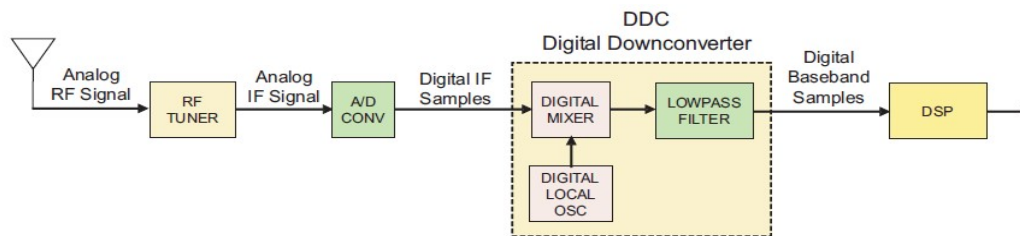




## The MORE Project Guide to Software Defined Radio

Version 1.4

Software Defined Radio (SDR) has been around since the 1980's. The concept involves the use of specialized software and hardware to perform conversion of analog-to-digital (A/D) signals for reception and digital-to-analog (D/A) signals for transmission of radio. Here is a block diagram of an SDR reception process (from the Pentek SDR Handbook by Rodger Hosking <<https://www.pentek.com/sftradhandbook/sftradhandbook.cfm>>):



The receive-only RTL-SDR v3 USB dongle (provided to MORE Project students, and internally depicted at <[https://www.rtl-sdr.com/wp-content/uploads/2020/02/improvements\\_v3new800x800.jpg](https://www.rtl-sdr.com/wp-content/uploads/2020/02/improvements_v3new800x800.jpg)>) incorporates the functions shown above. One end of the dongle is connected to an antenna (such as the telescopic RaTLSnake by Nooelec) via a twist-on SMA connector, and the other end is plugged into the USB port of a computer. Software must be downloaded and properly configured in order to recognize, decode and display (in sound and graphics) the digital signals that are translated by the hardware.

To set up your RaTLSnake antenna, first find a location near your computer where you can mount the magnetic base. Be sure to NOT place it on or close to anything that can be affected by strong magnets (such as credit cards, disk drives or other electromagnetic storage devices). A steel pie pan, heating vent, radiator cover or a ferromagnetic metal plate should work well. If you can slightly elevate the location of the base (not on the floor) and place the antenna near a window, this may help improve the radio signal reception. Next, screw the end of the telescopic antenna onto the connector on the magnetic base. The orientation of the top of the antenna should be straight up (toward the sky). The antenna may work well without needing to extend it (you can experiment with orientation and location later). The far end of the wire attached to the magnetic base should be screwed onto the SMA connector at one end of the RTL-SDR dongle. The USB end of the dongle can now be inserted into one of the USB ports of your computer. Remember to detach the dongle from your computer when you are not using the SDR, or before you reposition the antenna. The dongle will get a little bit warm when it is attached to the computer (even if you are not using the SDR software), this is normal.

In order to receive radio signals, you will need to download and install software onto your computer. There are numerous different free SDR programs that are compatible with the RTL-SDR dongle. One online guide that provides software suggestions for Windows, Mac OS, and Linux is at: <<https://www.rtl-sdr.com/rtl-sdr-quick-start-guide/>>. For a more precise set of instructions, we recommend that first-timers follow the step-by-step directions at: <<https://learn.adafruit.com/getting-started-with-rtl-sdr-and-sdr-sharp>>. (You can also download the PDF instruction manual via <<https://cdn-learn.adafruit.com/downloads/pdf/getting-started-with-rtl-sdr-and-sdr-sharp.pdf>>.)

The most important thing to know about the software installation is that you MUST follow ALL of the steps VERY closely. Skipping a step, doing steps out of order, not looking closely at the pictures in the manual and not following the instructions exactly, may result in a lack of reception, or noise instead of a clear signal. For Windows, the version of the SDR-Sharp software (and the associated Zadig USB driver) that are available via the Adafruit website are not the latest ones, but these do not require .NET installation and have been tested to work through at least Win10, so you should be fine with this for starters. If you want to install a later version of the software, do that after you've gotten the earlier version working, have become familiar with the controls and features on the interface, and have explored various bands and channels.

Try this: Type in the number of a local FM station that you can receive on a regular radio. For example, in NJ, the 101.5 station would be typed in as 000.101.500.000 at the top, above the signal display. Can you hear the broadcast? Move your pointer on the screen and click to select different signals. Press and hold your mouse button and slide your mouse left or right (slowly!) to see different frequencies near the one you typed in. Look for peaks and try to select the center of the peak. Slide down to FFT Display in the menu panel and turn ON (check) Mark Peaks and a little circle will appear on the display whenever the SDR software recognizes peaks in signals it receives – click on those peaks in the display with your mouse, and you should hear a clear FM station. Experiment with finding the NOAA Weather Radio stations as explained in the Adafruit manual.

If you've followed the installation instructions and have your SDR working, CONGRATULATIONS! Enjoy listening to FM broadcast and NOAA Weather Radio stations. If you're stuck, go back through the instructions and step through them (carefully) again. If you do not see or hear any signals and you have a local FM frequency selected, click on the gear icon in the upper left corner of the SDR-Sharp window and make sure that the Sampling Mode is Quadrature and the RF Gain slider is set around 40 dB. If you're seeing signals on the display and aren't hearing anything, make sure your computer's speaker isn't muted (check the speaker icon near the top left of the display, and also the speaker settings in your computer's control panel). If you're not seeing motion in the signal on screen, make sure that your USB (with antenna attached) is plugged in and the right arrow near the top left of the display (between the menu and gear icons) is toggled to Start. If you're seeing signal display motion and just hearing noise, make sure that you have the FM button selected, in the Radio menu to the left of the signal display.

If you're still having some problems, this video will take you very slowly through the installation steps for a more recent version of SDR-Sharp: <<https://www.youtube.com/watch?v=rUwRt5qn-6U>>. Hopefully, and with some patience, you should be able to get the software working and can tune in and enjoy your local FM broadcast stations, using either a newer or older version of the software (for your PC, Mac or Linux machine).

Here's where the fun starts! This video by Clayton Smith VE3IRR helps you understand the settings, and orients you to the bands your SDR can receive (depending on what antenna you are using), with different modes (CW, LSB, USB, etc.): <<https://www.youtube.com/watch?v=laKEYEyrRgk>>. Watch this video all the way through (it's only 17.5 minutes) to get an idea of the types of signals the SDR can decode. Then experiment with hunting for stations that you can “see” in the display, while changing the settings so you can also hear the audio signals. Check out the SDR section at <<http://n2re.org/more-project-resource-page>> for MORE links and information.

We will review this material in our GOTA session, but do attempt the installation and try out your SDR before then, so that you can ask your trainers some questions. SDR is a great way to learn what's on the air! Have fun!

*The Make Operating Radio Easier (MORE) Project <[n2re.org/m-o-r-e-project](http://n2re.org/m-o-r-e-project)> is a grant-funded initiative to increase understanding and participation in Amateur (Ham) Radio, through education and hands-on activities. The ambitious goals of the 2-year MORE Project are: to train and license 500 new U.S. Radio Amateurs (ages 12+); to examine and explore various types of radio signals, such as by using Software Defined Radio (SDR) and 2M HTs; and to help our new Hams learn basic communications protocols by observing and participating in HF and VHF operations. Contact Dr. Rebecca Mercuri, K3RPM via <[rtmercuri@ieee.org](mailto:rtmercuri@ieee.org)> for further information.*