



SDRplay Limited

An Introduction to Software-Defined Radio

sdrplay.com

SP WF SP+WF COMBO < ZOOM > TIME MDX FREQ.

SETT. MA SDRplay MAIN

In SR: 250000

0 SP1 SP2 RX ADD VRX
1 SP1 SP2 RX DEL VRX
LO LOCK
STOP
MEM PAN

LNA AGC ADV PERF

GR BW 0.200 M

6/24/2016 12:45:54 PM

St1: 11% IFGR: 49dB
Sys: 20% T.GR: 49dB
Err.: 0

www.sdrplay.com
favourite

SETT. RDSW EXW SDRplay RX CONTROL RSYN1 MCTR TCTR 0-00

DEEM 50u STEP: 500 Hz 14.320.000 -55.2 dBm RMS

MODE AM SAM FM CW DSB LSB USB USER

VFO - QM FM MODE CW OP FILTER NB NOTCH

VFO A A > B NFM MFM CWPK 2000 2200 NBW NCH1

VFO B B > A WFM SWFM ZAP 2400 2700 NBN NCH2

QMS QMR CWAFK NR NBOFF NCH3

-84 dB AGC NCH4

SQLC OFF FAST NCHL

MUTE MED SLOW

7 160 6 80 9 40
4 30 5 20 8 17
1 15 2 12 3 10
0 2 Clear Enter

Contents

- What is an SDR?
- Why do I want one?
- Review of SDR solutions
- SDR software
- Applications
- Panadapters
- Where to buy an RSP and find further information

What is an SDR?

A radio communication system where 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.

What comprises an SDR?

1. Hardware to amplify, filter and digitize radio signals
1. Software to provide advanced filtering, demodulation/decoding and control functions

Why do I want one?



- True general coverage
- Work one frequency and still monitor the band
- Panadapter (regular vision vs rifle scope!)
- Filters! (brick-wall envelopes... software updatability)
- Audio and IF Digital Signal Processing (DSP)
- Harness the power of your existing PC
- Multiple VFOs
- Record large bandwidths
- Record/playback of audio
- Special purpose receiver:
 - WX satellites, aircraft monitoring, digital stations, TV, Ionosondes! etc etc
- **Can you ever have too many receivers?** 😁

Review of SDR receivers:

The Catalyst for Hams: RTL Dongle

- see <http://www.rtl-sdr.com>
- Designed for mobile TV reception outside the US (esp. Europe)
- Italian ham realized that the hardware was broadband--very broadband--so he wrote a new firmware that can be used with the TV dongle and a PC to yield Software Defined Radio Reception
- Cheap! Began around \$100 but now down to \$10 or less for some models



Review of SDR receivers

– what to consider:



- **Frequency Range:** The range of frequencies the SDR can tune to.
- **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. Some SDR's give their resolution in ENOB which stands for effective number of bits.
- **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.
- **Price**

Review of SDR receivers



Comparisons with other common Wideband Commercial Software Defined Radios

SDR	Tune Low (MHz)	Tune Max (MHz)	RX Bandwidth (MHz)	ADC Resolution (Bits)	Transmit? (Yes/No)	Price (\$USD)
RTL-SDR (R820T)	24	1766	3.2	8	No	~20
Funcube Pro+	0.15 410	260 2050	0.192	16	No	~200
Airspy	24	1800	10	12	No	199
SDRplay	0.001	2000	10	12	No	120 - 192
HackRF	30	6000	20	8	Yes	299
BladeRF	300	3800	40	12	Yes	400 & 650
USRP 1	DC	6000	64	12	Yes	700

For those who just want to receive a wide range of signals, we recommend the Airspy or SDRPlay as an upgrade to the RTL-SDR. If you are mainly interested in narrowband signals the Funcube Dongle Pro+ may be worth considering.

Review of SDR receivers – The 8-bit dongle



R820T RTL2832U a.k.a RTL-SDR

Cost: \$10 – 22 USD

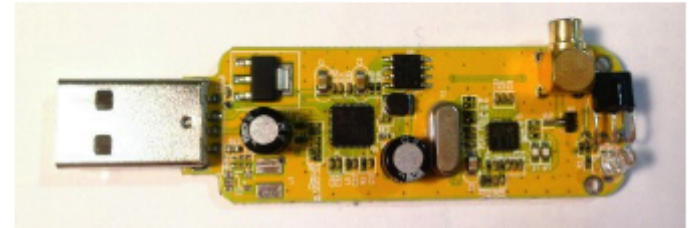
Frequency Range: approx. 24 MHz – 1766 MHz

ADC Resolution: 8 Bits

Max Bandwidth: 3.2 MHz / 2.4 or 2.8 MHz max stable.

TX/RX: RX Only

Preselectors: None



The RTL-SDR is still the best 'bang for your buck' software defined radio out there. While it was never designed to be used as a general purpose SDR in the first place, its performance is still surprisingly good. If you're on a budget or are just starting out with SDR or radio this is the one to get. ([Link](#))

source: rtl-sdr.com

Cheap and cheerful!

Review of SDR receivers

High-end example - The Perseus:



Perseus SDR

Cost: \$1,100 USD

Frequency Range: 10 kHz – 40 MHz

ADC Resolution: 14 Bits

Max Bandwidth: 1.6 MHz

TX/RX: RX Only

Preselectors: Yes 10 switched

Many owners of this SDR claim that it is one of the lowest noise SDRs available and that it is great for DXing. ([Link](#))



source: rtl-sdr.com

Expensive and capable!

The RSP Family

SDRplay 14320000



SDRplay software interface showing a spectrum plot and control panels. The top panel displays 'SDRplay' and '14320000'. The bottom panel shows various settings and controls, including 'SP1', 'SP2', 'RX', 'LNA', 'AGC', 'ADV', 'PERF', 'STOP', 'MEM PA...', 'In SR: 250000', 'ADD VRX', 'DEL VRX', 'LO LOCK', 'DSB', 'LSB', 'USB', 'USER', 'FILTER', 'NB', 'NOTCH', 'NCH1', 'NCH2', 'NCH3', 'NCH4', 'AGC', 'OFF', 'FAST', 'MED', 'SLOW', 'RMS', '13970', '40', '30', '20', '17', '15', '12', '10', '2', 'Clear', 'Enter'.



KEY FEATURES	RSP1	RSP2	RSP2pro
Continuous coverage from 1 kHz to 2 GHz (RSP1 from 10 kHz)	✓	✓	✓
Up to 10 MHz visible bandwidth	✓	✓	✓
Powers over the USB cable with a simple type B socket	✓	✓	✓
High Performance ADC silicon technology (not another 8 bit dongle!)	✓	✓	✓
8 built in front-end pre-selection filters	✓		
10 high-selectivity, built in front-end preselection filters			✓
Software selectable (On/Off) Low Noise Preamplifier	✓		
Software selectable multi-level Low Noise Preamplifier		✓	✓
SDRuno—World Class Windows SDR software	✓	✓	✓
Open API for new apps development	✓	✓	✓
Single SMA antenna socket	✓		
2 x SMA Software Selectable Antenna Inputs		✓	✓
1 x High Impedance Input for long wire antennas		✓	✓
Software selectable MW /FM notch filters		✓	✓
Highly stable 0.5PPM TCXO trimmable to 0.01PPM		✓	✓
24MHz Reference clock input / output connections		✓	✓
4.7V Bias-T (Port B only)		✓	✓
Robust and strong plastic case	✓	✓	
RF shielding layer inside case		✓	
Rugged metal case			✓

Which RSP for me?

All RSPs from SDRplay are Software Defined Radios which can turn a PC into a general coverage receiver or spectrum analyser spanning VLF (1kHz) through to Microwaves (2GHz).

With dual 12 bit A/D front end converters and very sharp 5th order Chebyshev filters, the RSP allows processing of a 10MHz slice of radio spectrum all in one go.

- RSP1 has single input, low-price. Great choice for building a panadapter!
- RSP2 adds:
 - Multiple inputs (for antenna switching)
 - AM/FM Broadcast Band Filters
 - Bias-T available for powered antennae (5V)
 - TCXO (for greater accuracy)
 - Reference Oscillator In/Out (for even greater accuracy or synchronisation)
- RSP2pro is the same specification as RSP2 but in a rugged metal case

Ham Radio Science says...



The screenshot shows the top of the Ham Radio Science website. The header includes the site name, social media icons (Twitter, Facebook, Google+, RSS, Email), and navigation links (HOME, RESOURCES, DISCLAIMER, FORUM). Below the header is a secondary navigation bar with categories: ANNOUNCEMENTS, FEATURED, INTERFACES, OPERATING, OPINIONS, PROJECTS, REVIEWS, and SDR RADIO.

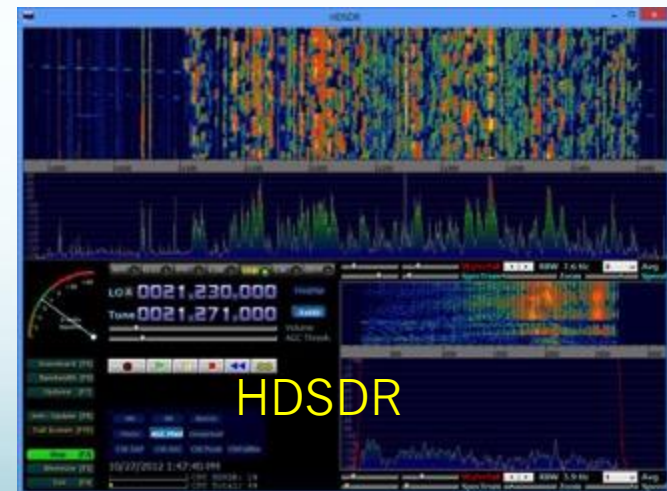
The main content area features an article titled "SDRPlay RSP2 Review" dated November 22, 2016, with "Featured" and "2 Comments" tags. The article includes an introduction, a photo of the RSP2 and RSP2 pro hardware, and a section titled "HAM IT UP CASE" with an Amazon product listing for the "NooElec NESDR" for \$19.95 with Prime shipping.

Conclusion

It was hard to believe that the very competent RSP1 could be made any better of a value, but the SDRPlay Team were able to pull it off. The RSP2 really ups the ante against it's competition with features it offers.

Software

- **SDRuno – World class Windows software (included)**
- Multi-platform support for Windows, Mac, Linux, Android, Raspberry Pi 2/3
- Compatible with existing open source radio software
- ExtIO based plugin ensures compatibility with growing number of packages
- Access to free Mirics Radio & TV decode software (Europe)
- Software upgradeable for future standards
- API provided to allow demodulator or application development
- 3rd Party **free** software including SDR-Console, HDSDR and CubicSDR



SDRuno



SDRuno – Key Features



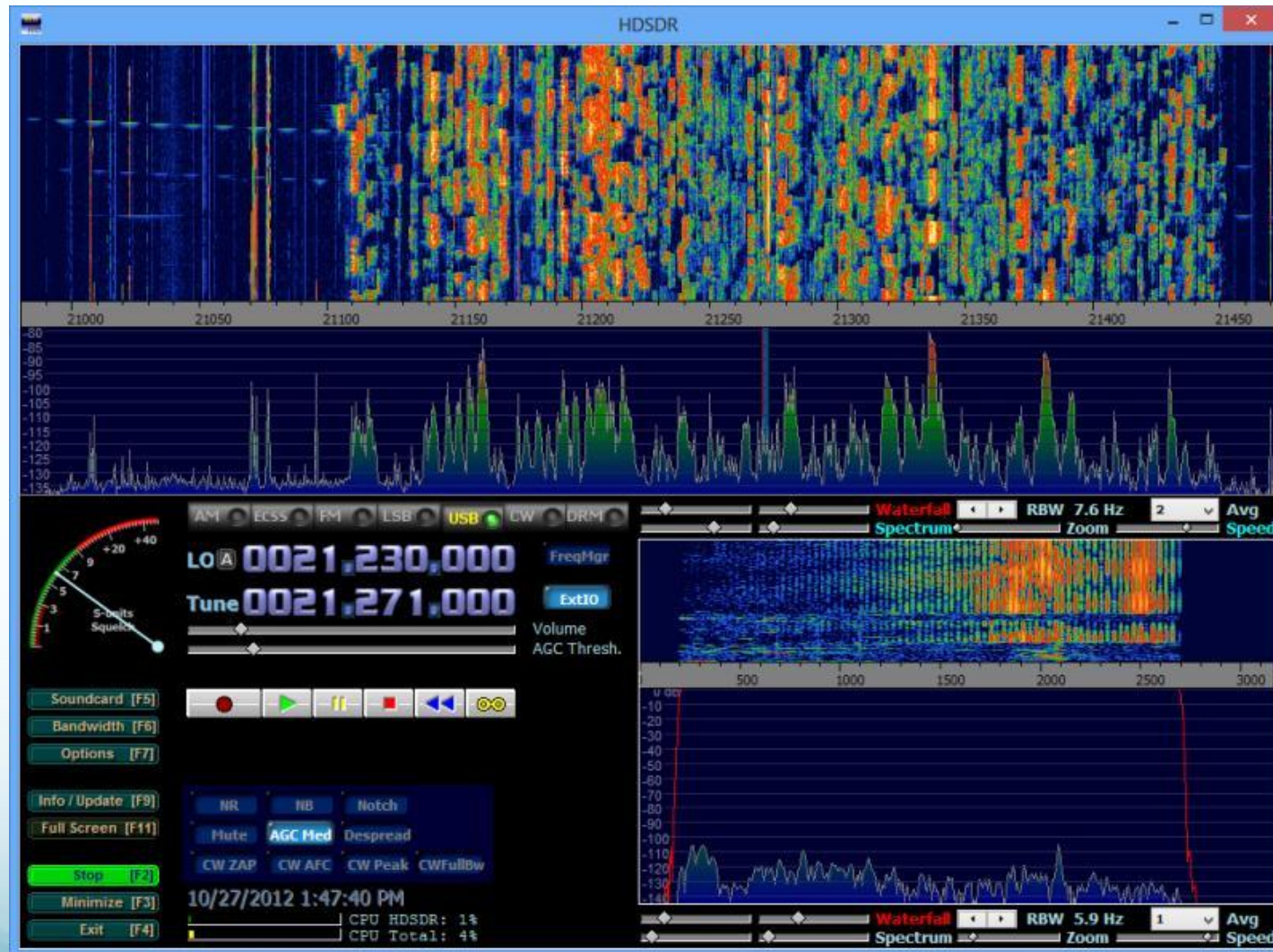
- Up to 10MHz visible bandwidth
- Up to 16 VRX (Virtual Receivers)
- Main and Auxiliary Spectrum Windows for each VRX
- Multiple Memory Banks
- Programmable Notch filters
- Support for 3rd party software via Virtual Audio Connections
- Support for OmniRig (Panadapter) and T-mate Controller
- Calibrated Power Meter
- *Plus so much more!*

SDRuno – Key Features



See all of 80m and 40 m at the same time!

HDSDR (Windows)



SDR-Console (V3 now available!)



Software:

- 6 receivers (VFOs)
- SSB, CW, AM, FM, FM-Stereo
- WASAPI & ASIO audio support

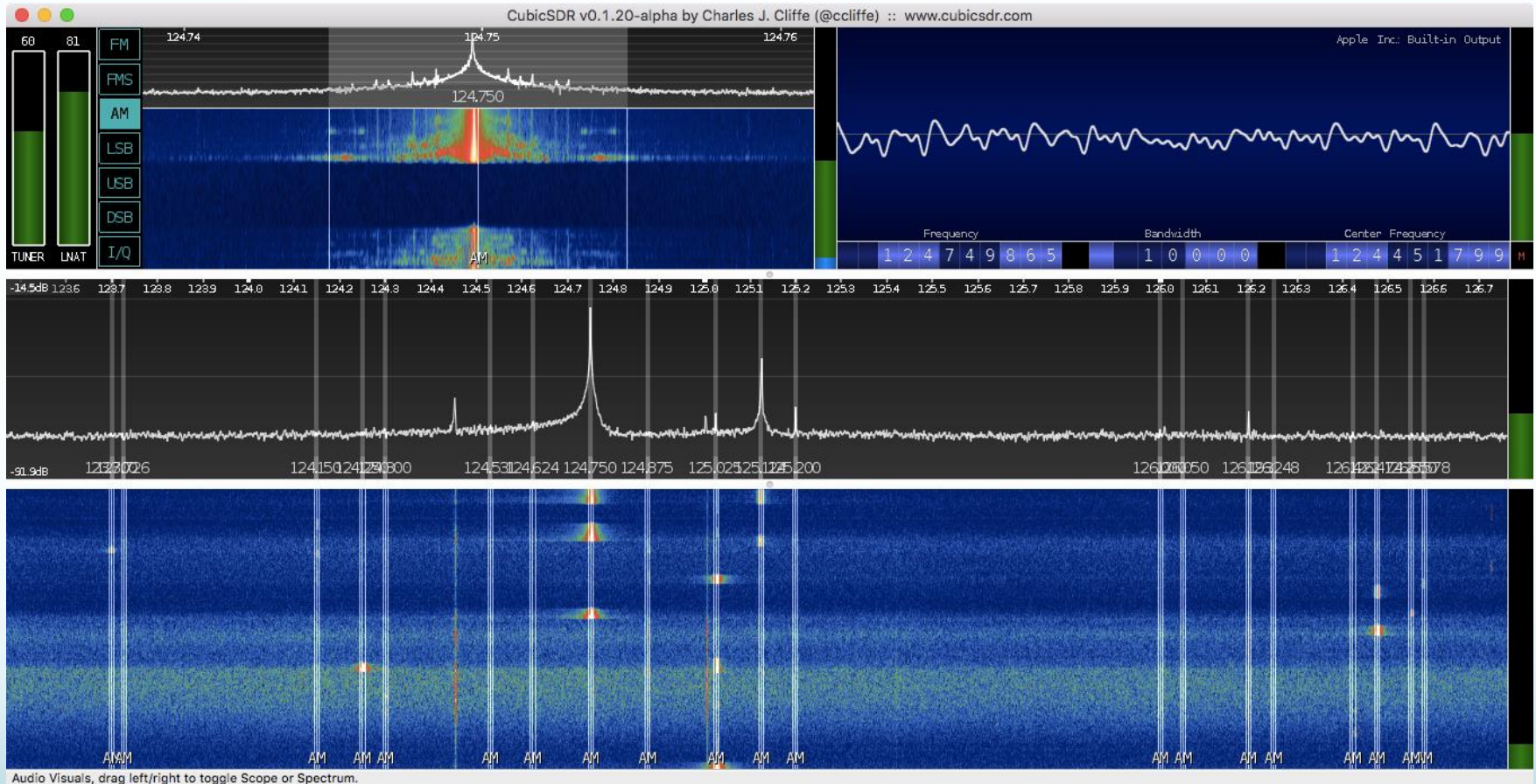
DSP:

- AGC
- CW Peak Filter
- Noise Blanker (NB)
- Noise Reduction (NR)
- Notch
- Squelch

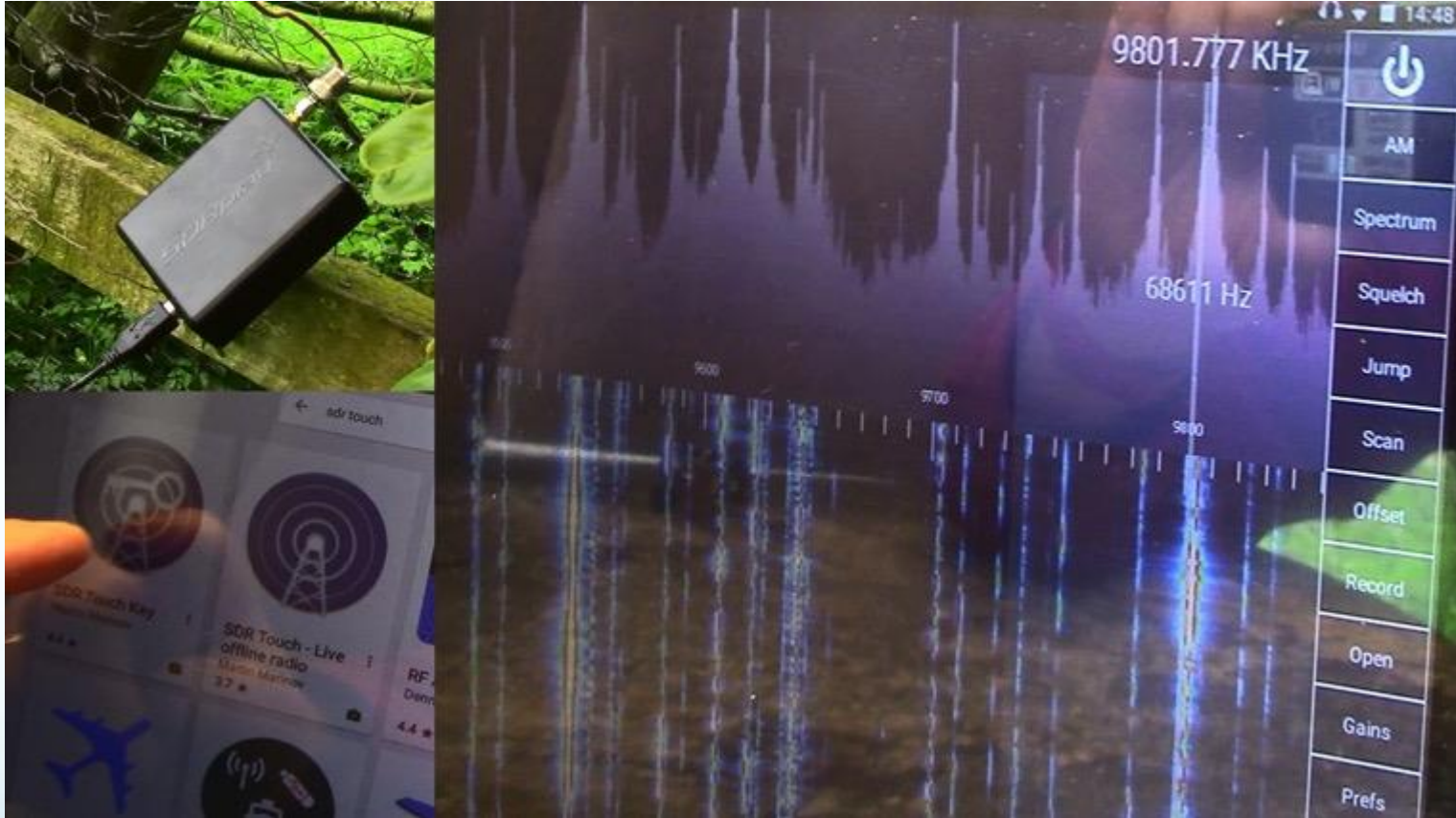
Other:

- Audio Spectrum
- Data Record / Playback
- Favourites / Memories
- Server functionality

Cubic SDR (Windows, Mac, Linux)



Android Phones and Tablets



- SDR Touch (RSP1 only) and SDRplay Driver, available from the Android Market
- The Android device must support USB On-The-Go

Summary - Platforms + software examples supported by RSP



- Windows (XP, 7, 8, 10) for SDR-Console, HDSDR, Studio1 etc.)
- Mac (CubicSDR)
- Linux (CubicSDR, gr-osmosdr)
- Android (SDR Touch & SDRplay plug-in)
- Raspberry Pi 2/3 (growing Github resources)
- ARM64 (SoapySDR and CubicSDR)



Applications

- Today's SDRs offer the opportunity to go beyond traditional Ham communications
- The following slides illustrate some real-world examples from our customers – all using the RSP!
- Some of them require the use of add-on software, most of which is available free!

Applications: An RF Power meter



Using the SDRplay RSP2 for versatile RF Power measurement



1% accuracy!



www.SDRplay.com

Add-on Software - Satellite working



WD9EWK VHF crossed dipole
& Tablet + RSP for telemetry

NOAA Weather satellite - Wxtoimg



Credit: Jeff Broughton, WB8RJY

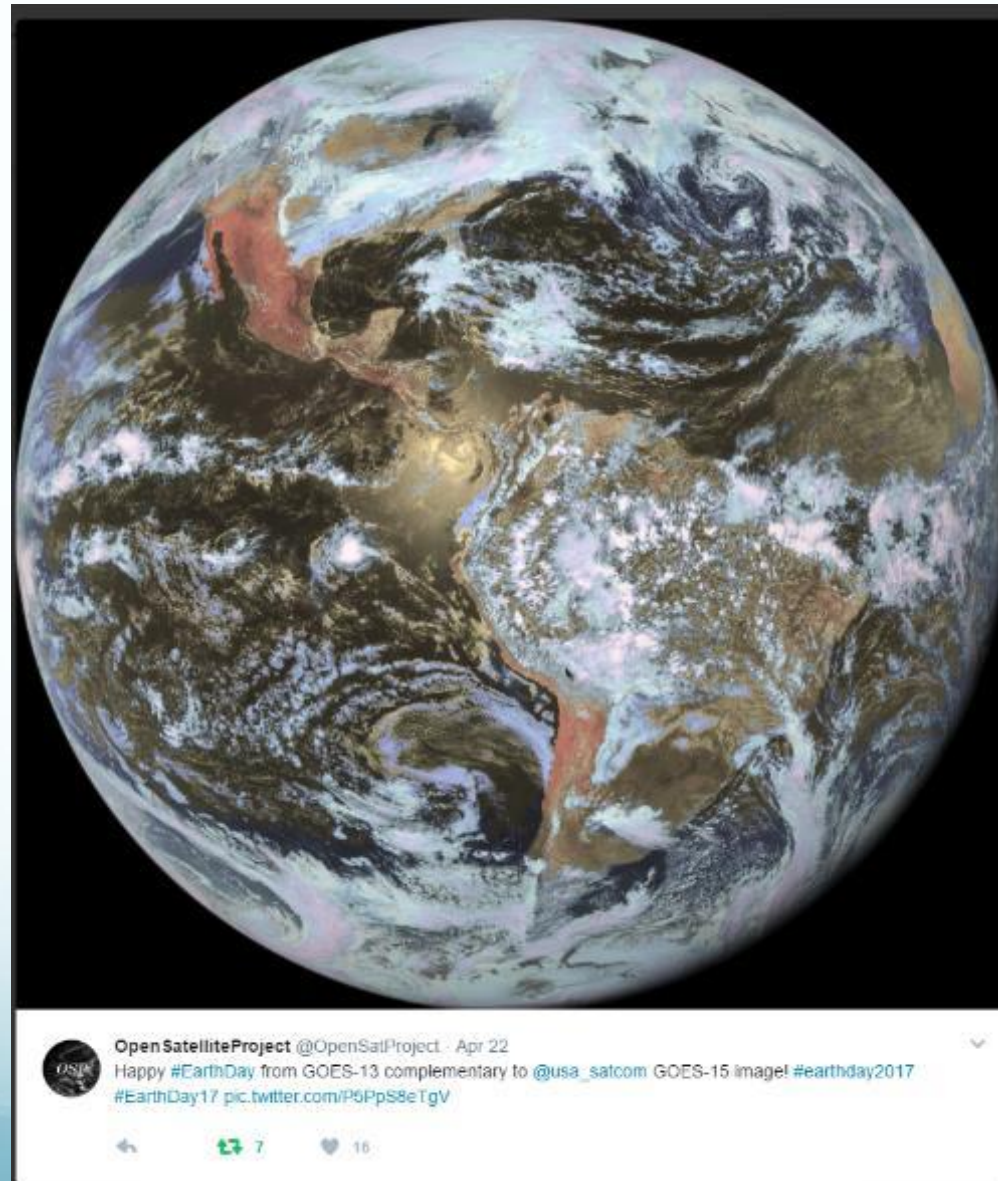
User pictures from the facebook group:
www.facebook.com/groups/sdrplay/

Wxtoimg:
<http://www.wxtoimg.com>



Credit: Sefi Merkel

*Hi Resolution satellite images
(1.7GHz)
RSP2*



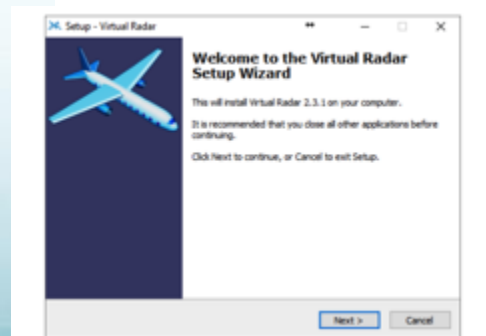
ADS-B using Dump1090



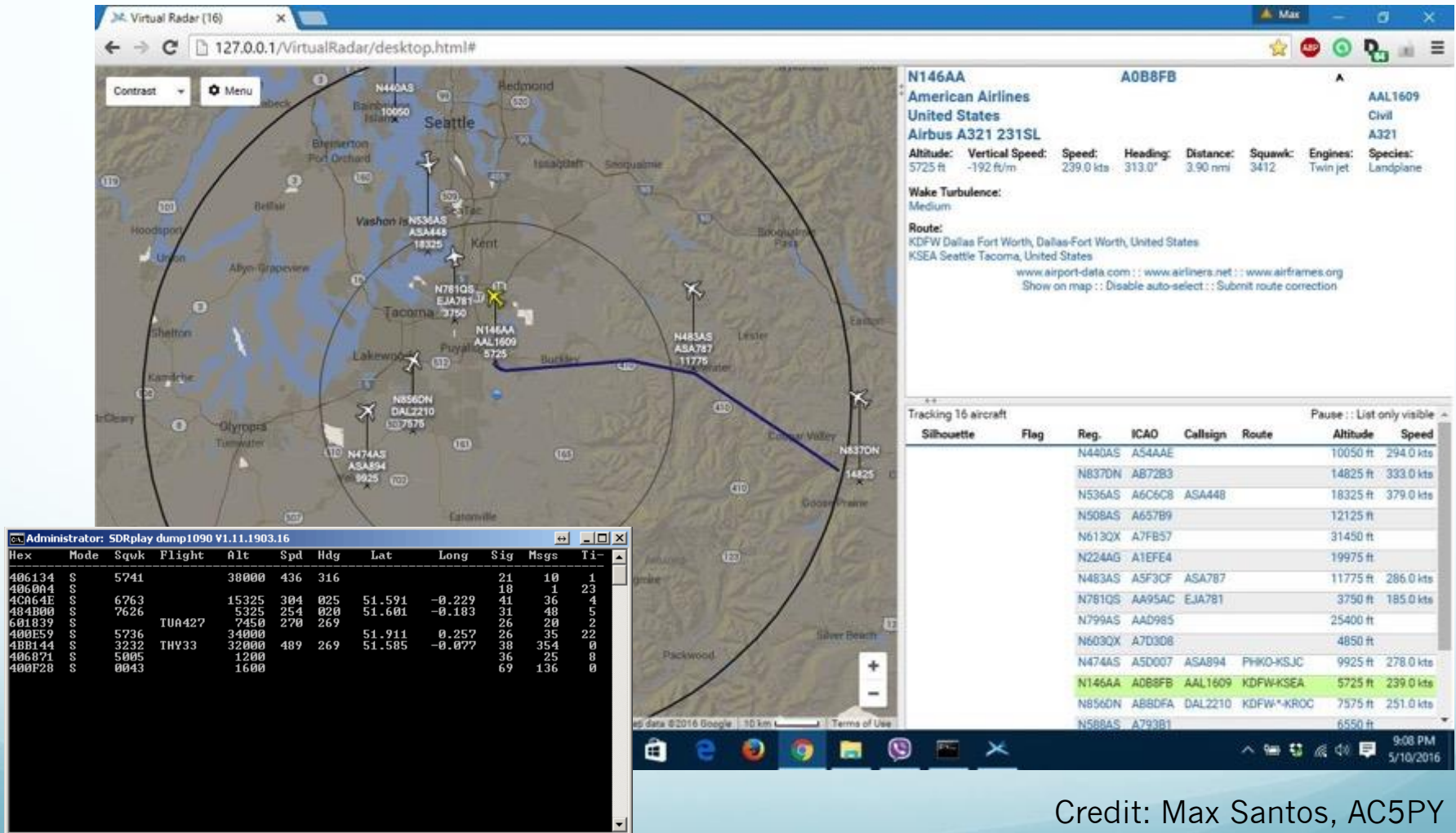
Detect aircraft in your vicinity – SDRplay provides s/w and set-up wizards to drive ‘Virtual radar’ mapping software

The screenshot shows the SDRplay website with the following content:

- Navigation menu: Home, Start Here, Platforms, Community, Purchase, Reviews, Blog, FAQ, About Us, Contact
- Current page: Windows (with subtext: Windows related information)
- Section: Generic Documentation
 - RSP Single Page Datasheet (English)
 - RSP Single Page Datasheet (French)
 - Detailed Technical Specification
 - API Specification
 - AGC Technical Note
 - RSP Conceptual Block Diagram
 - RSP Schematics
- Information boxes:
 - Current API Installer: 1.8.1 (Release date: 11th January 2016)
 - Current EXTIO Plugin: 3.8.3 (Release date: 23rd February 2016)
 - Current SDR# Plugin: 2.2 (Release date: 12th October 2015)
 - ADS-B (dump1090): 1.13 (Release date: 1st May 2016) User Guide



ADS-B decoding example using Dump1090 and VRS



Virtual Radar (16)
127.0.0.1/virtualRadar/desktop.html#

N146AA A0B8FB
American Airlines
United States
Airbus A321 231SL
Altitude: 5725 ft -192 ft/m
Vertical Speed: -192 ft/m
Speed: 239.0 kts
Heading: 313.0°
Distance: 3.90 nmi
Squawk: 3412
Engines: Twin jet
Species: Landplane
Wake Turbulence: Medium
Route: KDFW Dallas Fort Worth, Dallas-Fort Worth, United States
KSEA Seattle Tacoma, United States
www.airport-data.com : www.airliners.net : www.airframes.org
Show on map :: Disable auto-select :: Submit route correction

Tracking 16 aircraft

Silhouette	Flag	Reg.	ICAD	Callsign	Route	Altitude	Speed
		N440AS	A54AAE			10050 ft	294.0 kts
		N837DN	AB72B3			14825 ft	333.0 kts
		N536AS	A6C6C8	ASA448		18325 ft	379.0 kts
		N508AS	A657B9			12125 ft	
		N6130X	A7FB57			31450 ft	
		N224AG	A1EFE4			19975 ft	
		N483AS	AS5F3F	ASA787		11775 ft	286.0 kts
		N781QS	AA95AC	EJA781		3750 ft	185.0 kts
		N799AS	AAD985			25400 ft	
		N6030X	A7D3D8			4850 ft	
		N474AS	ASD007	ASA894	PHKO-KSJC	9925 ft	278.0 kts
		N146AA	A0B8FB	AAL1609	KDFW-KSEA	5725 ft	239.0 kts
		N856DN	AB8DFA	DAL2210	KDFW-KROC	7575 ft	251.0 kts
		N588AS	A793D1			6550 ft	

```

Administrator: SDRplay dump1090 V1.11.1903.16
Hex Mode Squk Flight Alt Spd Hdg Lat Long Sig Hsgs Ti-
406134 $ 5741 38000 436 316 21 10 1
406004 $ 18 1 23
4CA64E $ 6763 15325 304 025 51.591 -0.229 41 36 4
484B00 $ 7626 5325 254 020 51.601 -0.183 31 48 5
601839 $ 7450 270 269 26 20 2
400E59 $ 5736 34000 26 35 22
4B8144 $ 3232 THY33 32000 489 269 51.911 0.257 30 354 8
406871 $ 5005 1200 36 25 8
400F28 $ 0043 1600 69 136 0
  
```

Credit: Max Santos, AC5PY

Another example: Dump1090 and VRS



PAUL-PC-Radio x + Free license (non-commercial use only)

127.0.0.1/VirtualRadar/desktop.html

N69838 **A94B50**

UNITED
United Airlines
United States
Boeing 737-924

Altitude: 35000 ft Vertical Speed: 0 ft/s Speed: 518.8 kts Heading: 26.1° Distance: 77.39 mi Squawk: Engines: Twin jet Species: Landplane Wake Turbulence: Medium

Route:
EWR Newark Liberty, United States
FLL Fort Lauderdale Hollywood, United States

www.airport-data.com : www.airliners.net : www.airframes.org
Show on map : Disable auto-select : Submit route correction

Tracking 24 aircraft

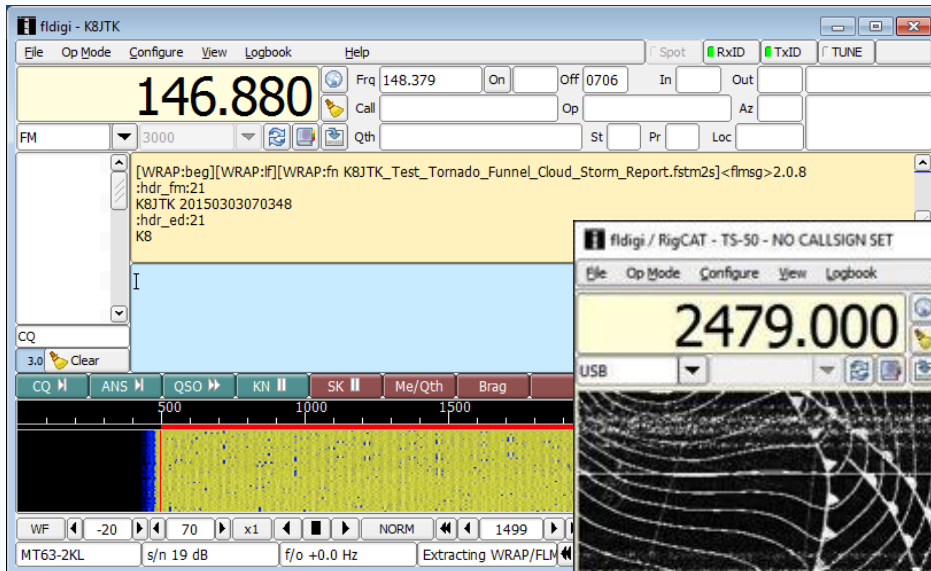
Flag	Silhouette	Reg.	ICAO	Callsign	Route	Altitude	Speed	Alt & VSI	Receiver	Type	Avg. Sig	Squawk	Distance
UNITED		N69838	A94B50	UAL1886	EWR-FLL	35000 ft	518.8 kts	35000 ft 0 ft/s	KCHS2	B739			77.39 mi
		C-FWSV	C03C02	WJA1039		39000 ft	509.4 kts	39000 ft -1 ft/s	KCHS2	B737	6267		39.71 mi
		A88C00	NK180	SDQ*LG4		36975 ft	517.5 kts	36975 ft 0 ft/s	KCHS2				35.41 mi
AIR CANADA		N508AY	A657BF	AAL1728	TPA-CLT	24950 ft	468.2 kts	24950 ft 0 ft/s	KCHS2	A321			7365 35.12 mi
		A96B65	1217			31975 ft	367.2 kts	31975 ft 1 ft/s	KCHS2				1742 30.40 mi
jetBlue		N659JB	A8AEF3	JBU1211	BOS-BUF	31975 ft	373.2 kts	31975 ft 0 ft/s GPS	KCHS2	A320			1351 29.53 mi
jetBlue		N632JB	A845F4	JBU678	LAX-JFK	35225 ft	543.8 kts	35225 ft 12 ft/s GPS	KCHS2	A320			0757 22.38 mi
CANJET		C-FTCZ	C0327A	TSC837		37000 ft	559.0 kts	37000 ft 0 ft/s	KCHS2	B738			7721 19.29 mi
		A1E9AF	799			38000 ft	342.4 kts	38000 ft 0 ft/s	KCHS2				14.71 mi
		N135LT	A08E00						KCHS2	LN44			
		N225RP	A1F519			39325 ft		39325 ft 0 ft/s	KCHS2	H238			
		N296WN	A30DC5			39000 ft		39000 ft 0 ft/s	KCHS2	B737			6221
		A08AE7				36000 ft		36000 ft 0 ft/s	KCHS2				4062
US AIRWAYS		N448AW	A5686A			27500 ft		27500 ft 0 ft/s	KCHS2	CRJ2			
		N166HL	A10882			40000 ft		40000 ft 0 ft/s	KCHS2	LJ60			3417
		N379CA	A45560			37000 ft		37000 ft 0 ft/s	KCHS2	CRJ7			1007

Virtual Radar Server: <http://www.virtualradarserver.co.uk>

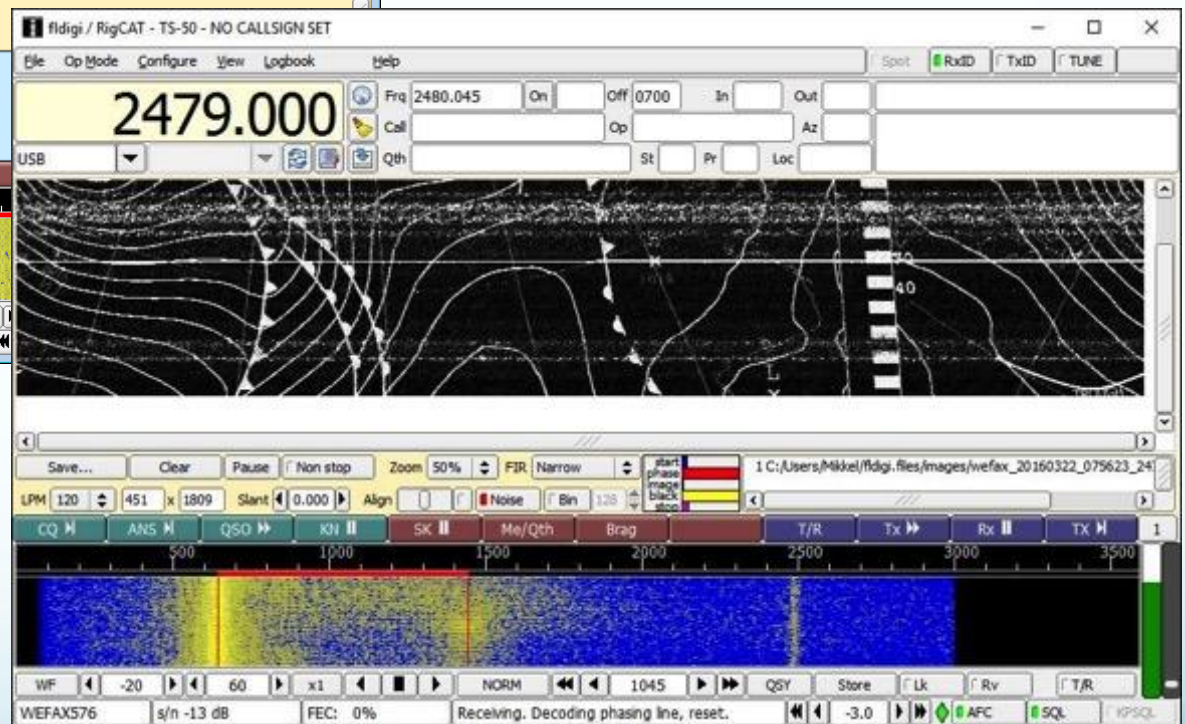
Credit: Paul Jones, NN4F

FLdigi

NBEMS (Narrow Band Emergency Messaging System)



...and WEFAX Decoding

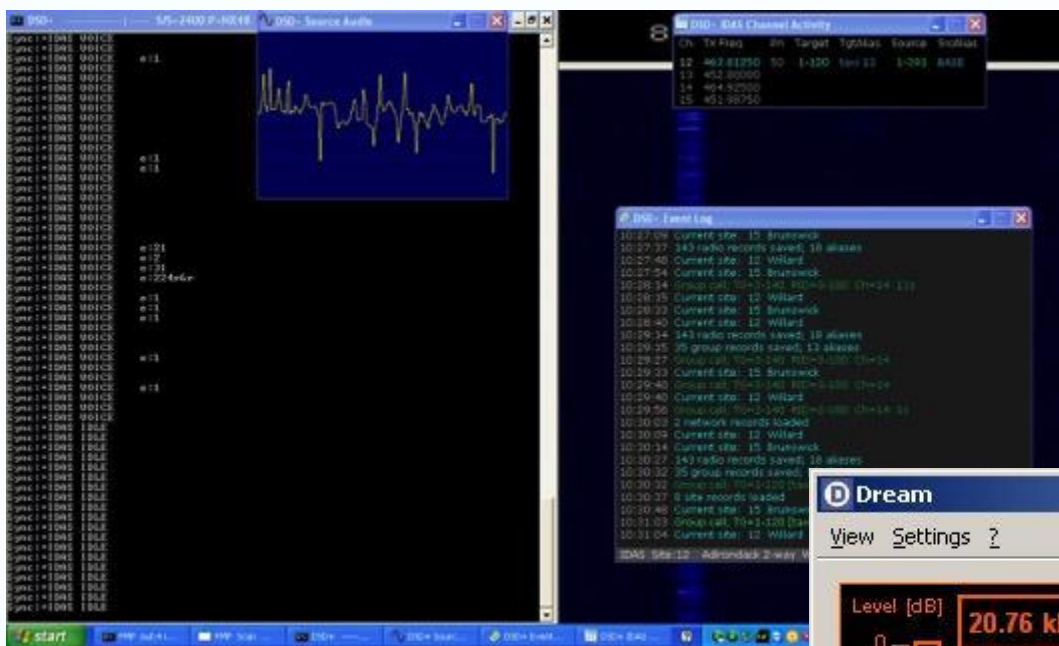


Credit: Jeff Kopcak, k8jtk

Credit: Erik Mikkil Wied

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

Digital Speech Decoding with DSD+



DRM with Dream

Credit: David Stark, NF2G

DSD+:

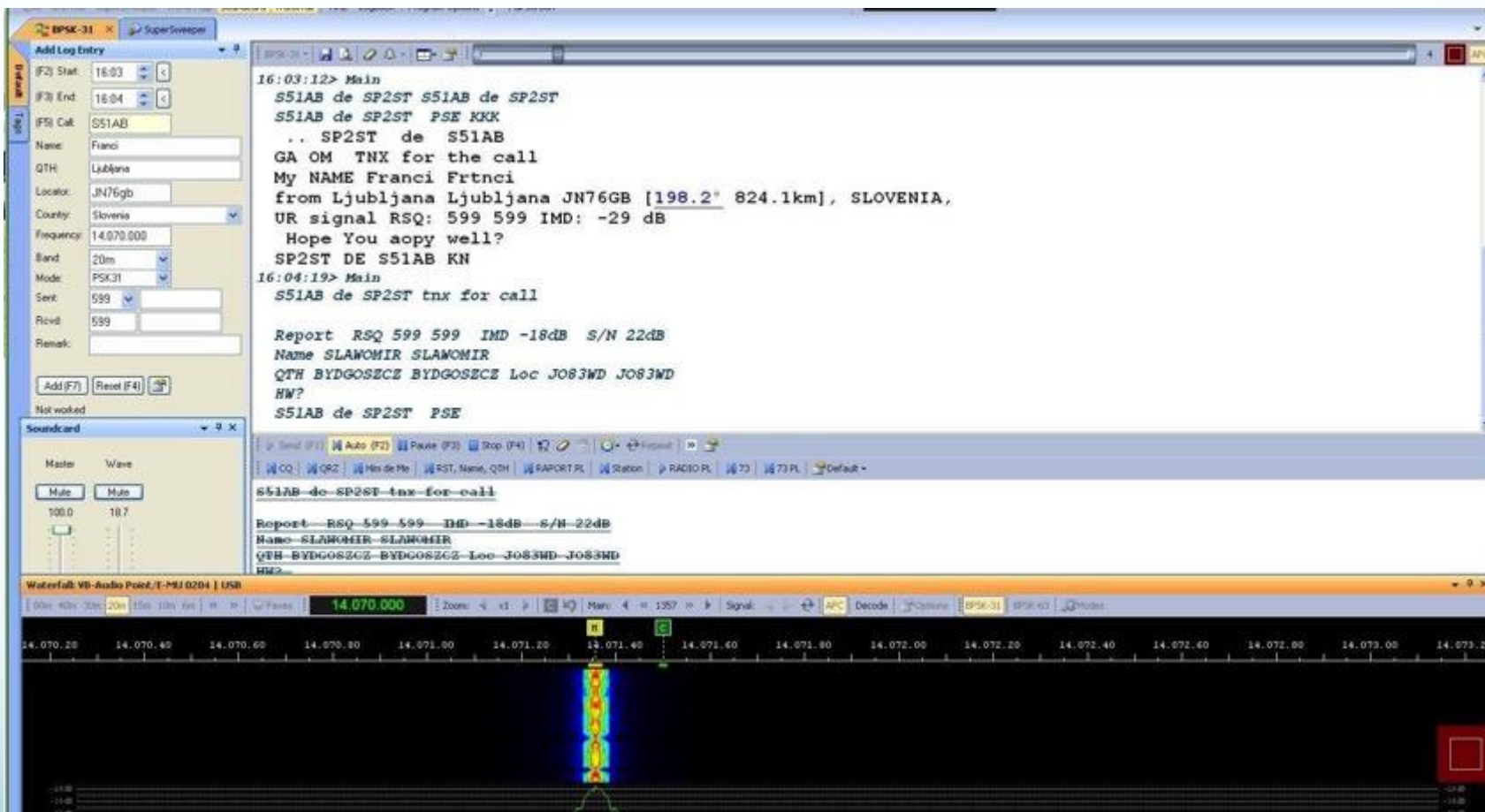
<http://www.dsdplus.com>

Dream:

<https://sourceforge.net/projects/drm/>



Digital Master 780 (Ham Radio Deluxe)



Ham Radio Deluxe / DM780: <http://ham-radio-deluxe.com>

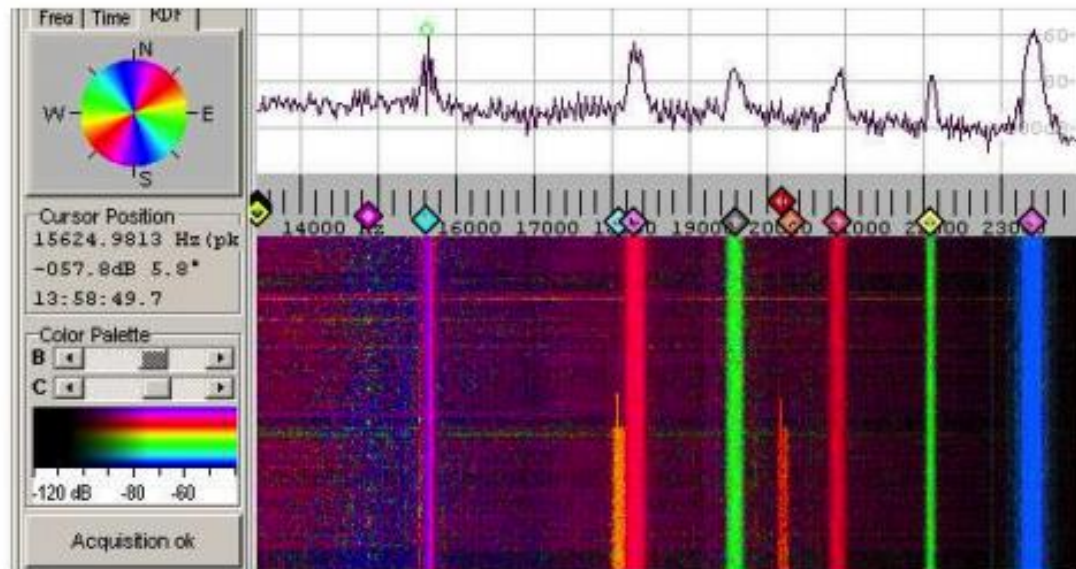
Credit: Sławomir Teclaw, SP2ST

Other EXTIO-based software:

- Spectrum Analyzer example

"I took the SDRplay HSDR ExtIO DLL file and loaded it into Spectrum Lab, and it works 😊 - needs more investigating, but it sure works.... "

The Spectrum Analyzer software can be downloaded from
<http://www.qsl.net/dl4yhf/spectra1.html>



DL4YHF's Audio Spectrum Analyser

Spectrum Laboratory for Soundcard with Waterfall and FFT.


QSL.NET

Panadapters

- Hardware Requirements

- An RSP – to acquire signals across the frequencies of interest.
- A TRX (or main RX)- preferably with either RxOut or IF Out capabilities, and CAT (Computer Aided Transceiver) capability to allow interaction with the SDR software.
- A PC – to run the SDR software and allow control signals to pass back and forth between the SDR software and the transceiver.

* Please see our website for an overview of panadapters, including these slides.

A blue, multi-pointed starburst shape with a white outline, containing text.

RSP1 makes a
great low cost
Panadapter!

Panadapters

- Antenna Considerations



- The RSP can share the same antenna as your transceiver, or in some situations you may prefer to use an entirely separate antenna.
- If a separate antenna is used care must be taken with the physical layout to ensure that near-field effects do not overload the RSP1 when you are transmitting from the transceiver.
 - Article discussion of near-field effects: http://www.w8ji.com/antenna_coupling.htm
- If a shared antenna is used it may either be connected “behind” the transceiver, in which case internal circuitry in the transceiver will protect the RSP, or using a splitter “in front of” the transceiver. If a splitter is used it is essential that a switch is implemented that isolates the RSP from the antenna during transmit!
- **In any configuration the maximum input power to the RSP must not exceed 0dBm**

On the following slides we will look at these configurations in more detail...

DO NOT directly connect the RSP to the same antenna as your transmitter, or to an antenna in the near field of a transmitting antenna, as this is likely to result in irreversible damage to your RSP and invalidate your warranty.

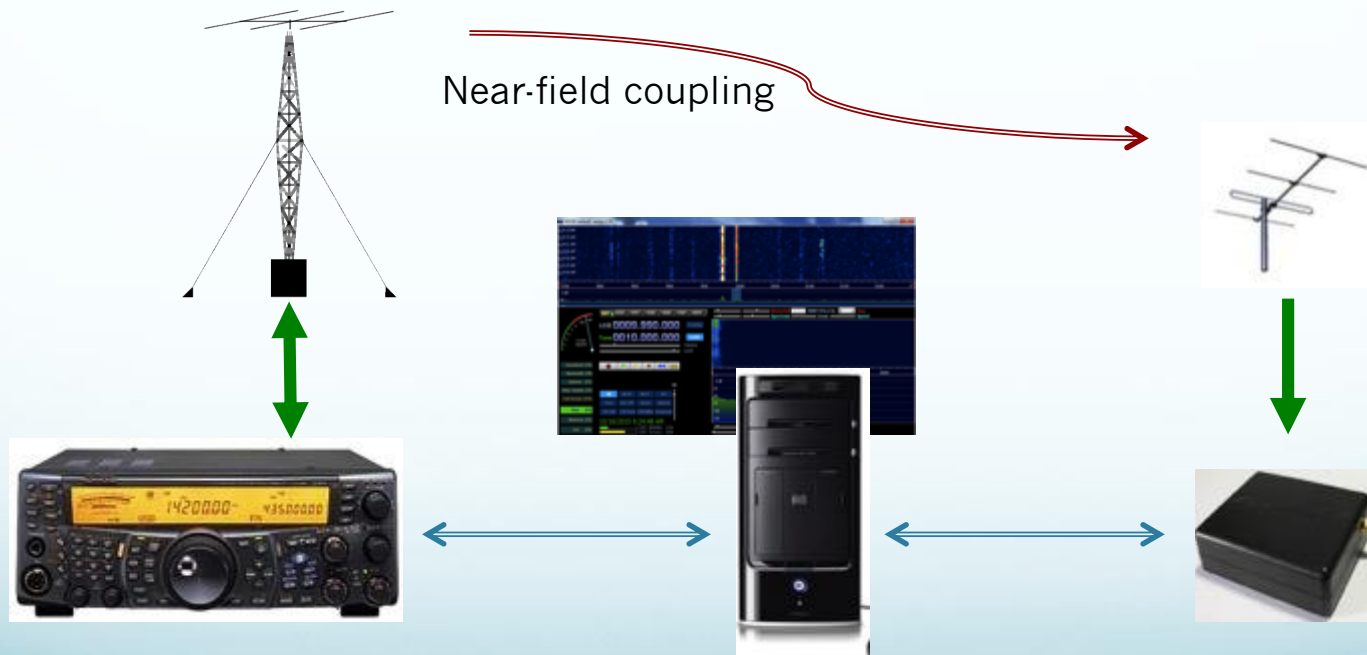
Panadapters

- Antenna Considerations



Separate antenna

- Care must be taken with the physical layout to ensure that near-field effects do not overload the RSP when you are transmitting from the transceiver.
 - See this article for a discussion of near-field effects: http://www.w8ji.com/antenna_coupling.htm



DO NOT directly connect the RSP to an antenna in the near field of a transmitting antenna, as this is likely to result in irreversible damage to your RSP and invalidate your warranty.

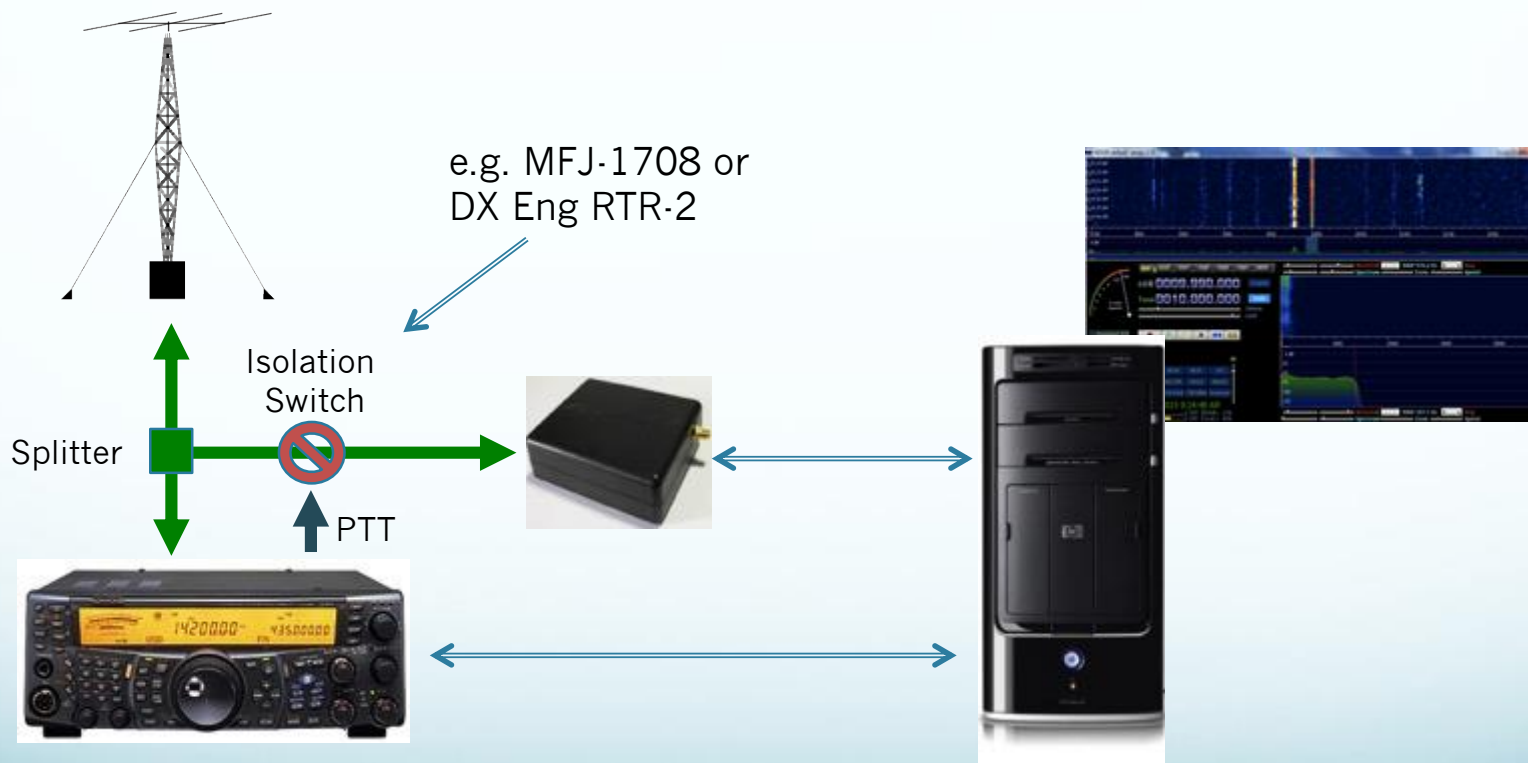
Panadapters

- Antenna Considerations



Shared antenna using splitter

- A switch must be used to isolate the RSP during transmit!



DO NOT directly connect the RSP to the same antenna as your transmitter as this is likely to result in irreversible damage to your RSP and invalidate your warranty.

Panadapters

- Antenna Considerations



Shared antenna “behind” the transceiver

- Internal circuitry isolates the RSP



IF Out: - Displayed bandwidth limited by transceiver on-board filters
- RSP tuned to IF frequency

RF Out: - RSP can display up to the full 10MHz bandwidth capability

Panadapter

- Software Requirements



- Any of the SDR Software programs that support the RSP can be used to provide a basic spectrum display.
- Most also have built-in capabilities for CAT and other add-on software, to allow for communication between the SDR software and the transceiver.
- Ham Radio Deluxe and OmniRig are commonly used for synchronization/control between the Txcr and RSP.
- We recommend you research the available options and select according to your expectations and requirements:

HSDR:	www.hdsdr.de
SDR-Console:	www.sdr-radio.com
CubicSDR:	cubicsdr.com
Ham Radio Deluxe:	ham-radio-deluxe.com
OmniRig:	www.dxatlas.com/omnirig/
N4PY:	http://www.n4py.com/

For more information and purchase:



- Company website: www.sdrplay.com
 - We have distributors located [worldwide](#)
 - US Distributor: [Ham Radio Outlet](#)
- Community Forums: www.sdrplay.com/community/
- Email:
 - North America: support-usa@sdrplay.com
 - Rest of World: support@sdrplay.com
- Facebook: [SDRplay](#) and [SDRuno](#) specifically
 - Independent groups run by enthusiastic users!
- Google / YouTube
 - Many videos covering how to use the various software packages, implementing panadapters and much more. Use the Google search function!
 - SDRplay channel: <https://www.youtube.com/c/SDRplayRSP>