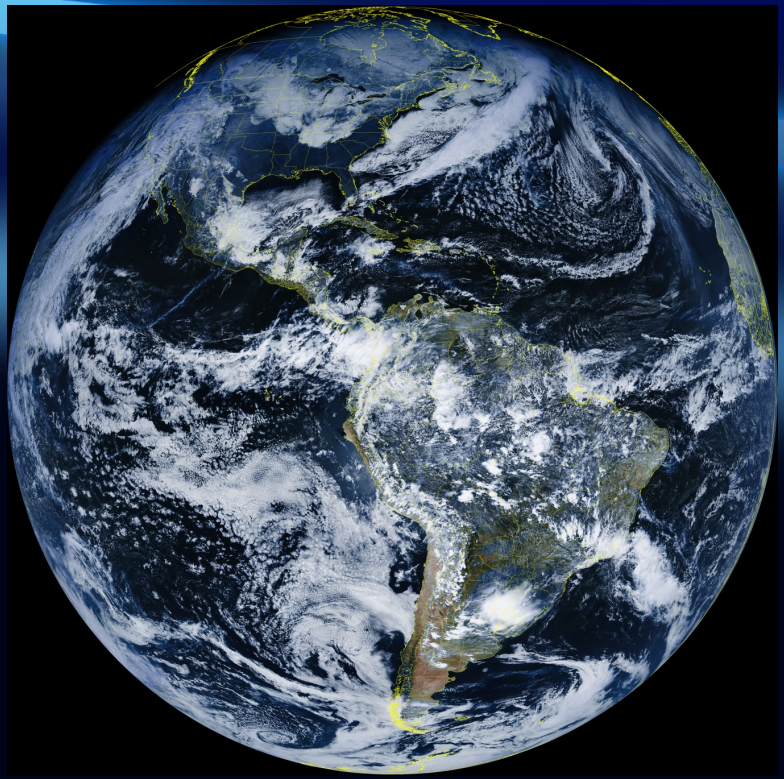
User pictures from the facebook group:
www.facebook.com/groups/sdrplay/

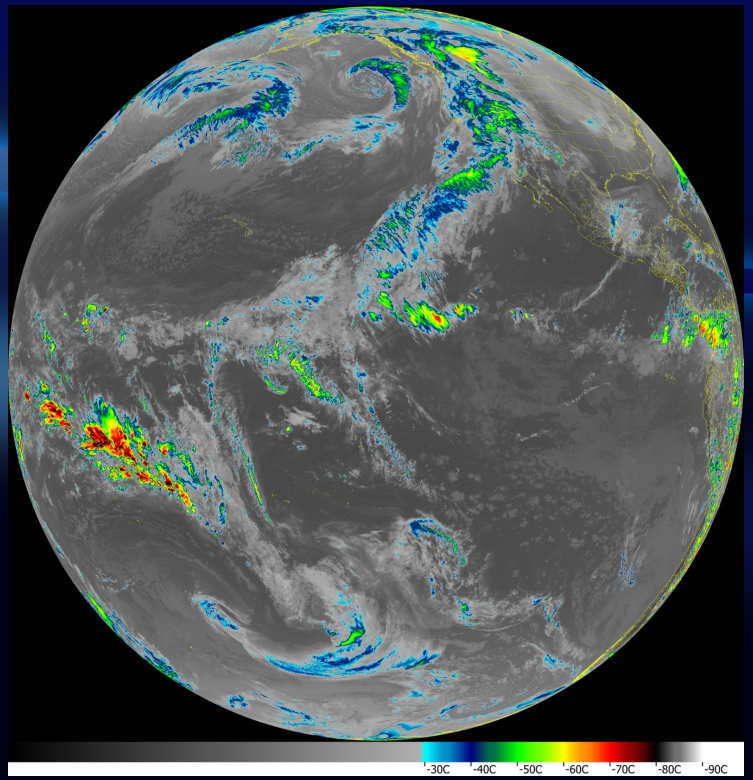
Wxtoimg:
http://www.wxtoimg.com



Credit: Hurricane Dorian by Bill Otten, KC9CS

High Resolution imagery received from the NOAA GOES 16 and GOES 17 satellites (1.7GHz)





Credit: Bern Bareis

www.sdrplay.com

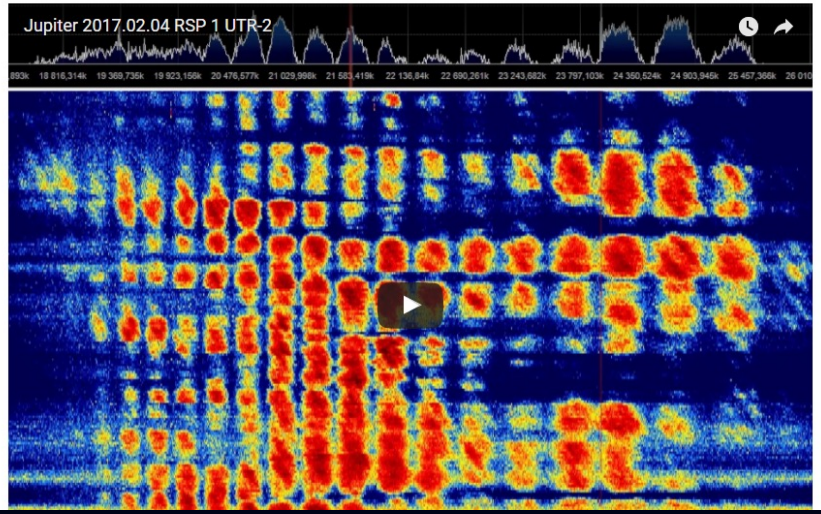
SDRplay

Tune in to Jupiter!

RECEIVING JUPITER NOISE BURSTS WITH AN SDRPLAY RSP1

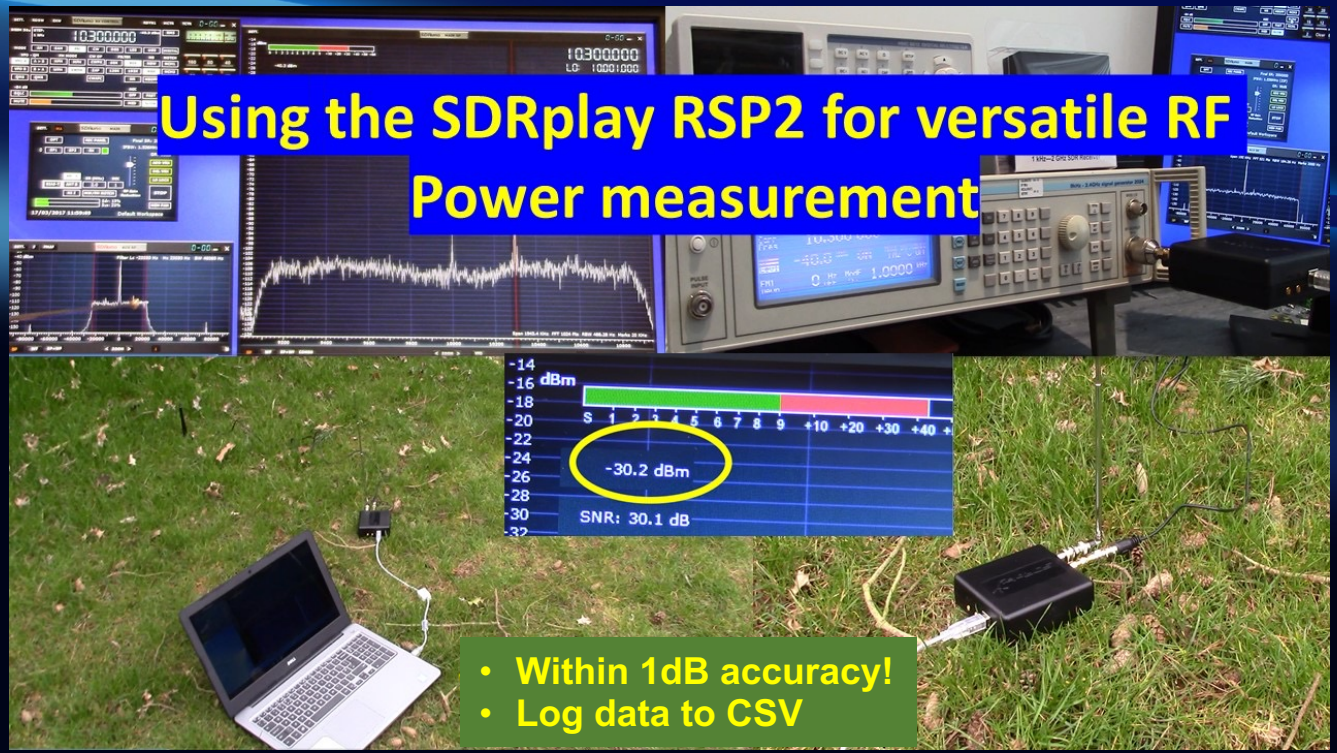
Over on YouTube user MaskitoISAE has uploaded a video showing him receiving some noise bursts from Jupiter with his SDRplay RSP1. The planet Jupiter is known to emit bursts of noise via natural 'radio lasers' powered partly by the planets interaction with the electrically conductive gases emitted by Io, one of the the planets moons. When Jupiter is high in the sky and the Earth passes through one of these radio lasers the noise bursts can be received on Earth quite easily with an appropriate antenna

In his video MaskitoISAE shows the 10 MHz of waterfall and audio from some Jupiter noise bursts received with his SDRplay RSP1 at 22119 kHz. According to the YouTube description, it appears that he is using the UTR-2 radio telescope which is a large Ukrainian radio telescope installation that consists of an array of 2040 dipoles. A professional radio telescope installation is not required to receive the Jupiter bursts (a backyard dipole tuned to ~20 MHz will work), but the professional radio telescope does get some really nice strong bursts as seen in the video.

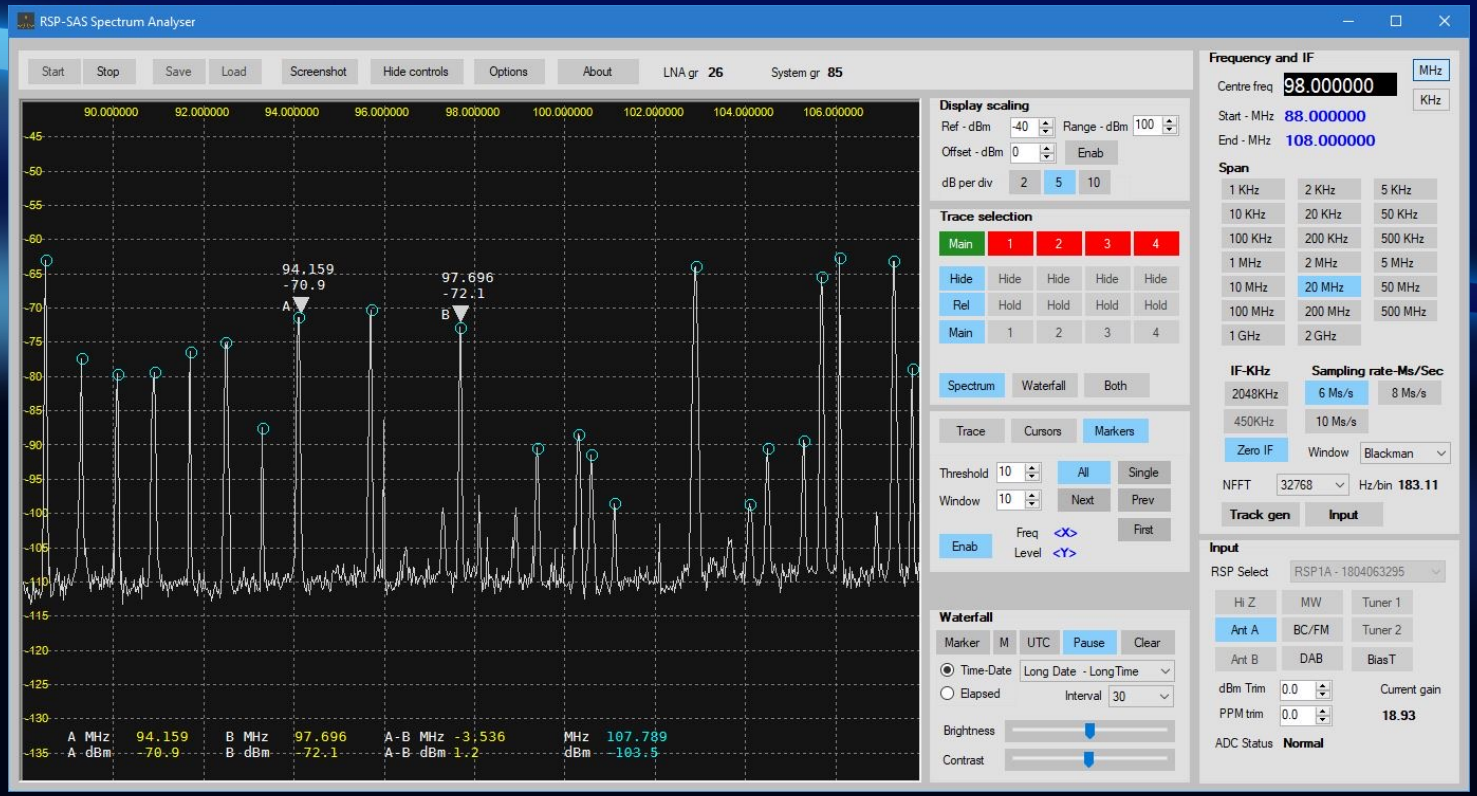


Doubles as a new piece of RF lab kit:

an RF Power meter – get one for work or play!



SAS Spectrum Analyser – Make your RSP into a Spectrum Analyser!



SDR hardware

SDRplay

SDR Variety

Performance

Price

- $10 – 100
- Low performance
- Introductory

8-bit Dongles

Small cost adder
Big performance gain

- $100 – 300
- Good performance
- Wide Coverage
- RSP, Airspy etc

General Purpose

Large cost adder
Modest performance gains

High End

- $500 – 1000s
- High performance
- Specialized functionality
- RF Space, Flex, ELAD etc

SDRplay

Review of SDR receivers – what to consider:

- **Frequency Range:** The range of frequencies the SDR can tune.
- **ADC Resolution:** Higher is better. More resolution means more dynamic range, less signal imaging, a lower noise floor, more sensitivity when strong signals are present and better ability to discern weak signals.
- **Instantaneous Bandwidth:** The size of the real time RF chunk available.
- **RX/TX:** Can the radio receive and/or transmit?
- **Preselectors:** Analogue filters on the front end to help reduce out of band interference and imaging.
- **Software:** Is your favourite package supported? Does manufacturer provide?
- **Price**

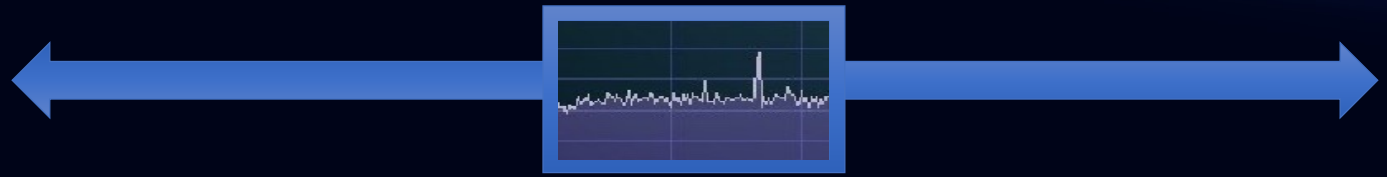
Instantaneous bandwidth illustration

RSP1a

RSPdx

10 MHz visibility

1kHz

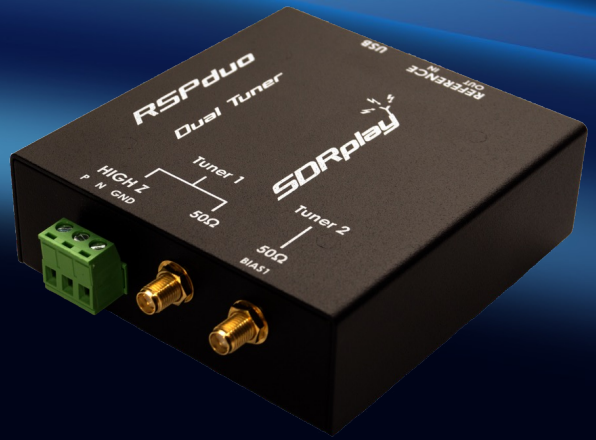


2GHz

SDRplay

RSPduo - Dual independent tuners!

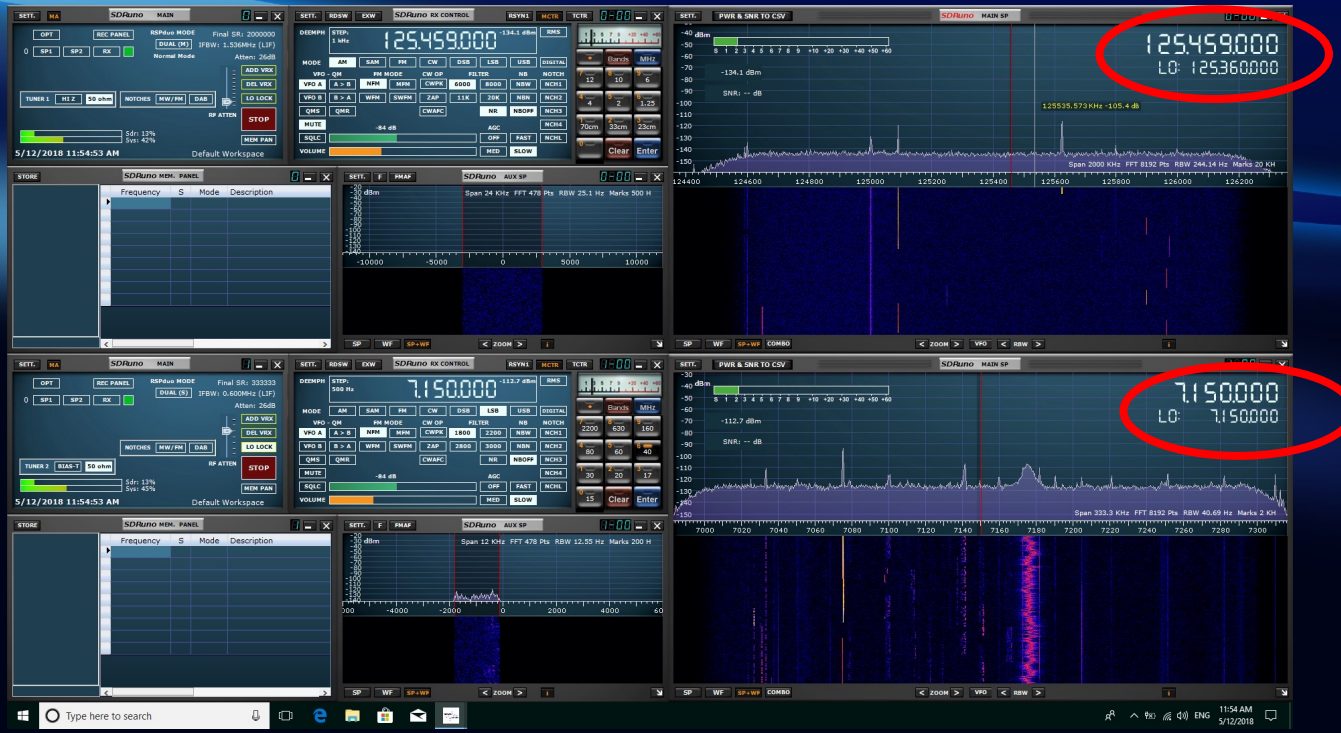
- Single 10MHz slice, like the other RSPs, or….
- Two independent “slices” anywhere in the coverage range



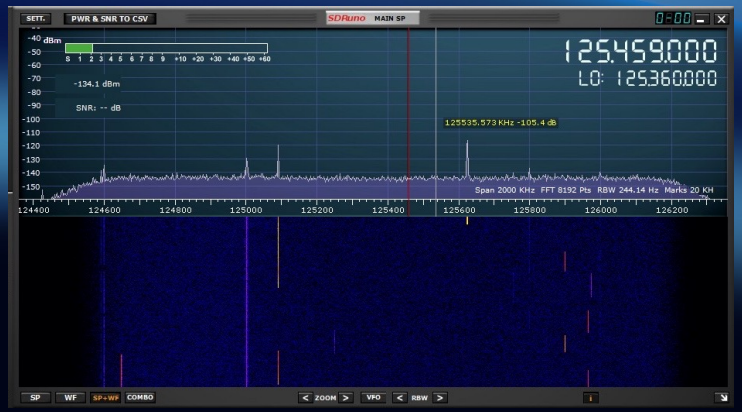
SDRplay Receivers – RSP Family

- Continuous SDR receiver coverage from VLF to 2 GHz
- All the amateur radio bands from VLF to 23cm
- High performance ADC technology (not another compromise SDR!)
- Built-in high performance front-end filters
- Use as a stand-alone general coverage receiver, or as a high resolution panadapter
- Visualize all the signals in multiple bands simultaneously
- SDRuno Windows SDR software provided free-of-charge
- Works on other platforms (Mac, Linux etc) using 3rd party SDR Software
- Works with 3rd party Windows software e.g. HDSDR, SDR-Console)
- Runs on a Raspberry Pi – download our SD Card image
- Ideal for portable operation (powered via USB)
- Can be used as a Spectrum Analyzer or an RF Power Meter
- Backed by the world's biggest and best SDR support community!

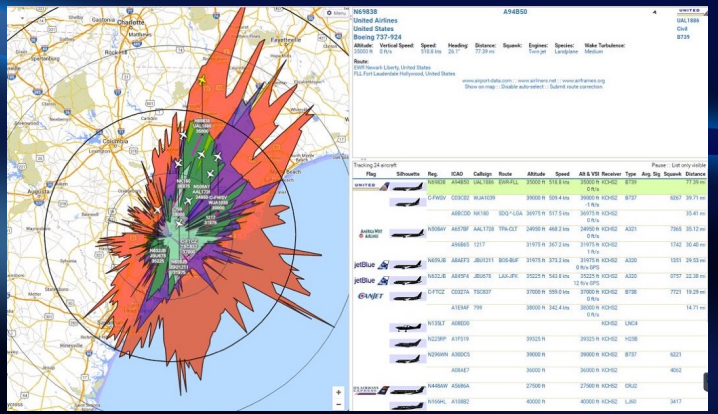
RSPduo - Monitor two widely spaced bands simultaneously!



RSPduo - Mix and match applications simultaneously!



ATC



ADSB

RSPduo - Diversity Tuning!!!

- RSPduo only
- MRC (Maximum Ratio Combination) for noise reduction (AUTO mode)
- Interference Rejection (Manual mode)

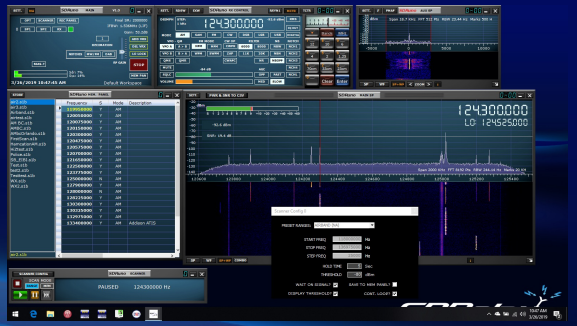
RSPdx – Multiple Inputs & HDR

- Improved replacement for RSP2/pro
- 3 Software selectable inputs
- Additional 500kHz LPF for LF/VLF
- HDR mode for enhanced performance under 2MHz
  - Great for Dxers!
- Notch filters on all inputs
- BNC input for reception up to 200MHz
- Rugged steel case

Software

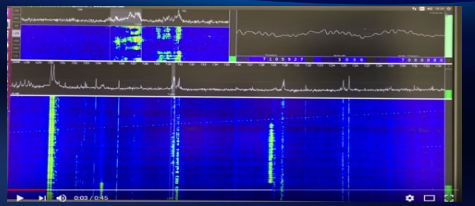
Software

- SDRplay owns and develops our own SDR software, optimised for the RSP family:
  - Software upgradeable for future standards
  - API provided to allow demodulator or application development
- SDRplay also provides Multi-platform API enabling Windows, Mac, Linux, Android, Raspberry Pi 3rd party software including: SDRConsole, HDSR and CubicSDR
- All the above software packages are available ***free of charge!***
- Supports 3rd party software e,g, loggers, Decoders, Rig Control etc

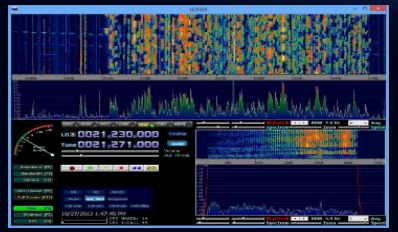


SDRuno

SDRConsole



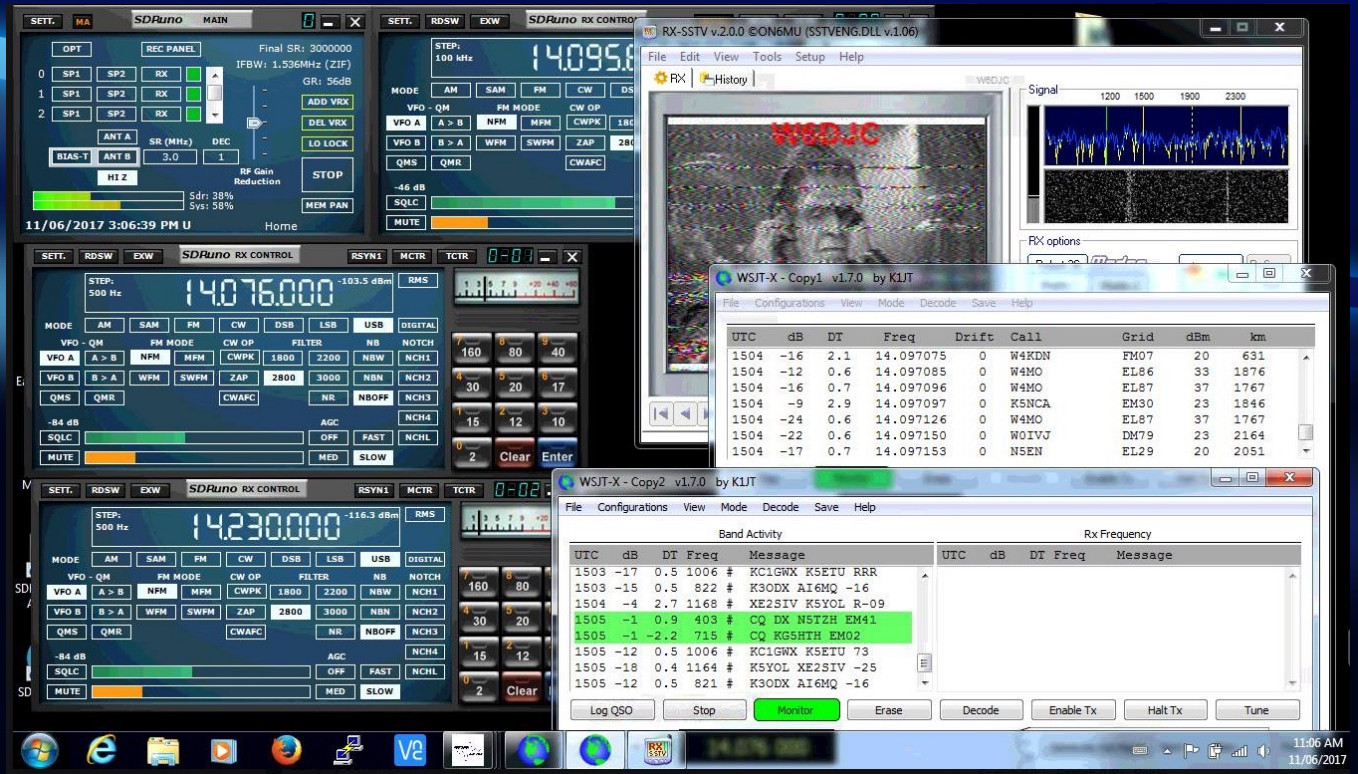
CubicSDR



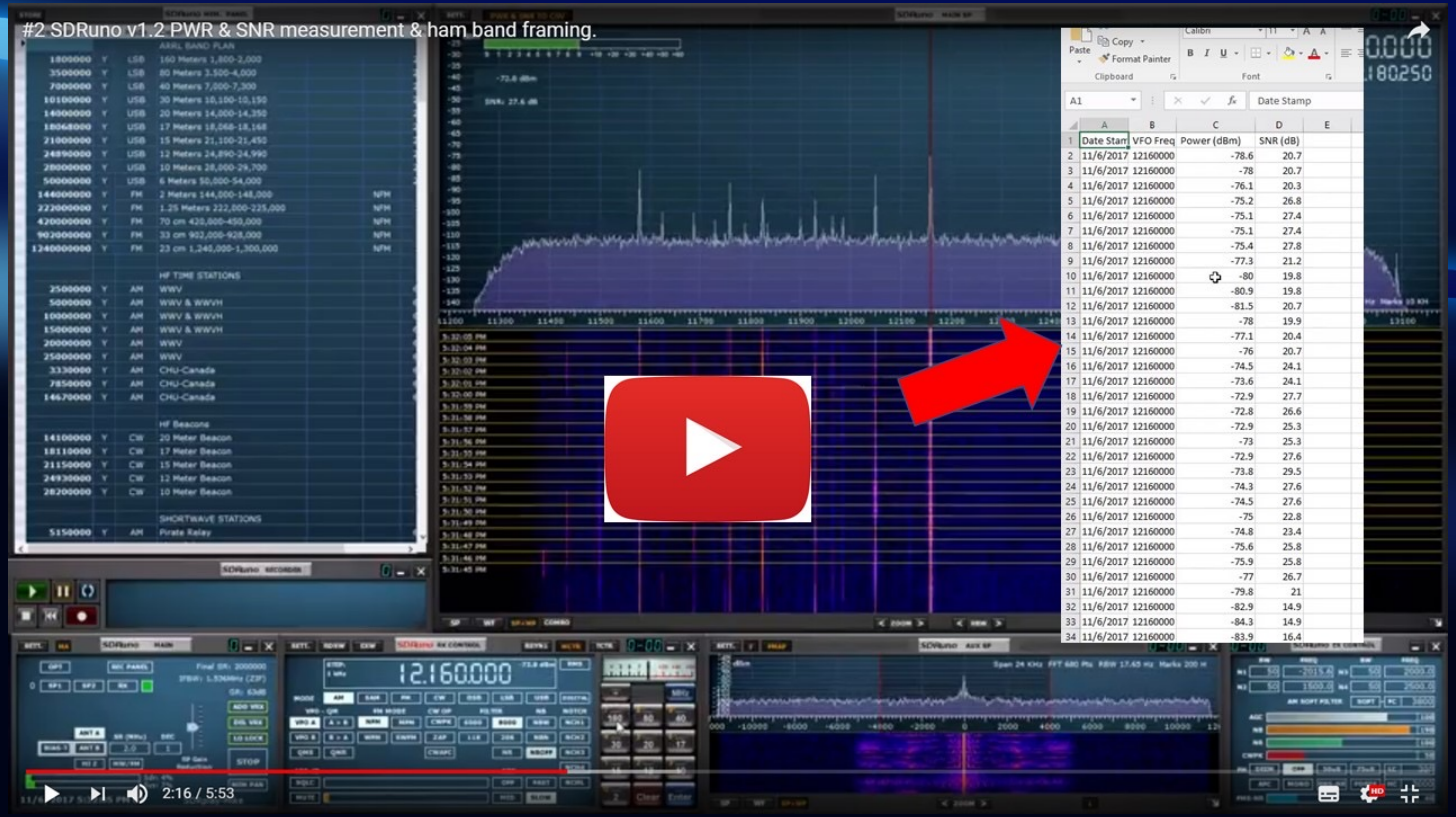
HDSDR

www.sdrplay.com

Multiple VFOs & different decode modes - simultaneously!

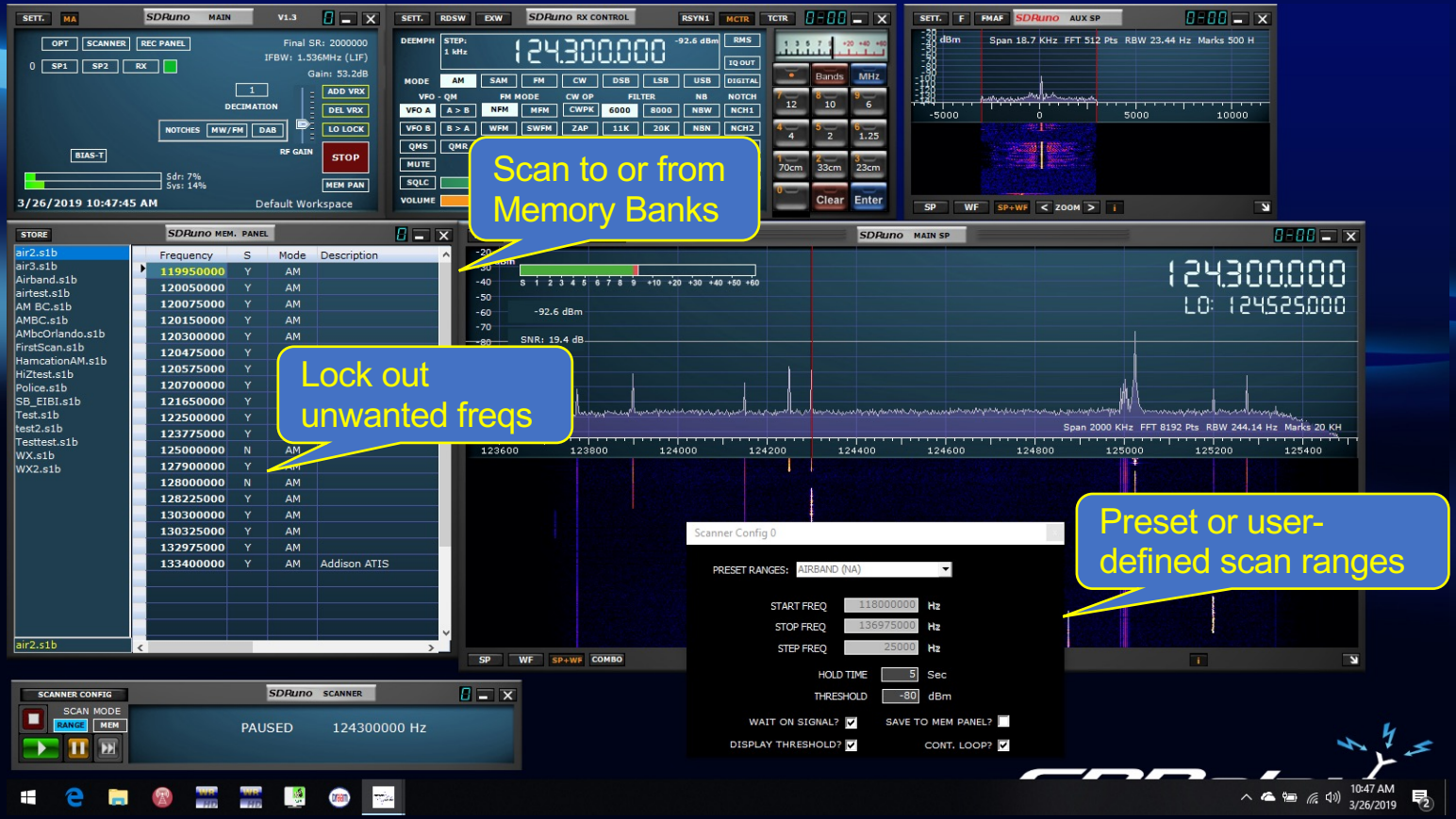


RF power level + SNR measurement & logging



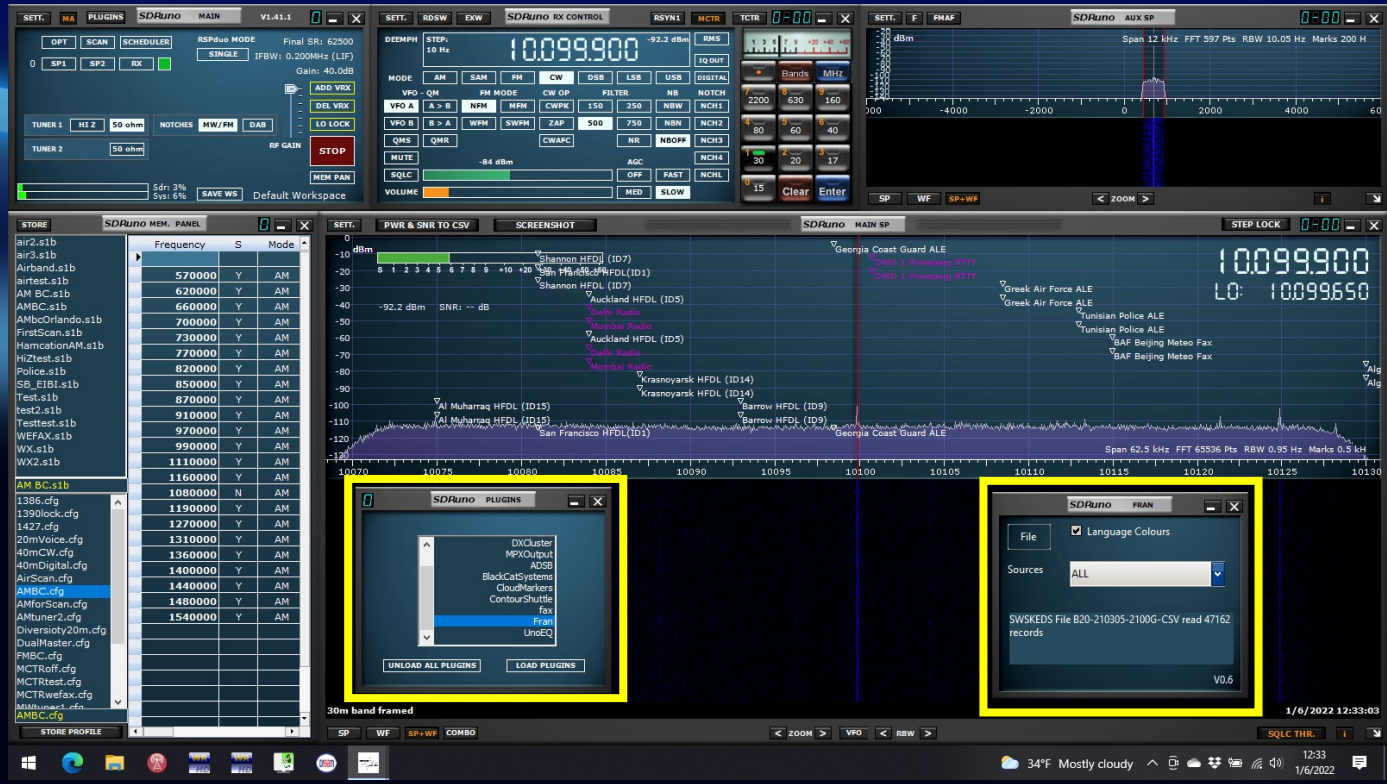
www.sdrplay.com

Scanning – scan a range of frequencies or your own preset frequencies

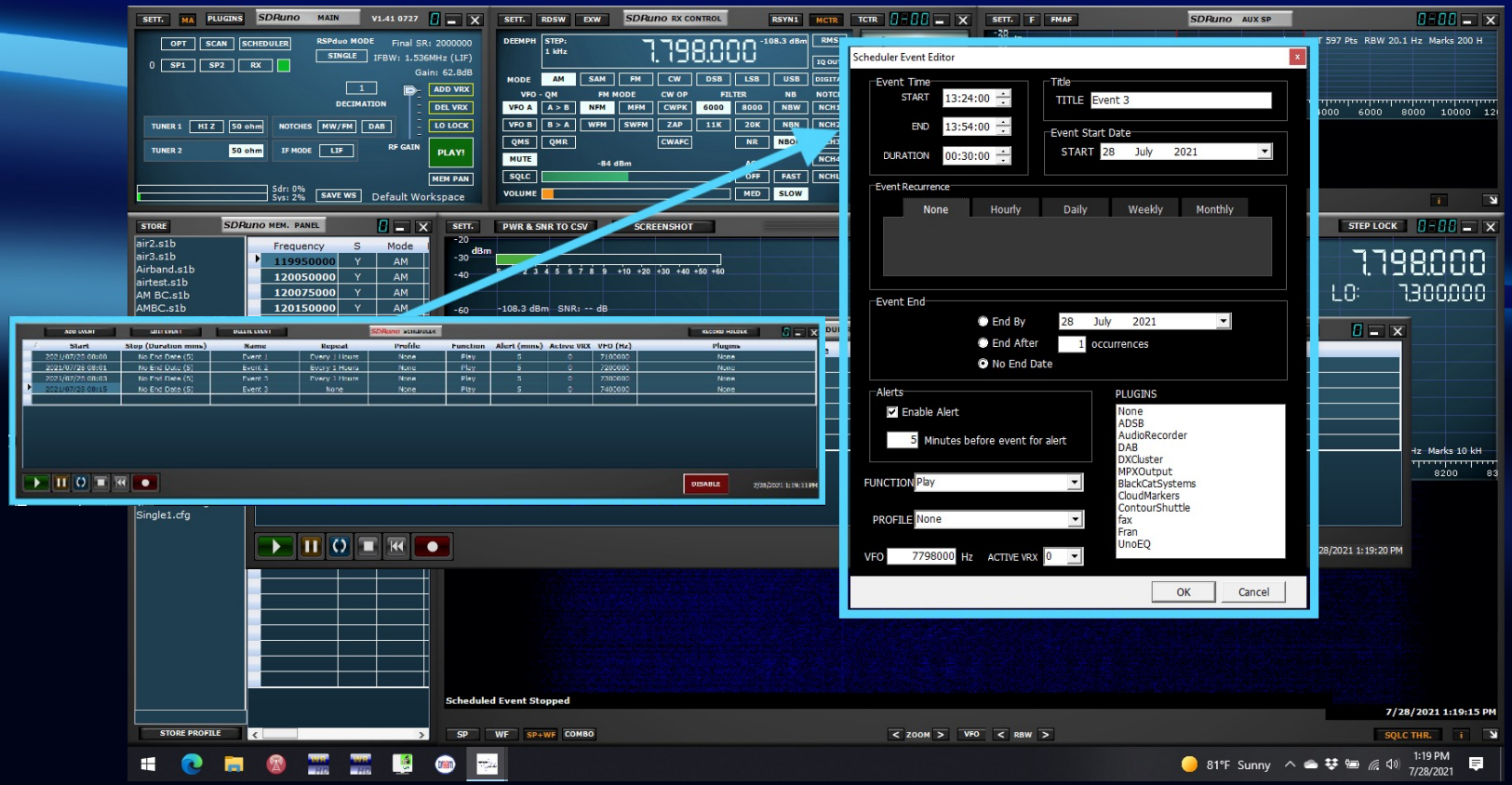


Plugins

- Enhance receiver capabilities:
  - Annotation
  - Decoders
  - Controllers
  - 3rd party Interface
  - Recorders
- SDRplay or 3rd party development

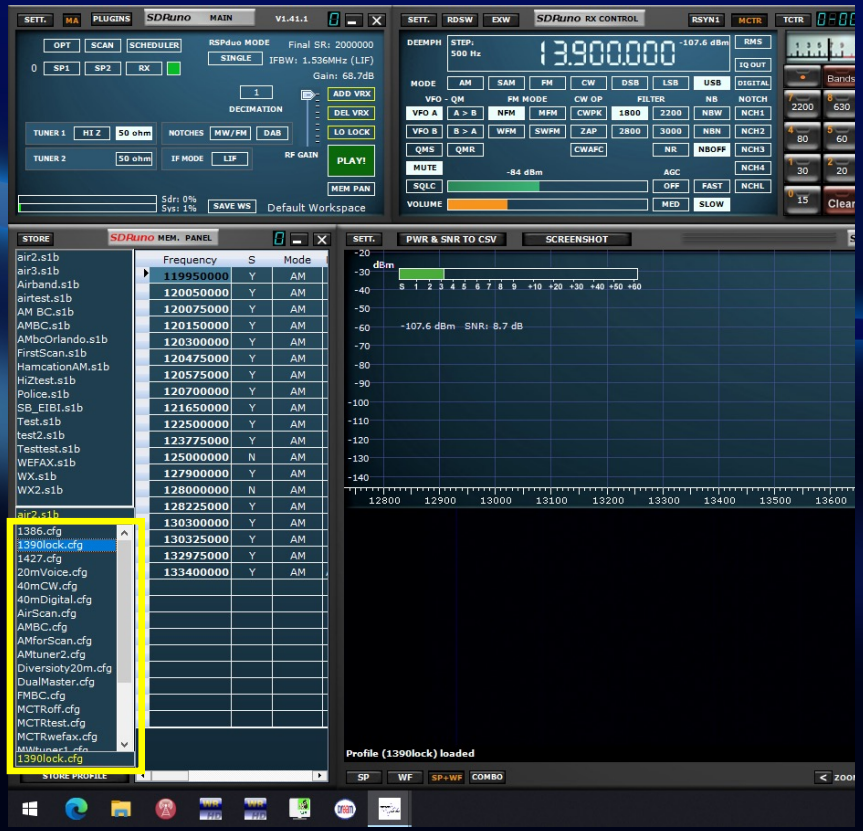


Scheduler


Scheduler Event Editor
Event Time
START 13:24:00
END 13:54:00
DURATION 00:30:00
Title
TITLE Event 3
Event Start Date
START 28 July 2021
Event Recurrence
None
Hourly
Daily
Weekly
Monthly
Event End
End By 28 July 2021
End After 1 occurrences
No End Date
Alerts
Enable Alert
5 Minutes before event for alert
PLUGINS
None
ADSB
AudioRecorder
DAB
DXCluster
MPXOutput
BlackCatSystems
CloudMarkers
ContourShuttle
fax
Fran
UnoEQ
FUNCTION Play
PROFILE None
VFO 7798000 Hz
ACTIVE VRX 0
OK
Cancel
Scheduled Event Stopped
7/28/2021 1:19:15 PM
81°F Sunny
1:19 PM
7/28/2021

Profiles

- Ensure receiver is set up correctly for:
  - Scheduled events
  - Specific user scenarios
- Store a complete set of radio parameters including:
  - LO and VFO
  - Sample rate (SR and DEC)
  - Gain
  - Input selection
  - Notch filters
  - VRX settings
- Examples:
  - AM broadcast
  - HF CW or FT8
  - FM Broadcast



SDRuno Software Roadmap

v1.42

- **Final Version of SDRuno**
  - Will continue to be supported for bug fixes etc
  - No new major enhancements will be added
- **Nomenclature: V1.42 build xxxx**
  - where xxxx is a unique 4 digit number typically based on MMDD
- All SDRuno software enhancements (except those for specific hardware) are applicable to all RSP models!
- The update notifications (if they are turned on) will make you aware of when a release is ready. If you do not want these notifications, the update notifier can be disabled in the main panel OPT menu.
- For more info: https://www.sdrplay.com/sdruno-roadmap/

Introducing SDRconnect

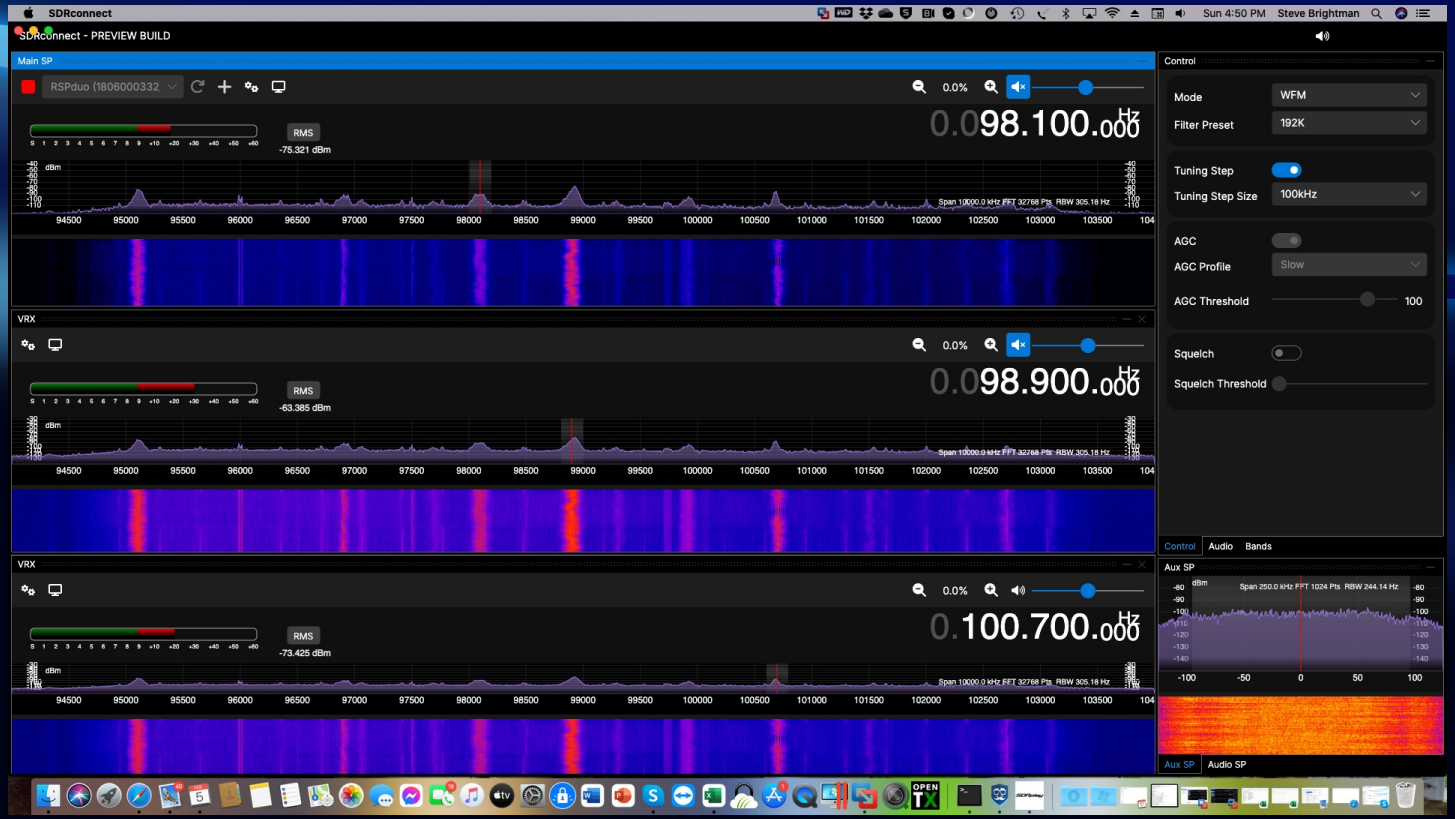
- Complete rewrite of SDRuno
  - Both SDRuno and SDRconnect can be installed on the same machine
  - SDRuno v1.42 will continue to be supported (bug fixes etc only)
- Cross Platform (x86, ARM, MacOS, Linux, Windows, Android)
- New Remote Server and Client (cross platform)
  - Access your RSP from anywhere – home LAN or across the internet!
- Complete GUI rewrite and update
  - More intuitive / easy to use interface
  - Ability to lock panels together
- Modular architecture
  - Easily add additional functionality
- Compatible with all current RSPs (RSP1A, RSPdx, RSPduo)
  - Compatible with RSP2 & RSP2pro discontinued products
  - Due to hardware limitations the RSP1 is not supported, but SDRuno 1.42 can still be used
- ***Preview release is imminent!*** *(see https://www.sdrplay.com/sdrconnect/ for updates)*

SDRplay

Introducing SDRconnect - Example screenshot

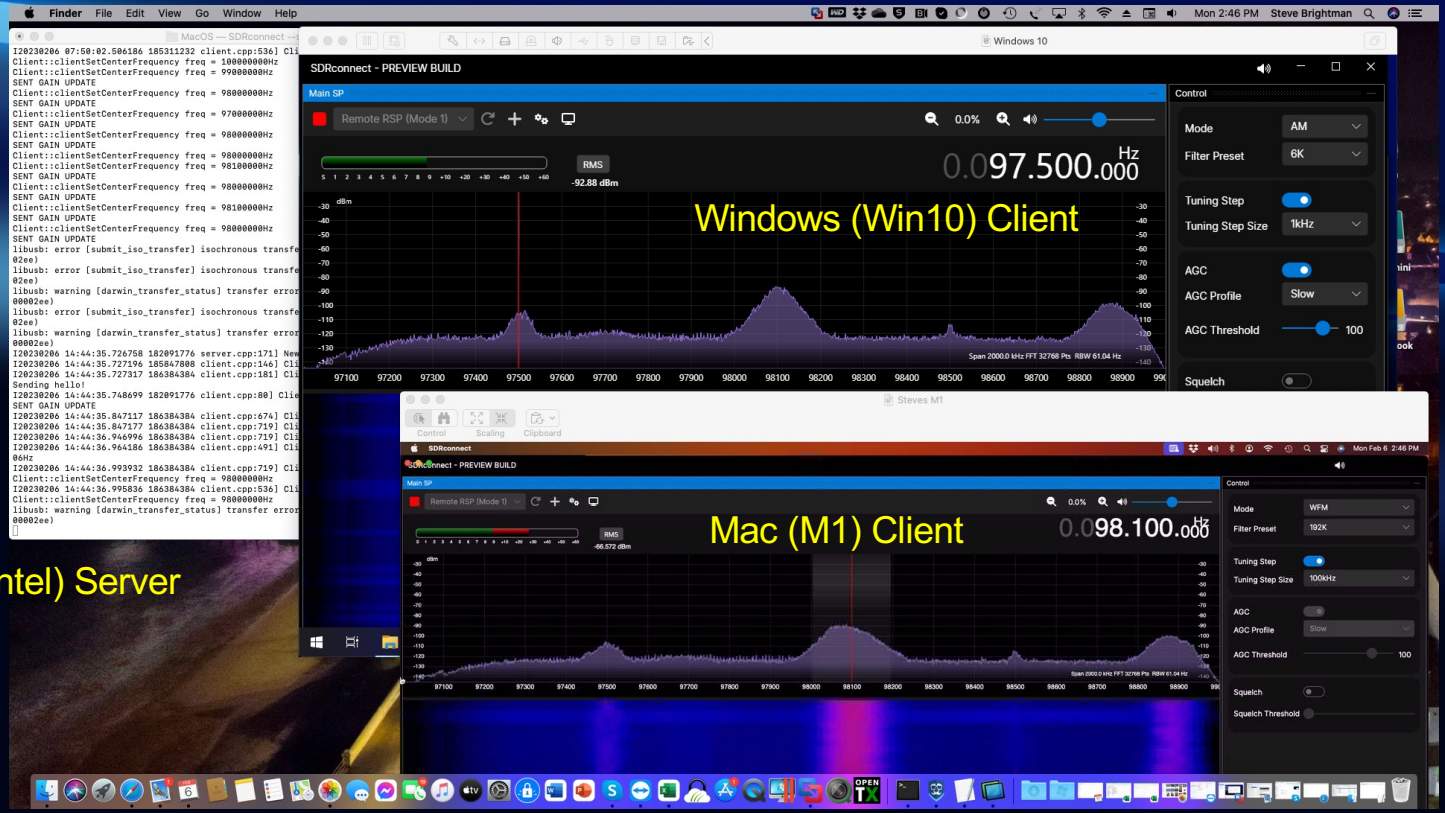
Mac Version

Multiple VRX



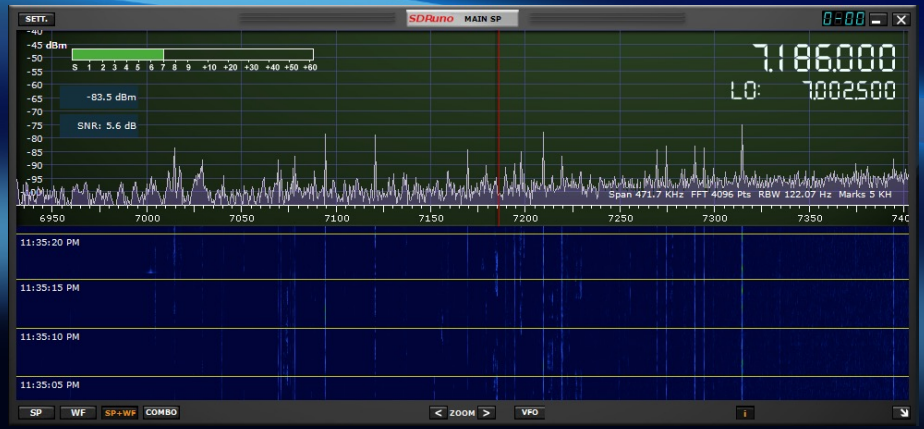
Note: GUI not yet finalized!

Introducing SDRconnect - Example screenshot



Panadapters

What is a Panadapter?



"Go-to" choice for Kenwood, Yaesu, Icom, Elecraft etc!

- "Panadapter is short for Panoramic Adapter. The simple answer is that it allows us to see a panoramic display of the band our radio is tuned to. We can see every signal"*.
- Early implementations used a PC soundcard to achieve this function but were therefore limited to 200 kHz of bandwidth because they rely on the sound card.
- The advent of affordable SDR hardware such as the RSP1A has allowed implementations with much greater bandwidth, and hence much more usefulness.
- Combined with readily available, and capable, SDR software Panadapters are now an affordable and easy to implement reality!

* Definition courtesy KA9MOT http://mypanadapter.com/

Why panadapter?

- Add new capabilities / visibility to any rig
- Synchronize the the rig to the software if it has a CAT port
- Work one frequency while monitoring the whole band
- Monitor multiple bands in addition to the one you’re working
- Arbitrarily large spectrum scope
- Less cost, more features than factory add-ons,

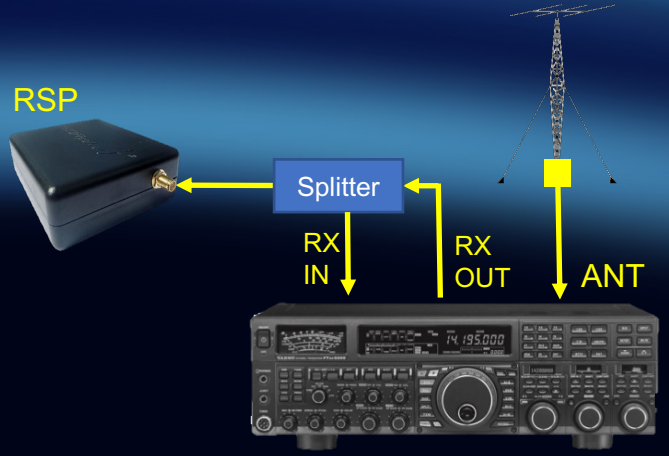
Monitoring 3 bands with SDRuno

SDRplay

The perfect Panadapter companion for your rig

- Any of the SDR Software programs that support RSP can be used to provide a basic spectrum display.
- SDRuno, HDSDR, SDR Console and CubicSDR have built-in capabilities for CAT and other add-on software, to allow for communication between the SDR software and the transceiver.
- OmniRig is commonly used for synchronization/control between the TRx and SDR Rx, but other control software, e.g. HRD, DXlab etc. can be incorporated using SDRuno's CAT capability
- App notes and videos available from sdrplay.com

Use a T/R switch if not using protected transceiver IF or RF out!



- RSP protected by rig's internal T/R
- Splitter if required (e.g. Yaesu)
- RX BW limited by IF

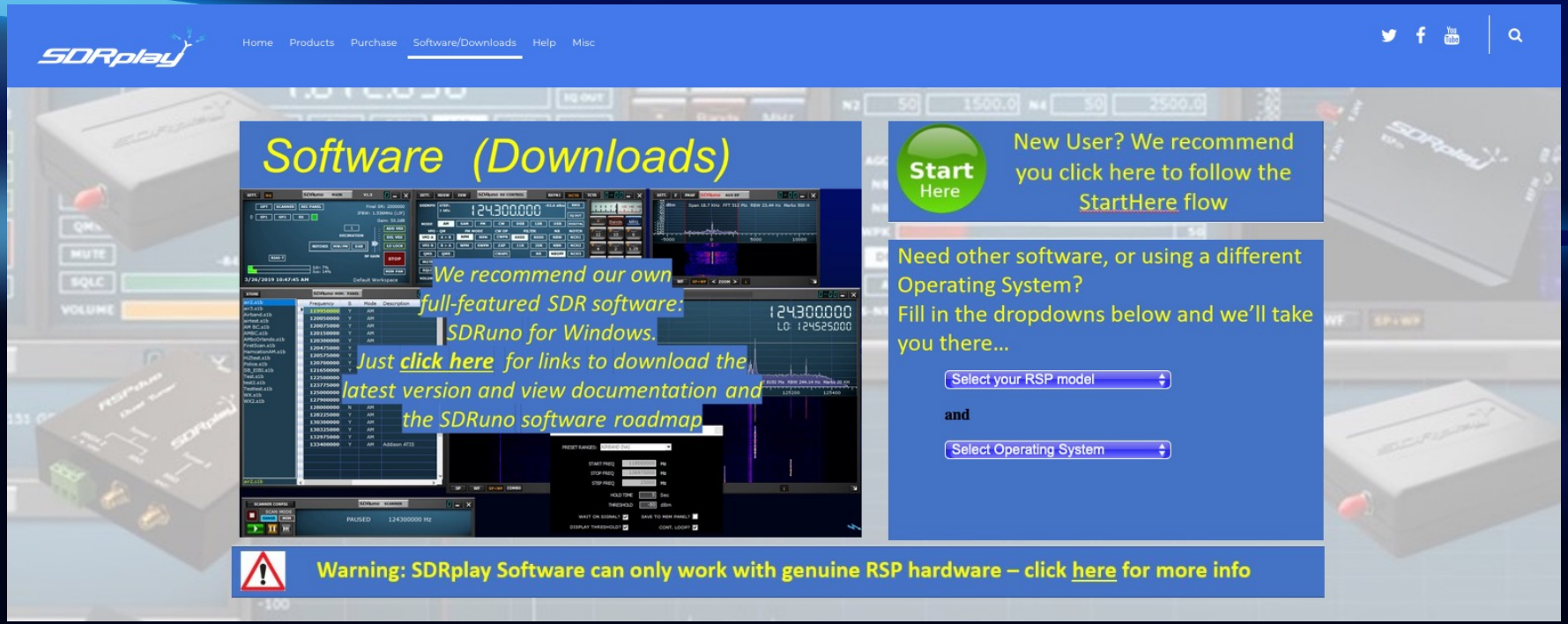
- RSP protected by T/R
- T/R shares signal
- Widest RX bandwidth
- *Always connect PTT!*

- RSP protected by rig's internal T/R
- Direct connection (e.g. Kenwood TS-590SG)

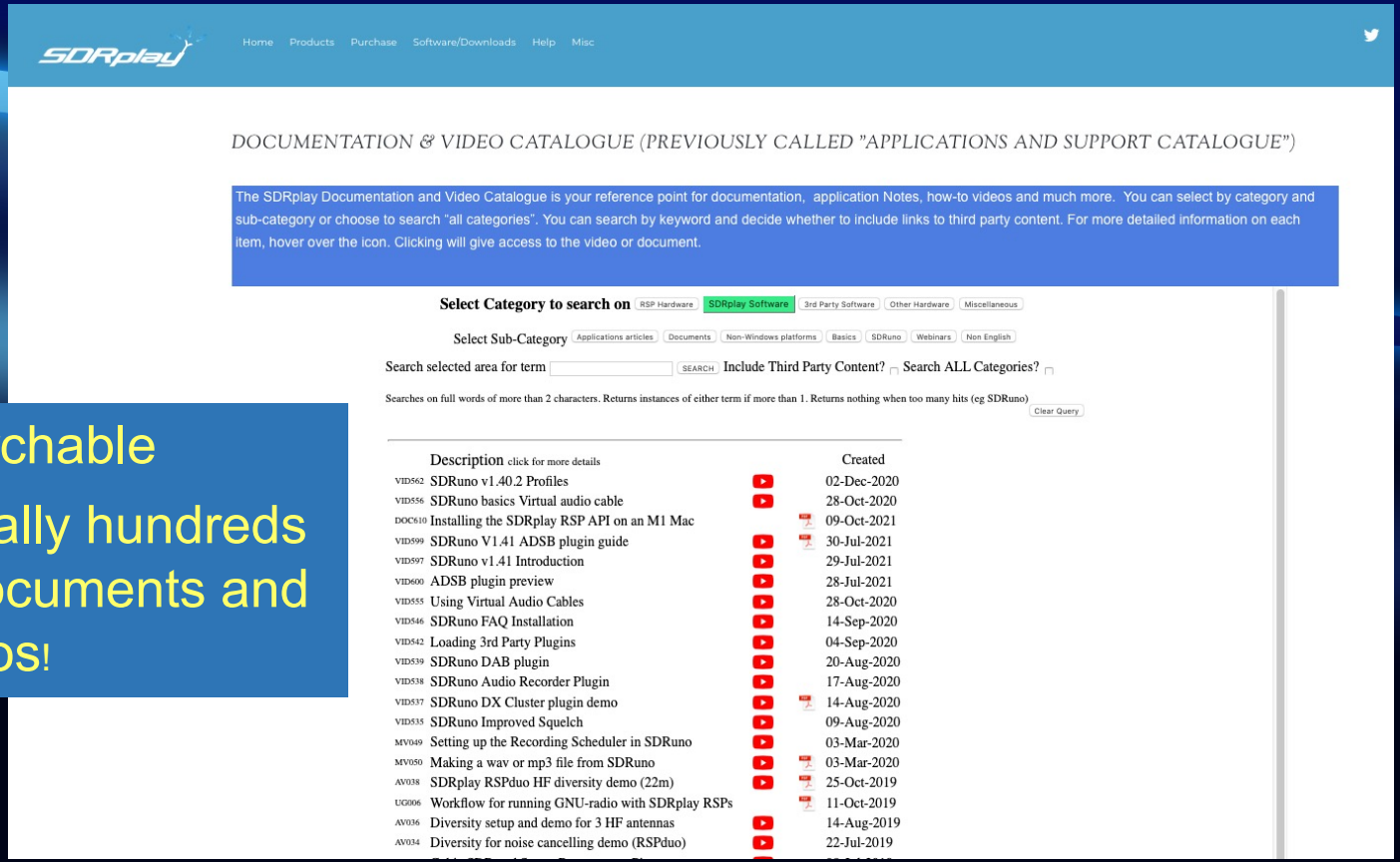
www.sdrplay.com

Support and further information

Software Downloads

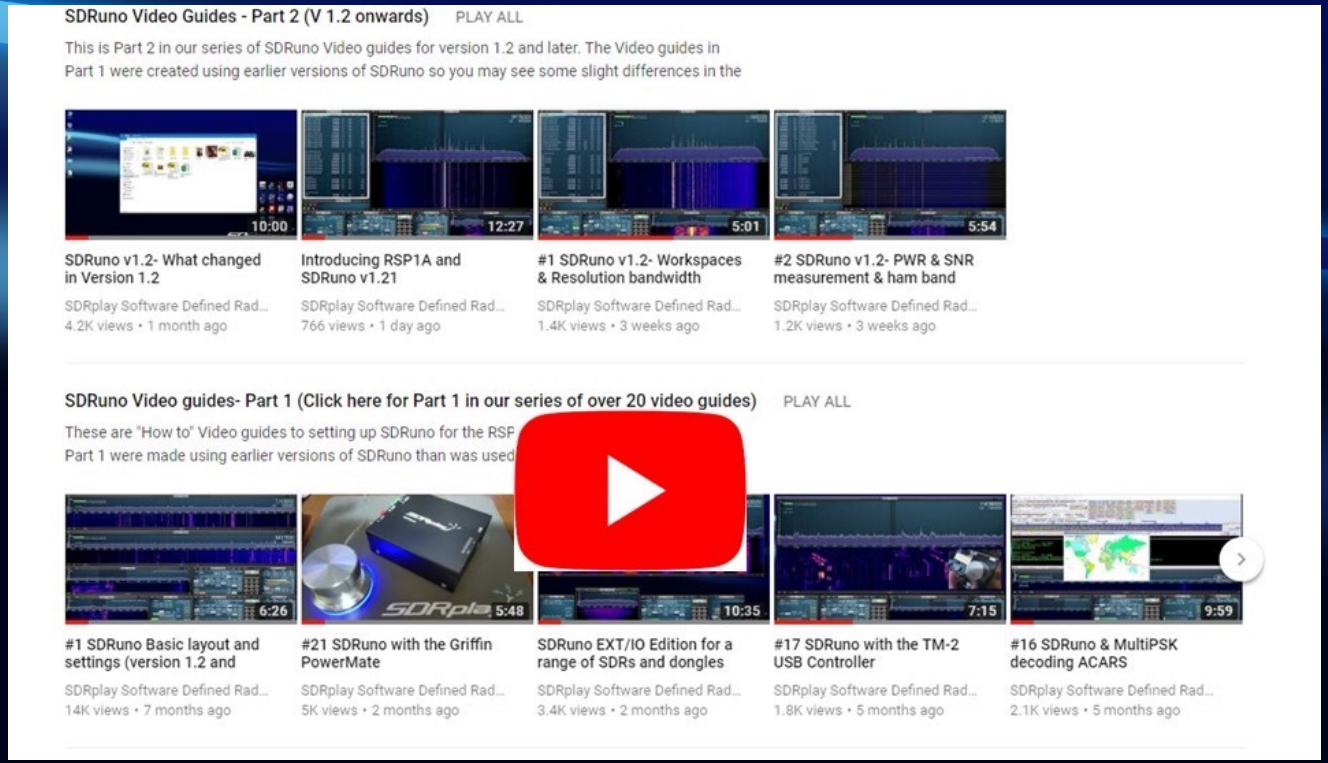


Documentation and Video Catalog



- Searchable
- Literally hundreds of documents and videos!

How-to videos: SDRplay YouTube Channel



www.youtube.com/c/SDRplayRSP

Facebook Groups

More than 10,000 users helping each other!

Direct support from SDRplay

For more information:

Thank You!

- Company website: www.sdrplay.com
  - Check out the ***Applications & Support Catalog*** at: https://www.sdrplay.com/apps-catalogue/
- Users Forum: https://groups.io/g/SDRPlayUsers
- Email: support-usa@sdrplay.com
- Facebook: SDRplay and SDRuno specifically
  - Independent groups run by enthusiastic users!
- **Where to purchase?**
  - Ham Radio Outlet (US): https://www.hamradio.com