

# An Introduction to Software Defined Radio

Presenter:  
Steve Brightman, K15ENW



## What is an SDR?

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

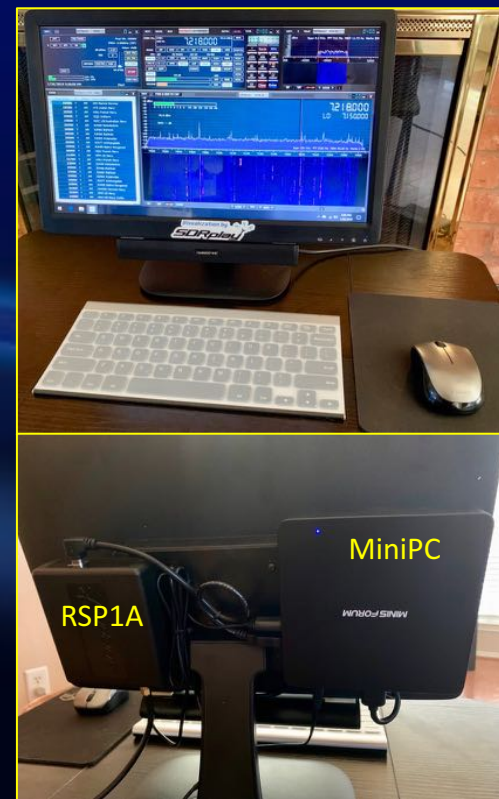
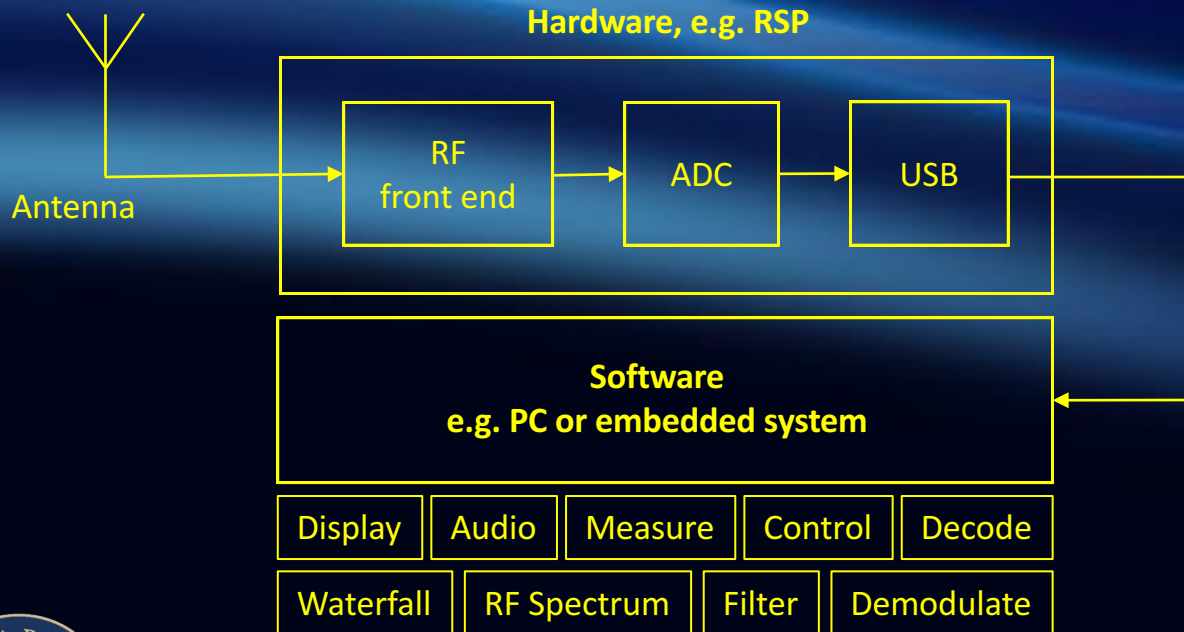
(e.g. mixers, filters, amplifiers, modulators/  
demodulators, detectors, etc.)

...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



# Simplified SDR Block Diagram



Example implementation



# Why do I want one?

## Top Ten List

1. True general coverage
2. Work one frequency and still monitor the band (or another band!)
  - Panadapter (suddenly your eyes can do 1000X what only your ears could do previously, one signal at a time!)
3. Filters! (brick-wall envelopes... improving all the time with s/w upgrades)
4. Audio and IF Digital Signal Processing (DSP)
5. Harness the power of your existing Computer
6. Multiple VFOs and/or virtual receivers
7. 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?

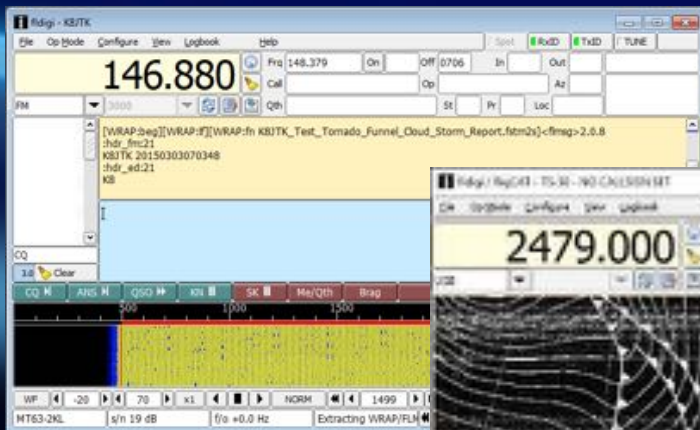


# *Application Examples*



# Digital Decoding

Fldigi NBEMS (Narrow Band Emergency Messaging System)

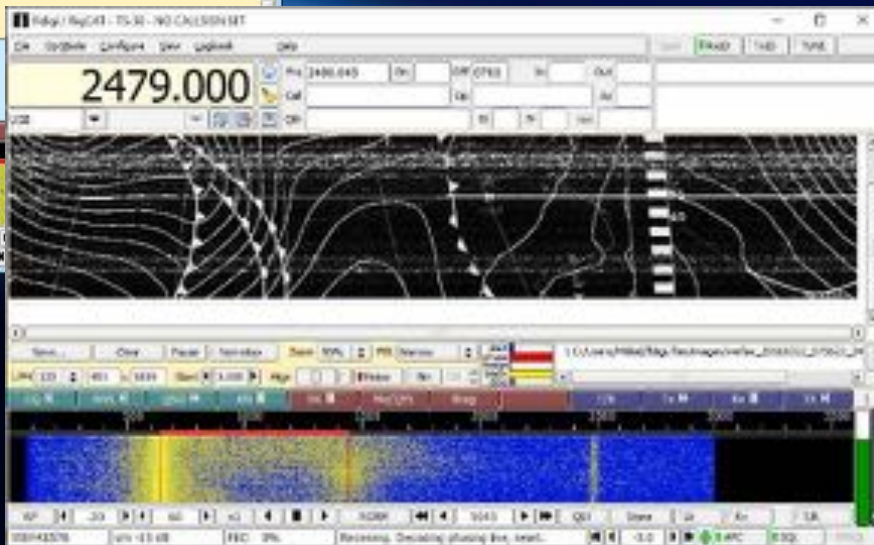


Credit: Jeff Kopcak, k8jtk

Fldigi: <http://www.w1hkj.com>

Also supports DSD, DSD+, MultiPSK,  
DM780 and more via VAC and CAT  
control

...and WEFAX Decoding



Credit: Erik Mikkil Wied





# Satellite working



WD9EWK VHF crossed dipole  
& Tablet + RSP for telemetry



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



Credit: Jeff Broughton, WB8RIY

User pictures from the facebook group:

[www.facebook.com/groups/sdrplay/](http://www.facebook.com/groups/sdrplay/)

Wxtoimg:

<http://www.wxtoimg.com>



Credit: Sefi Merkel

# High Resolution satellite images (1.7GHz) RSP2

..including latest GOES-16



# SDRplay forum on Sat imaging



SDRPLAY

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How to get some very impressive GOES High Resolution Satellite images using the RSP2 and SDRUno

UNAUTHORIZED

NOVEMBER 20, 2017

"Revolutionary weather satellite image reception is more challenging than APT weather satellite image reception, but can be achieved well using an SDRplay RSP2 as described in this new post on our forum. The author writes "Before getting started in putting together a receiving system for HRT and LRT images, it is a good idea to [...]"

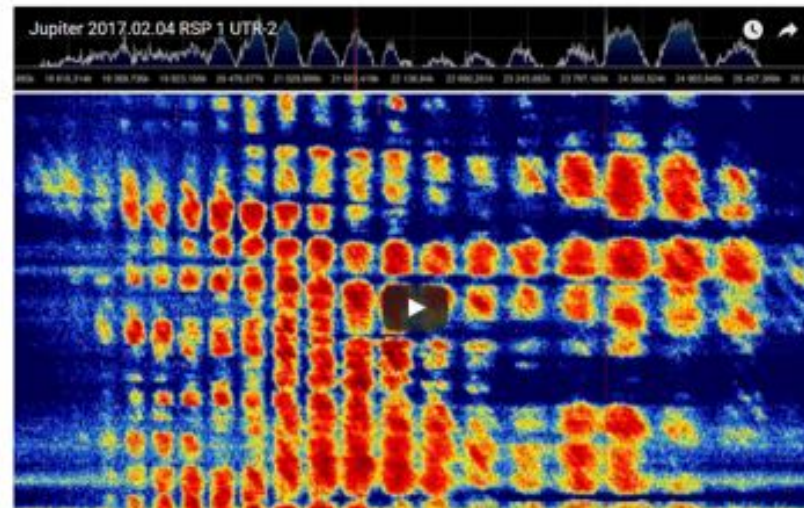


# Tune in to Jupiter!

## RECEIVING JUPITER NOISE BURSTS WITH AN SDRPLAY RSP1

Over on YouTube user [MaskitoSAE](#) 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 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 [MaskitoSAE](#) 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!*

**Using the SDRplay RSP2 for versatile RF  
Power measurement**

**Within 1dB accuracy!**

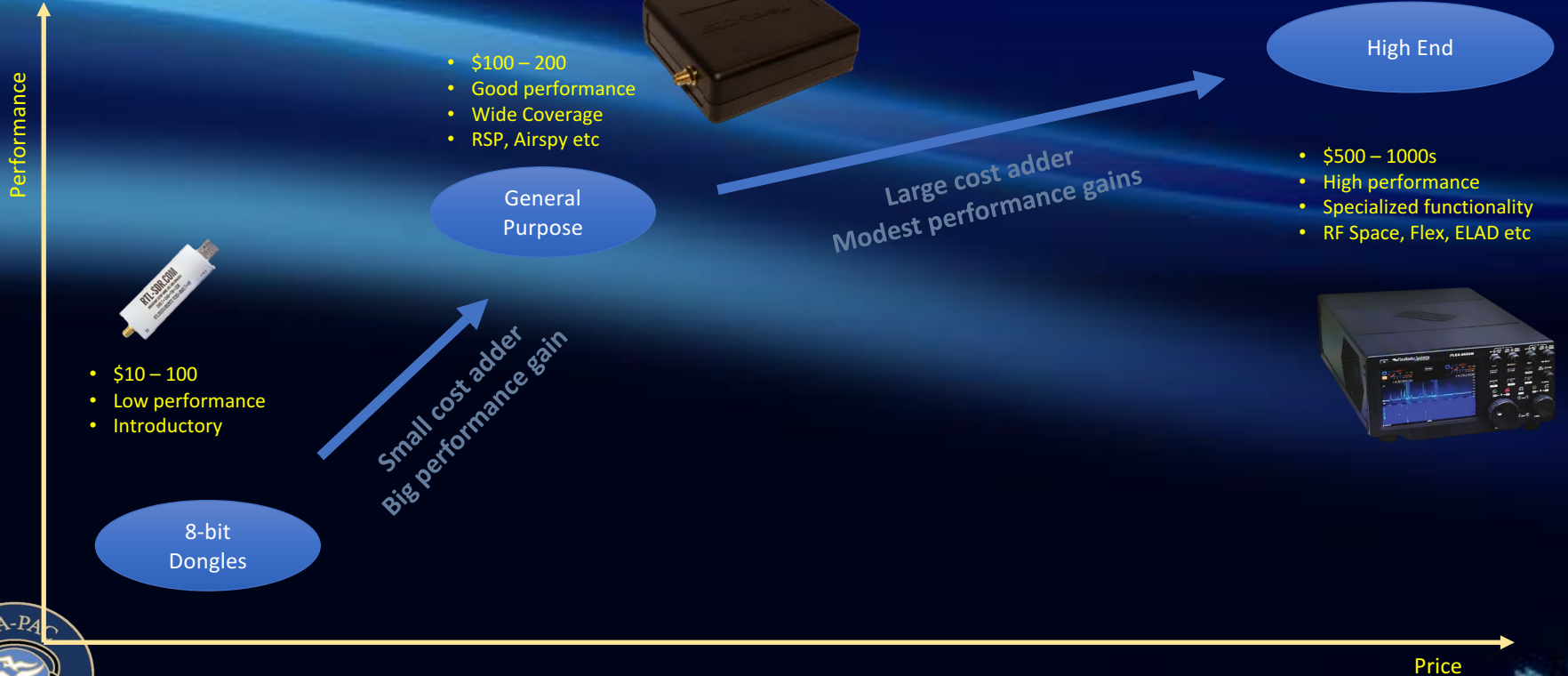
[www.SDRplay.com](http://www.SDRplay.com)



# *SDR hardware*



# SDR Variety



# 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**





# 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
- Also works with other platforms (Mac, Linus etc) and popular SDR Software (e.g. HDSDR, SDR-Console & Cubic SDR)
- Run on a Raspberry Pi3 – 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!



# Instantaneous bandwidth illustration

RSP1



RSP2



RSP2pro



RSP1a



10 MHz visibility

1kHz



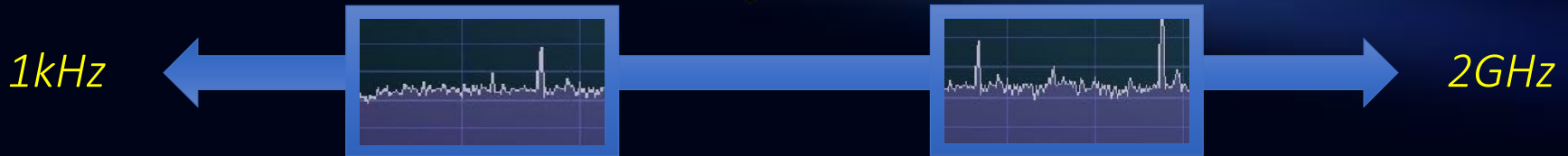
2GHz



# Introducing the RSPduo - Dual independent tuners!



“...the biggest change to SDR since the RSP1!”



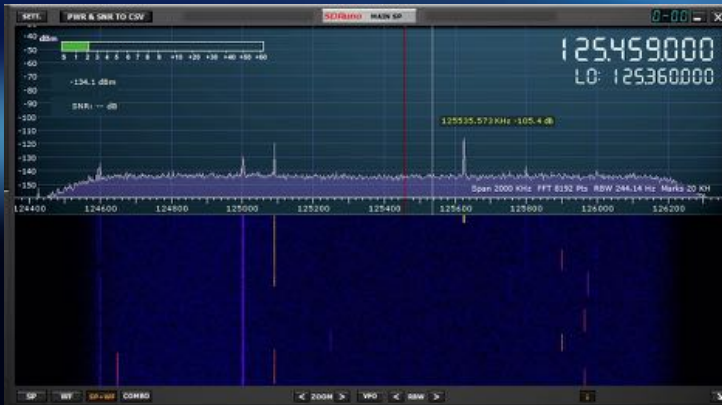
Two independent “slices” anywhere in the coverage range



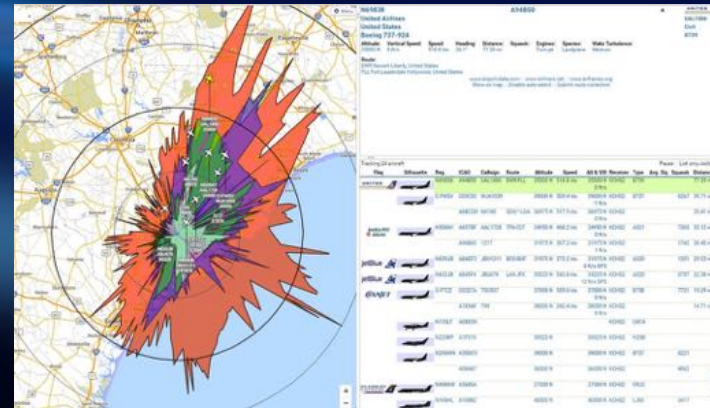
# Monitor two widely spaced bands



# Mix and match applications, simultaneously



ATC



ADSB



# *Software*



# Software

- SDRplay offers Multi-platform support for Windows, Mac, Linux, Android, Raspberry Pi 2/3 via 3<sup>rd</sup> party software including:



SDRConsole



HDSDR



CubicSDR

- In addition SDRplay owns and develops our own software, SDRUno (Windows only) for the RSP family:

- Based on Studio1 which cost \$179
- Software upgradeable for future standards
- API provided to allow demodulator or application development



- All the above software packages are available **free of charge!**

# Multiple VFOs & different decode modes simultaneously!

The screenshot displays the SDRplay software interface with three Virtual Front Panels (VFOs) and two decode windows. The VFOs are stacked vertically, each showing a different frequency: 14095.8, 14076.000, and 14230.000. The top VFO window includes a 'STOP' button and a '14095.8' display. The middle VFO window shows a '14076.000' display and various control buttons. The bottom VFO window shows a '14230.000' display and similar controls. Two decode windows are overlaid on the VFOs. The top decode window shows a video stream of a person's face with the call sign 'W3ZJC' overlaid in red. The bottom decode window shows a table of decoded signals with columns for UTC, dB, DT, Freq, Samps, Calls, Drid, dBm, and An.

UTC	dB	DT	Freq	Samps	Calls	Drid	dBm	An
1004	-24	2.1	14.097075	0	W4R20	2107	20	432
1004	-12	0.6	14.097005	0	W4R00	2106	32	1876
1004	-16	0.7	14.097096	0	W4R00	2107	37	1747
1004	-9	2.9	14.097097	0	K0SCA	2103	23	1846
1004	-24	0.4	14.097126	0	W4R00	2107	37	1747
1004	-22	0.6	14.097150	0	W02VU	2179	25	2144
1004	-17	0.7	14.097153	0	302EH	2129	20	2052







# SDRuno 1.3 – Scanning and IQ out!

The screenshot displays the SDRplay software interface with several key components:

- Top Left:** Control panel for the SDR hardware, including buttons for 'SCAN', 'STOP', and 'PAUSE', and a 'Default WorkSpace' label.
- Top Center:** A digital display showing the current frequency: 124300000.
- Top Right:** A waterfall plot showing the frequency spectrum with a prominent signal at the current frequency.
- Bottom Left:** A 'W/LOCK' window containing a table of frequency locks. A yellow callout bubble points to this window with the text 'Lock out unwanted freqs'.

W/LOCK	Frequency	Mode	Description
W/LOCK	517950000	AM	
W/LOCK	520050000	AM	
W/LOCK	520675000	AM	
W/LOCK	520850000	AM	
W/LOCK	520900000	AM	
W/LOCK	520950000	AM	
W/LOCK	520975000	AM	
W/LOCK	521000000	AM	
W/LOCK	521025000	AM	
W/LOCK	521050000	AM	
W/LOCK	521075000	AM	
W/LOCK	521100000	AM	
W/LOCK	521125000	AM	
W/LOCK	521150000	AM	
W/LOCK	521175000	AM	
W/LOCK	521200000	AM	
W/LOCK	521225000	AM	
W/LOCK	521250000	AM	
W/LOCK	521275000	AM	
W/LOCK	521300000	AM	
W/LOCK	521325000	AM	
W/LOCK	521350000	AM	
W/LOCK	521375000	AM	
W/LOCK	521400000	AM	
W/LOCK	521425000	AM	
W/LOCK	521450000	AM	
W/LOCK	521475000	AM	
W/LOCK	521500000	AM	
W/LOCK	521525000	AM	
W/LOCK	521550000	AM	
W/LOCK	521575000	AM	
W/LOCK	521600000	AM	
W/LOCK	521625000	AM	
W/LOCK	521650000	AM	
W/LOCK	521675000	AM	
W/LOCK	521700000	AM	
W/LOCK	521725000	AM	
W/LOCK	521750000	AM	
W/LOCK	521775000	AM	
W/LOCK	521800000	AM	
W/LOCK	521825000	AM	
W/LOCK	521850000	AM	
W/LOCK	521875000	AM	
W/LOCK	521900000	AM	
W/LOCK	521925000	AM	
W/LOCK	521950000	AM	
W/LOCK	521975000	AM	
W/LOCK	522000000	AM	
W/LOCK	522025000	AM	
W/LOCK	522050000	AM	
W/LOCK	522075000	AM	
W/LOCK	522100000	AM	
W/LOCK	522125000	AM	
W/LOCK	522150000	AM	
W/LOCK	522175000	AM	
W/LOCK	522200000	AM	
W/LOCK	522225000	AM	
W/LOCK	522250000	AM	
W/LOCK	522275000	AM	
W/LOCK	522300000	AM	
W/LOCK	522325000	AM	
W/LOCK	522350000	AM	
W/LOCK	522375000	AM	
W/LOCK	522400000	AM	
W/LOCK	522425000	AM	
W/LOCK	522450000	AM	
W/LOCK	522475000	AM	
W/LOCK	522500000	AM	
W/LOCK	522525000	AM	
W/LOCK	522550000	AM	
W/LOCK	522575000	AM	
W/LOCK	522600000	AM	
W/LOCK	522625000	AM	
W/LOCK	522650000	AM	
W/LOCK	522675000	AM	
W/LOCK	522700000	AM	
W/LOCK	522725000	AM	
W/LOCK	522750000	AM	
W/LOCK	522775000	AM	
W/LOCK	522800000	AM	
W/LOCK	522825000	AM	
W/LOCK	522850000	AM	
W/LOCK	522875000	AM	
W/LOCK	522900000	AM	
W/LOCK	522925000	AM	
W/LOCK	522950000	AM	
W/LOCK	522975000	AM	
W/LOCK	523000000	AM	
W/LOCK	523025000	AM	
W/LOCK	523050000	AM	
W/LOCK	523075000	AM	
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W/LOCK	523175000	AM	
W/LOCK	523200000	AM	
W/LOCK	523225000	AM	
W/LOCK	523250000	AM	
W/LOCK	523275000	AM	
W/LOCK	523300000	AM	
W/LOCK	523325000	AM	
W/LOCK	523350000	AM	
W/LOCK	523375000	AM	
W/LOCK	523400000	AM	
W/LOCK	523425000	AM	
W/LOCK	523450000	AM	
W/LOCK	523475000	AM	
W/LOCK	523500000	AM	
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W/LOCK	523575000	AM	
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W/LOCK	523875000	AM	
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W/LOCK	524075000	AM	
W/LOCK	524100000	AM	
W/LOCK	524125000	AM	
W/LOCK	524150000	AM	
W/LOCK	524175000	AM	
W/LOCK	524200000	AM	
W/LOCK	524225000	AM	
W/LOCK	524250000	AM	
W/LOCK	524275000	AM	
W/LOCK	524300000	AM	
W/LOCK	524325000	AM	
W/LOCK	524350000	AM	
W/LOCK	524375000	AM	
W/LOCK	524400000	AM	
W/LOCK	524425000	AM	
W/LOCK	524450000	AM	
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W/LOCK	524750000	AM	
W/LOCK	524775000	AM	
W/LOCK	524800000	AM	
W/LOCK	524825000	AM	
W/LOCK	524850000	AM	
W/LOCK	524875000	AM	
W/LOCK	524900000	AM	
W/LOCK	524925000	AM	
W/LOCK	524950000	AM	
W/LOCK	524975000	AM	
W/LOCK	525000000	AM	
- Bottom Center:** A large waterfall plot showing the frequency spectrum. A yellow callout bubble points to the plot with the text 'Scan to or from Memory Banks'. The plot shows a signal at 124300000 Hz and a lock at 124525000 Hz.
- Bottom Right:** A control panel for the scan function. A yellow callout bubble points to this panel with the text 'Preset or user-defined scan ranges'. The panel includes fields for 'START FREQ', 'STOP FREQ', and 'STOP FREQ', along with checkboxes for 'WHIT ON SIGNAL?', 'SAVE TO HIGH PANEL?', 'DISPLAY THRESHOLD?', and 'CONT. LEGHT?'. The 'RESET RANGED' dropdown is set to 'Current Range'.
- Bottom Left:** A 'SCAN MODE' window showing 'PAUSED' and '124300000 Hz'.



# Sneak Peak - SDRuno 1.32 – Diversity Tuning!!!

Dual Gain Sliders

New Diversity Panel  
(shows phase and amplitude)



- Coming Soon
- RSPduo only



# SDRuno Software Roadmap

## 1.32:

Diversity (RSPduo only)

## 1.4:

Plugin support (via documented API)

Remote client support

VFO IQ and audio recording

Automatic LO system (user just sets VFO)

Better support for multiple VRX use (improved settings support)

Improved INI file support (backup/restore)

Improved service support (restart/recovery)

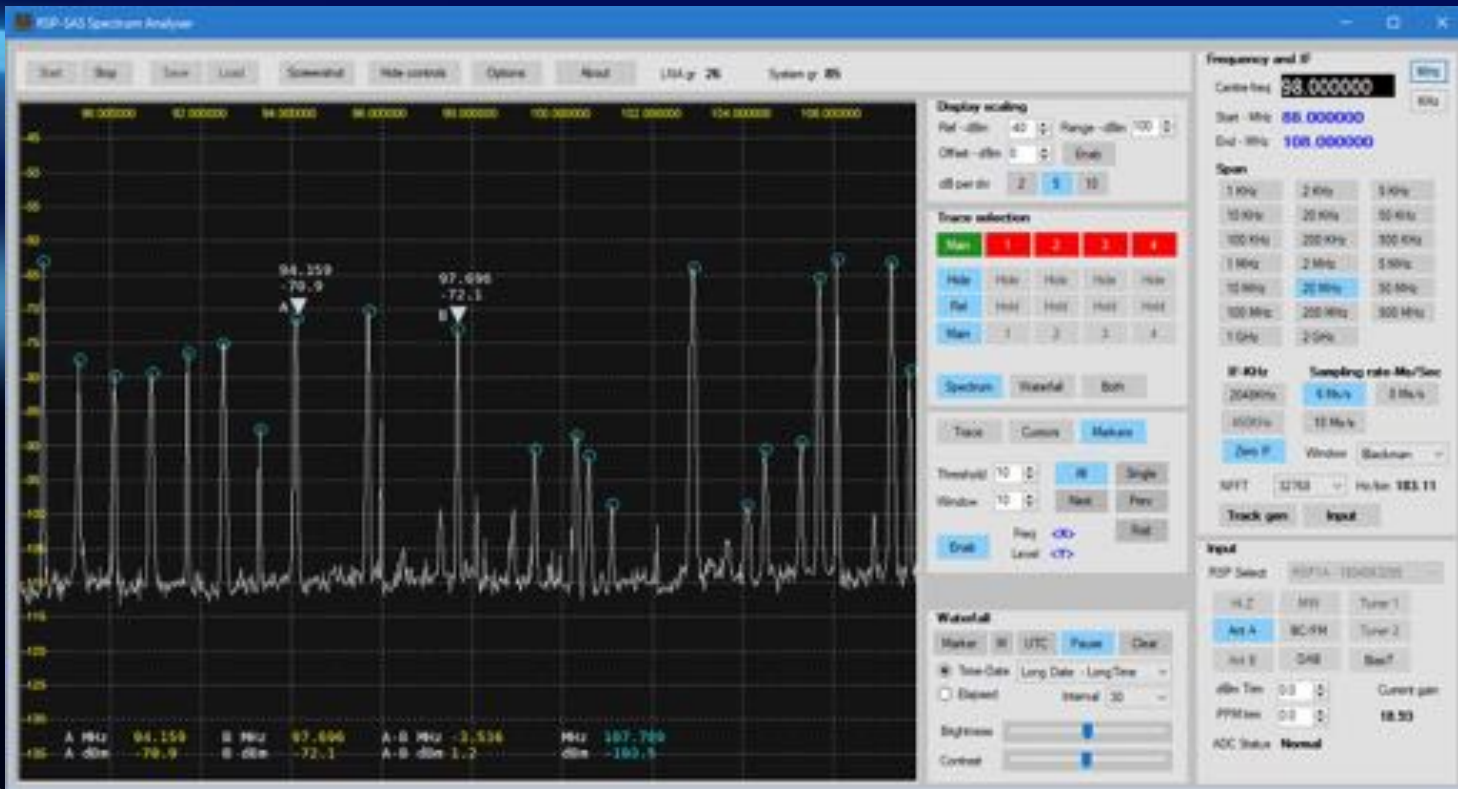
## 2.0:

Cross platform support (Windows, Linux/x86, MacOS)

All versions will also include bug fixes and user feedback (where possible)



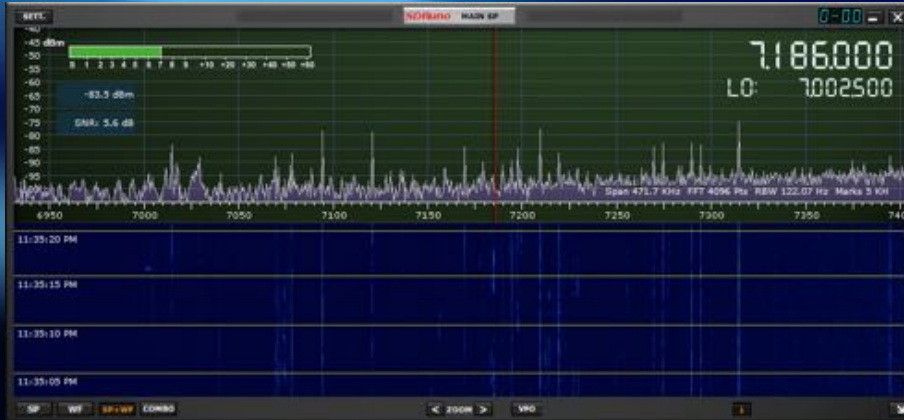
# SAS Spectrum Analyser – Make your RSP into a Spectrum Analyser!



# *Panadapters*



# What is a Panadapter?



*“Go-to” choice for Kenwood,  
Yaesu, Icom, Elecraft etc!*

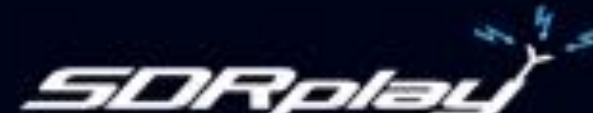
- “Panadapter is short for Panoramic Adapter. The simple answer is that it allows us to see a panoramic display of the band our radio is tuned to. We can see every signal”\*.
- Early implementations used a PC soundcard to achieve this function but were therefore limited to 200 kHz of bandwidth because 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

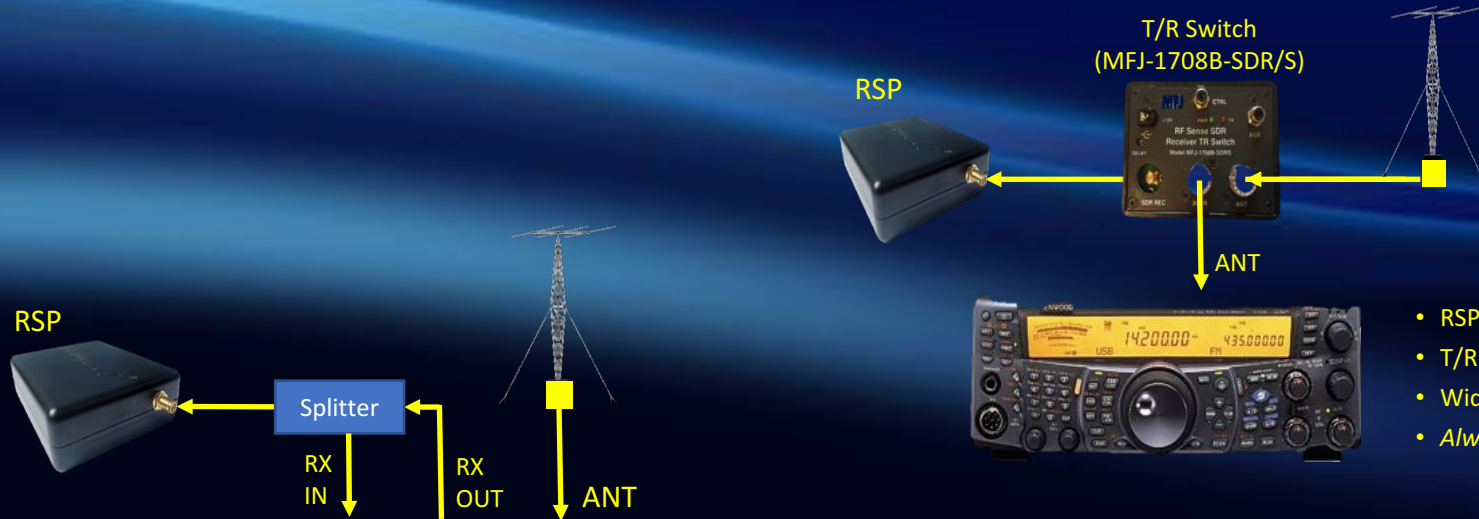


# *The perfect Panadapter companion for your rig*

- 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](http://sdrplay.com)



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



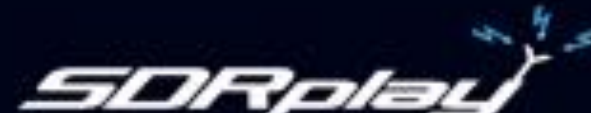
- RSP protected by T/R
- T/R shares signal
- Widest RX bandwidth
- *Always connect PTT!*

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

[www.sdrplay.com](http://www.sdrplay.com)



*Support and further information*



# Software and documentation – Software Downloads

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## Downloads

### SOFTWARE

Windows Linux x86 Mac Raspberry Pi **Android**

ARM64

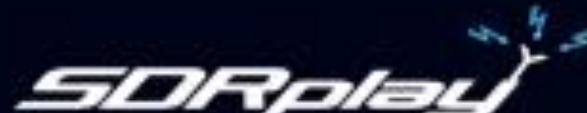
- [SDRUNO – V1.22 \(13TH JAN 2018\)](#)  
(RSP1/RSP1A/RSP2) Includes hardware driver
- [SDRUNO – V1.24 \(24TH AUGUST 2018\)](#)  
(RSP1Base) Includes hardware driver
- [SAS SPECTRUM ANALYSER – V0.9A](#)  
(12th June 2018) (RSP1/RSP1A/RSP2) Includes hardware driver
- [HSDR – V2.76A \(13TH JULY 2018\)](#)

### DOCUMENTATION

Software App Notes Community Guides How To Guides

Video guides & Media Links **Datasheets**

- [SDRUNO USER MANUAL](#)  
(version 1.22 / 13th January 2018)
- [SDRUNO \(RSPDUO\) USER MANUAL](#)  
(version 1.23 / 18th May 2018)
- [SDRUNO MANUEL UTILISATEUR \(FRANCAIS\)](#)  
(version 1.23 / 18th May 2018 – merci à André Meunier)
- [SDRUNO RELEASE NOTES](#)



# Software and documentation – Applications and Support Catalog

SDRplay

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## APPLICATIONS AND SUPPORT CATALOGUE

The SDRplay Applications and Support Catalogue is your reference point for numerous Application Notes, Application Notes, Application Notes and much more! You can scroll through the entire list, or use the category drop-down to hone in on your area of interest. Or you can just look for keywords in the search box. For each entry, click on the corresponding icon for the YouTube Video or the PDF document. For more detailed information on each item, click or tap on the description (PC users can also hover over the icons)

Select category: [ ] Enter word or phrase to search on: [ ] Sort by: [ ]

Description	Created
Link to more support options	26-Jan-2019
Basic Introduction to SDR & RSP1A	05-Jun-2018
Introducing the RSPduo	18-May-2018
Sevenfortyone unboxes the RSPduo	18-May-2018
Starburn Video Guide for RSP1A	02-Feb-2018
Sevenfortyone unboxes the RSP1A	08-Dec-2017
Getting started with RSP2 or RSP2pro	25-Nov-2016
Basic Troubleshooting the RSP	20-Jul-2018
Tech Minds unboxes the RSPduo	18-May-2018
New features in SDRplay v1.22	18-Jan-2018
SDRplay Cookbook	15-Jan-2018
Setting up a paralyser	11-Oct-2017



# How-to videos: SDRplay YouTube Channel

## SDRruno Video Guides - Part 2 (V 1.2 onwards) [PLAY ALL](#)

This is Part 2 in our series of SDRruno Video guides for version 1.2 and later. The Video guides in Part 1 were created using earlier versions of SDRruno so you may see some slight differences in the



### SDRruno v1.2- What changed in Version 1.2

SDRplay Software Defined Rad...  
4.2K views · 1 month ago

### Introducing RSP1A and SDRruno v1.2.1

SDRplay Software Defined Rad...  
766 views · 5 day ago

### #1 SDRruno v1.2- Workspaces & Resolution bandwidth

SDRplay Software Defined Rad...  
1.4K views · 2 weeks ago

### #2 SDRruno v1.2- PWR & SNR measurement & ham band

SDRplay Software Defined Rad...  
1.2K views · 3 weeks ago

## SDRruno Video guides- Part 1 (Click here for Part 1 in our series of over 20 video guides) [PLAY ALL](#)

These are 'How to' Video guides to setting up SDRruno for the RSP. Part 1 were made using earlier versions of SDRruno than was used



### #1 SDRruno Basic layout and settings (version 1.2 and

SDRplay Software Defined Rad...  
1.4K views · 7 months ago

### #21 SDRruno with the Griffin PowerMate

SDRplay Software Defined Rad...  
8K views · 2 months ago

### SDRruno EXT/IO Edition for a range of SDRs and dongles

SDRplay Software Defined Rad...  
3.4K views · 2 months ago

### #17 SDRruno with the TM-2 USB Controller

SDRplay Software Defined Rad...  
1.3K views · 5 months ago

### #16 SDRruno & MultiPSK decoding ACARS

SDRplay Software Defined Rad...  
2.1K views · 5 months ago

# Facebook Groups

SDRplay SDRUno

Public group

About

Discussion

Chats

Announcements

Members

Events

Videos

Photos

Files

Joined ▾ Notifications Share ... More

Search this group

Write Post Add Photo/Video Live Video More

Write something...

Photo/Video Watch Party Tag Friends ...

NEW ACTIVITY ▾

Jon Hudson 6 hrs

When using the dual tuners of the RSPduo, or multiple RSPs on a single computer you sometimes want them all tuned to the same frequency, e.g. for antenna comparisons. This video shows how you can set this up from within SDRUno: <https://youtu.be/9rhQZPY688I>

Synchronised VFOs

See more

SDRplay

INVITE MEMBERS

Enter name or email

MEMBERS

SUGGESTED MEMBERS

Friends

Lauren Jacobs

Laura Anne Car

CN Dong

See More

DESCRIPTION

This is an UNOFFICIAL SDRUno software the

GROUP TYPE

Support

CREATE NEW GROUPS

SDRplay

THE UNOFFICIAL USER GROUP FOR

CONTINUOUS COVERAGE 1MHz-2MHz

RSP1 - RSP1A - RSP2 - RSP2pro - RSPduo

12/16BIT ADC 10MHz SPECTRUM

WWW.SDRPLAY.COM

Joined ▾ Notifications Share ... More

Search this group

Write Post Add Photo/Video Live Video More

Write something...

Photo/Video Watch Party Tag Friends ...

MEMBERS 9,954 Members

SUGGESTED MEMBERS

Friends

Tereza Byrne Invite Member

Foster Cooperstein Invite Member

Paul Noel Invite Member

See More

DESCRIPTION

This group is an independent group for all owners and future own... See More

GROUP TYPE

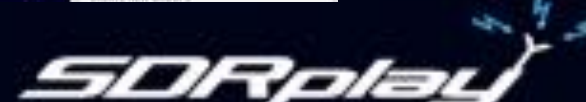
Support

CREATE NEW GROUPS

Mike Ladd Rising Star 6 mins

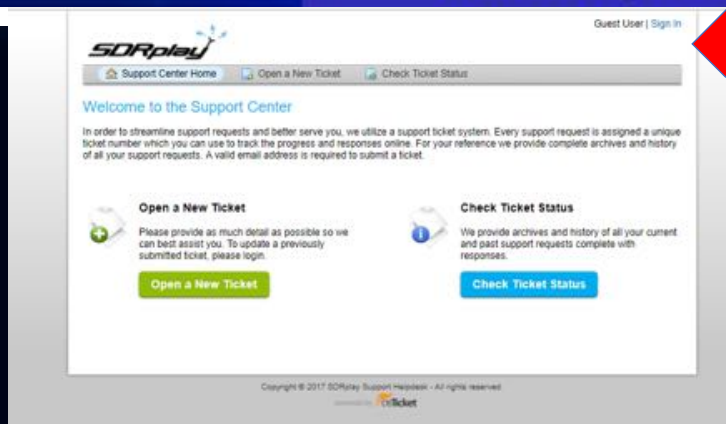
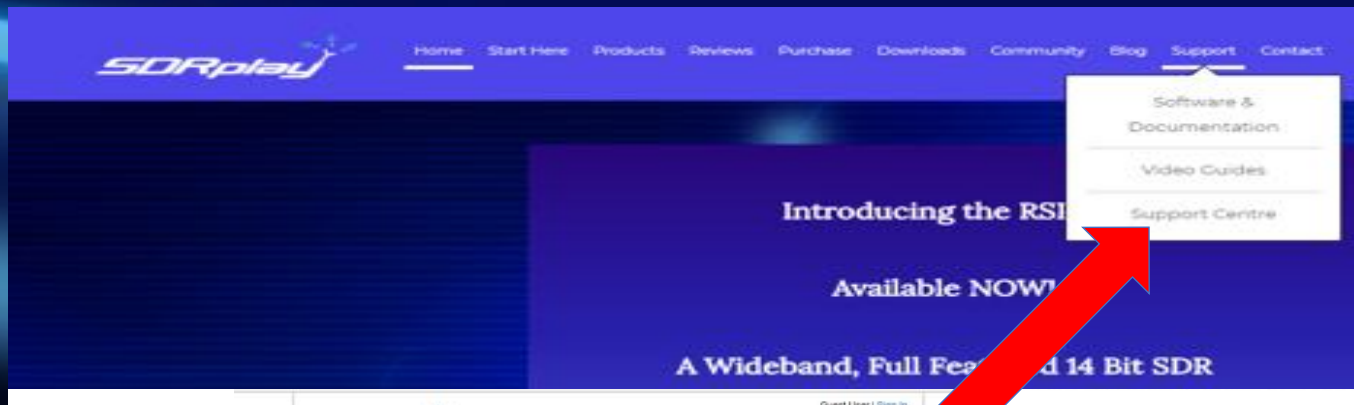
Radio Romania Int (DRM) 9495. Great signal and perfect decode into South Florida using the RSPduo and a W6LVP loop indoors on the ground floor.

Nearly 10,000 users  
helping each other!





# Direct support from SDRplay



www.sdrplay.com



Hardware + Software + Community =

So many reasons to get one!



- Visualise multiple bands at the same time  
Free SDRplay software
- Designed & manufactured in the UK
- Perfect gift to entrance the next generation
- Using the RSP2 for versatile RF Power Measurements
- Free SDRplay software  
Use Virtual Audio Cable to popular decoding sites
- Satellite Imaging
- Explore new bands
- FreeDV  
Explore new digital modes JT65, QRP+ etc

Recommended by authors of both HDSDR and SDR-Console  
Backed by the world's biggest & best SDR support community!

[www.SDRplay.com](http://www.SDRplay.com)



# For more information

- Company website: [www.sdrplay.com](http://www.sdrplay.com)
  - Check out our new **Applications & Support Catalog** at:  
<https://www.sdrplay.com/apps-catalogue/>
- Community Forums: [www.sdrplay.com/community/](http://www.sdrplay.com/community/)
- Email: [support-usa@sdrplay.com](mailto: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>
  - Direct from manufacturer: <https://www.sdrplay.com/purchase/>

Thank You!

See the RSP family at the HRO booth and Panadapter Demo at the Kenwood Booth!

