

Getting Started with RTL-SDR and SDR-Sharp and CubicSDR

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Overview



Software-defined radio (SDR) is a technique for turning a computer into a radio. But not just an AM/FM radio - by using the computing power on your desktop you can listen and decode a wide variety of broadcasts. SDR can turn your computer into a weather-band receiver, a police/fire report scanner, a music listening station, and more! Instead of manually tuning inductors, its all done in software by chips fast enough to pick up and decode radio waves on the fly

If you've ever been curious about software defined radio (SDR), this USB stick is the easiest way possible to have fun with a powerful, configurable receiver. Packed with the powerful RTL2832U and R820T tuner, it can tune into signals from 24MHz to 1850MHz. That means you can use a computer (with Windows, Mac, or Linux) to tune into: FM Radio, AM signals (but not AM radio), CW (morse code!), unencrypted radio signals (such as those used by many police and fire departments), POCSAG pagers, and more.

In this tutorial we'll show how to get your very first listening adventure underway - listening to FM radio and decoding the RDS/RBDS data signal that is sent along with many FM radio stations as well.

Wan't lots more info? There's hundreds of tutorials, posts and projects over at http://www.rtl-sdr.com/

Next, we'll set up the software -- if you're using windows, head to the next page -- SDR-Sharp for Windows (https://adafru.it/Cd6). On mac os, jump to the page CubicSDR for mac os (https://adafru.it/Cd7).

To see some SDR action live, check out this episode of John Park's Workshop:

SDR-Sharp for Windows



Download & Install Software

We'll be using the awesome SDR# software for windows, which is really easy to use and very powerful as well! Visit http://sdrsharp.com/ (https://adafru.it/dsT) to download - we're using Rev 1243



If for some reason the site is down, we have a mirror of the install folder from 5/19/2014 (https://adafru.it/dsU)

We suggest downloading the latest version as there will be minor bug fixes, etc!

Opening sdr-install.zip	
You have chosen to	open:
🔒 sdr-install.zip	
which is: Com	pressed (zipped) Folder (151 KB)
from: http://se	drsharp.com
What should Firefo	x do with this file?
Open with	Windows Explorer (default)
<u> Save File</u>	
🔲 Do this <u>a</u> uto	matically for files like this from now on.
	OK Cancel

Save and uncompress the zip file

Sdr-install	0-	han "ge hanny all	00-1-	- 4 ∳ Se	earch sdr P
Organize 🔻 Include in library		New folder			
🔶 Favorites	Name	^	Date modified	Туре	Size
Desktop	httpget.exe		8/30/2012 9:50 PM	Application	83 KB
💱 Dropbox 🗏	🚳 install.bat		5/3/2014 9:41 PM	Windows Batch File	2 KB
 Phoenix EDID Designer Microbuilder Library shared Recent Places Downloads 	I unzip.exe		8/30/2012 9:21 PM	Application	72 KB
3 items					

Double-click on **install.bat**



This will download the latest build and extract it into the current folder. SDR# does not install into the toolbar or start menu!

		^		-	
🔆 Favorites	Name		Date modified	Туре	Size
Marktop	🍌 sdrsharp		5/10/2014 7:05 PM	File folder	
💝 Dropbox	httpget.exe		8/30/2012 9:50 PM	Application	83
🍌 Phoenix EDID Designer	install.bat		5/3/2014 9:41 PM	Windows Batch File	2
 Microbuilder Library shared 	🔝 unzip.exe		8/30/2012 9:21 PM	Application	72
Downloads	+ (m		

Driver Fix

Before we continue, we'll have to install the Windows driver for the RTL USB stick and then swap it for a 'low level access' driver. The default driver assumes you'll just be using the RTL-SDR for watching TV or radio but we want to be able to control it to do much more.



Plug in the stick, Windows should automatically install the REALTEK 2832U driver

Now from inside the SDR# directory, run Zadig which will do the driver swapping for us.

Here's a version 2.2 exe if you need it:

	https://ddahd.it/DK5	
	https://adafru.it/DkS	
🛃 Zadig		
Device Options Help	WinUSB (v6. 1. 7600. 16385)	Edit More Information WinUSB (libusb) libusb-win32 libusbK WinUSB (Microsoft)
No new version of Zadig was found		Zadig 2.1.0.658

From the Options menu, select List All Devices

🗾 Zadig				
Device	Opt	ions Help		
	\checkmark	List All Devices	1	
USB R	✓	Ignore Hubs or Composite Parents		▼ 🗖 Edit
Driver	✓ ✓	Create a Catalog File Sign Catalog & Install Autogenerated Certificate	*	More Information
USB II WCID		Advanced Mode Log Verbosity		libusb-win32 libusbK WinUSB (Microsoft)
11 device	s fou	nd.	_	Zadig 2.1.0.658

Then from the devices drop-down, find one that says **Bulk-In, Interface (interface 0)**. If there's more then one, select one at a time, and verify below to get the right one.

Check that you get USB ID 0x0BDA (vid) and 0x2838 (pid) and the RTL2832UUSB driver

Zadig	in and	
<u>D</u> evice <u>O</u> ptions <u>H</u> elp		
Bulk-In, Interface (Interface 0)		▼ Edit
Driver RTL2832UUSB (v64.1.617.20	WinUSB (v6. 1. 7600. 16385)	More Information WinUSB (libusb) libusb-win32 libusbK WinUSB (Microsoft)
11 devices found.		Zadig 2.1.0.658

Make sure to the right of the green arrow you see WinUSB

Click Replace Driver

Zadig		
Bulk-In, Interface (Interf Driver RTL2832UUSB (USB ID OBDA 2838 WCID ²	Installing Driver Installing Driver Replace Driver	Edit More Information WinUSB (libusb) libusb-win32 libusbK WinUSB (Microsoft)
Installing driver. Please wait.		Zadig 2.1.0.658



That's it!

SDR# FM Radio

Lets start by just listening to every-day FM radio. Open up SDRsharp.exe (you can close Zadig)

50R# v1.0.0.12	75 - IQ Imbalance: Gai	in = 1.000 Phase = 0.000"	- • ×
≡ ► +	¢ ≪ 0	000.000.000	
V Source Dther (Sound car NFM @ Al WFM @ D Shift Filter Black Bandwidth 10000 Squelch	d)		Zoom
Sean to grid	Step size		2 323 -
Correct IQ	Mark Peaks	• •963KHZ •042KHZ •321KHZ DC 321KHZ 642KHZ 963KHZ	
FM Stereo	Swap 1 & Q		
▼ Audio	_		
Samplerate	48000 sample/sec		
Input	[MME] Microsoft Soun	•	12 12 1
Output	[MME] Microsoft Soun		
Latency (ms)	100	A V	Speed
🔄 Unity Gain	Filter Audio		- [-
▼ AGC	_		1 (B)
Vise AGC	🔽 Use Hang		
Threshold (dB)	-50	IF Spectrum Audio Spectrum	
Decay (ms)	100		· ·
Slope (dB)	0		
▼ FFT Display			
View	Both		
1. C		DC 5KHz 10KHz 15KHz	

Begin by selecting the RTL-USB dongle instead of audio card

SDR# v1.0.0.1275 - IQ Imbalance: Gain =	1.000 Phase = 0.000°
≡ ▶ ♣ ≪ 0	000.000.0
▼ Source	A
Other (Sound card)	0
SoftRock / Si570	-10
FUNcube Dongle Pro	-20
RTL-SDR / USB	-30
RTL-SDR / TCP	-40
RESPACE SDR-IQ	-50
HackRF	-60
IQ file (*.wav)	
Other (Sound card)	-70
Bandwidth Order	-80
10000 🚔 500 🚔	= -90

Select WFM (wide-band FM radio) under the Radio signal type

▼ Sour	ce	_	_			
RTL-SDR	/ USB		•		0	
🔻 Radie	o	_			-10	
O NEM	O AM	C LSB	O USB		-30	
WFM	DSB	© C₩	© RAW		-40	
Shift			0		-50	
Filter	Blackman	-Harris 4	•		-60	
Bandwidth		Order			-80	
	180000 ≑		100 🛓	Ξ	-90	
Squelc	h	CW Shif	t		-100	

Click on Configure

<u> S</u> SDR# v1	.0.0.1275	- IQ Imba	alance: G	iain = 1	.000	Phas
			<u> </u>			I.
י ב ו	*	X	Ļ.,			1
V Sour	ce Co	onfigure			^	
RTL-SDR	/ USB		_	-		o [
▼ Radi	0					10
	- · · · ·		-			20
© NFM	O AM	C LSB	O US	в		30
WFM	DSB	CW	RAI	N	-	40
					-	50

And set the gain about half-way up

RTL-SDR Controller	x
Device R820	от
Generic RTL2832U OEM	•
Sample Rate	
2.4 MSPS	•
Sampling Mode	
Quadrature sampling	•
Offset Tuning	
RTL AGC	
Tuner AGC	
RF Gain 15.7 c	dB
·····	
Frequency correction (ppm) 0	÷
Close	

You can set your favorite frequency (FM station) by clicking on the large numbers up top

L.0	00 Phase = 0.00)0°	-				
•	Configure		.088.	00.00	00		
•	0				T		
	-10 -20 -30						
	-40 -50						
E	-60 -70 -80						
	-90 -90 -100						-(Co
	-110 -120						
	-130 86.800MHz	87.200MHz	87.600MHz	88.000MHz	88.400MHz	88.800MHz	89.200MHz

Click Play/Start and set the volume starting from low to high so you don't hurt your ears!



You can 'seek' for radio stations by looking for peaks. Click on them to tune in



With the latest versions of SDR-Sharp it will automatically detect and decode RBDS/RDS data that is sent along with FM radio



Chances are your radio station is also playing Donna Summer!

SDR# NWR (Weather) Radio

Most every-day AM/FM radios can't tune into theNOAA Weather Radio (NWR) All Hazards network but with RTL-SDR we can! NWR is the national weather alert system, which broadcasts weather data as well as emergency alerts. (https://adafru.it/Cd8)

Let's tune into the closest weather station to Adafruit Southern California, which is in Los Angeles. You'll want to tune into whatever station is closest to you.

Montgomery	036057	Albany	WXL34	162.550	ALL
Montgomery	036057	Cooperstown	WWH35	162.450	ALL
Montgomery	036057	Middleville	WXM45	162.425	ALL
Nassau	036059	Meriden	WXJ42	162.400	N
Nassau	036059	New York City DEGRADED	KWO35	162.550	ALL
Nassau	036059	Riverhead	WXM80	162 475	Central/E
New York	036061	New York City DEGRADED	KWO35	162.550	ALL
Niagara	036063	Buffalo	KEB98	102.330	ALL
Oneida	036065	Cooperstown	WWH35	162.450	S
Oneida	036065	Middleville	WXM45	162.425	ALL
Oneida	036065	Syracuse	WXL31	162.550	w
Onondaga	036067	Syracuse	WXL31	162.550	ALL

To begin, visit the NOAA weather station frequencies-by-county index here (https://adafru.it/Cd9)

The frequency is 162.550 MHz, type that into the SDR# frequency window



You can see a little peak, its much smaller signal than the FM radio stations. It's also much *thinner* which makes it a narrow-band FM rather than wideband. Since its voice, not stereo music, they use less of the frequency band, so select **NFM** as the decoding type

🔗 SDR# v1.0.0.1275 -	IQ Imbalance: Gain = 1.0
≡ • *	
▼ Source	^
RTL-SDR / USB	•
▼ Radio	
NFM ○ AM	O LSB O USB
🔘 WFM 🔘 DSB	© CW ⊚ RAW
Shift	
Filter Blackman-H	Hamis 4 🔹
Bandwidth	Order
8000 🌩	500 🚔 🗉
V Squelch	CW Shift
50 🌩	600
	Step size
Snap to grid 📝	12.5 kHz 🔻
Correct IQ	Mark Peaks 📃
FM Stereo	Swap I & Q
▼ Audio	
Samplerate //80	M eample/eac -

The station is marked as degraded, but by amplifying the gain on the RTL-SDR we were able to tune in

RTL-SDR Controller	×
Device	R820T
Generic RTL2832U OEM	-
Sample Rate	
2.4 MSPS	-
Sampling Mode	
Quadrature sampling	-
Offset Tuning	
RTL AGC	
Tuner AGC	
RF Gain	48 dB
Frequency correction (ppm)	0
	Close

You should be able to hear a computer-generated voice speaking out the weather forcast. It's not terribly exciting but it is very thorough, often giving very detailed reports. The signal continuously transmits so you can tune in at any time!

Going forward

now that you have some basic functionality working, try tuning into other frequencies, and trying the different kind of decoding (e.g. CW/AM/NFM) to tune into AM radio!

CubicSDR for mac os



Download & Install Software

On mac os, we'll be using the excellent CubicSDR (https://adafru.it/Cda) cross-platform, open source software. For this tutorial we'll use release version 0.2.3 Head to the Downloads (https://adafru.it/Cdb) page to grab the latest version, or click this link to directly download 0.2.3



Once you've downloaded the installer (in this case named **CubicSDR-0.2.3-Darwin.dmg**), double-click it to mount the disk image, and then drag the **CubicSDR.app** to your **Applications** folder as shown here.



Now, plug your RTL-SDR dongle into a USB port on your mac, and then double-click the CubicSDR.app in your

Applications folder to run it.

Start the SDR Device

When you launch CubicSDR, it will pop up a window asking you to select and start your SDR device. Pick the one named **Generic RTL2832U OEM :: 00000001** and then click **Start**.

Devices	SoapySDR Device Options			
 Devices Local Apple Inc.: Built-in Microphone ma++ ingalls for Cycling '74: Soundflower (2ch) ma++ ingalls for Cycling '74: Soundflower (64ch) Generic RTL2832U OEM :: 00000001 Local Net Remote Manual 	SoapySDR I Comparison of the second	SoapySDR Device Options V General Settings Name Generic RTL2832U OEM :: 0000 Offset (KHz) 0 Sample Rate 2.56MHz V Run-time Settings Direct Sampling Off Offset Tune False I/Q Swap False V Stream Settings		
Refresh Add Start	Ring buff Async bu	res Iffers	202144 15 0	

CubicSDR FM Radio

We'll begin by listening to some broadcast FM radio.



First, make sure your RTL device has started by clicking the File > Stop / Device menu item. When it is running you will see the waterfall frequency display moving at the bottom of the interface, as well as some moving waveforms in the other areas.



Signal Type

The CubicSDR software in combination with the RTL dongle can tune and demodulate different ranges and types of radio signals. For this example, we'll select Frequency Modulation Stereo (FMS) as the signal type.



Center Frequency

Next, you can tune in a station! Start by setting a center frequency for a station you like, by clicking on the numbers under the "Center Frequency" heading.



This will bring a range of frequencies into view -- approximately 3MHz at a time are available. Now, you can set a demodulator down on a range you want to tune. This is done by clicking in the waterfall display, with the cursor at the center of the frequencies you want to hear. This will usually be the orange and red display section, showing you where



Here, the demodulator has been set at 91.499261MHz, and we have a nice strong signal. Music plays!



You can see the fine tuning section in the upper left corner gives us a zoomed in view of the demodulator. You can drag this one left and right in the waterfall section to fine tune, or grab one of the outer edges of the demodulator to change the bandwidth that is being processed. Too wide and you'll pick up unwanted signals, too narrow and you'll start to cut off important parts of the signal.



You can search for other stations by scrubbing the peaks display left or right and looking for strong peaks. Set down a demodulator in the waterfall area under a strong peak to listen in.

-9.7d8.2	91.5 91.8 1.502	92.0	92.2 92.5	92.8 93	3.0 93.2	93.5 P
	EMS					

The frequency band for FM broadcast radio is 88MHz to 108MHz.

CubicSDR NWR (Weather) Radio

Most every-day AM/FM radios can't tune into theNOAA Weather Radio (NWR) All Hazards network but with RTL-SDR we can! NWR is the national weather alert system, which broadcasts weather data as well as emergency alerts. (https://adafru.it/Cd8)

Let's tune into the closest weather station to Adafruit Southern California, which is in Los Angeles. You'll want to tune into whatever station is closest to you.

Kings	006031	Bakersfield	WXL89	162.550	ALL
Kings	006031	Fresno	KIH62	162.400	ALL
Lake	006033	Ukiah	WNG720	162.525	NORTHERN
Lassen	006035	Fernley	WWG20	162.450	ALL
Lassen	006035	Susanville	WZ2530	162.500	ALL
Los Angeles	006037	Avalon	WNG584	162.525	EXTREME WEST
Los Angeles	006037	El Paso Mtns.	WNG659	162.425	N
Los Angeles	006037	Los Angeles	KWO37	162.550	ALL
Los Angeles	006037	Malibu Marine	KWL22	162.425	ALL
Los Angeles	006037	Sandberg	WZ2505	162.425	NORTH CENTRAL
Madera	006039	Fresno	KIH62	162.400	W
Marin	006041	Big Rock Ridge	KDX54	162.500	ALL
Marin	006041	San Francisco	KHB49	162.400	ALL
Mariposa	006043	Fresno	KIH62	162.400	SW
Mariposa	006043	Yosemite	KAD94	162.450	NORTH CENTRAL
Mendocino	006045	Point Arena	KIH30	162.550	W

To begin, visit the NOAA weather station frequencies-by-county index here (https://adafru.it/Cd9)

The frequency is 162.550 MHz, type that into the CubicSDR tuner window by hovering over the Center Frequency box and hitting spacebar.





You can see a little peak, its much smaller signal than the FM radio stations. It's also much *thinner* which makes it a narrow-band FM rather than wideband. Since it's voice, not stereo music, they use less of the frequency band, so select **NFM** as the decoding type.



Click to set a demodulator at the 162.550 MHz peak.



You should be able to hear a computer-generated voice speaking out the weather forecast. It's not terribly exciting but it is very thorough, often giving very detailed reports. The signal continuously transmits so you can tune in at any time!

Going forward

Now that you have some basic functionality working, try tuning into other frequencies, and trying the different kind of decoding (e.g. CW/AM/NFM) to tune into AM radio!

F.A.Q.

The SDR dongle seems to get hot!

Yep, these run pretty warm. As long as it's still working, you should be good to go. There's a pretty advanced chipset inside which can consume a lot of power

What kind of computer do I need?

You need a computer with at least one USB 2.0 or higher port. You will also need admin privs to install the software, we used it on Windows 7, XP should be the same. There's also software for Mac and Linux but we don't have tutorials for it. Google around for RTL-SDR and what you wanna do for lots of ideas!