TechTalk98

iSDR – Software Defined Radio for iPad & iPhone
"There is an app for SDR..."

by Ken Konechy W6HHC

Hams are entering into a digital world of communications. In my mind, it probably started with packet radio (at least the data were ones and zeros). Then the ham digital comm world moved along further with the increasing use of Digital Signal Processing (DSP) processors and PSK31 using soundcards. This entrance into a digital world for hams continues on with D-STAR, Software Defined Radio (SDR) and Digital-ATV (DATV). The most exciting technical area for ham radio is probably Software Defined Radio. This article provides a brief introduction to Software-Defined-Radio and an overview of doing SDR-to-iPAD using a free app called iSDR.

Introduction to Software-Defined-Radio

First, let me explain that Software Defined Radio does NOT mean that SDR does only digital modulations. SDR receives normal analog voice (SSB) and CW just as well as PSK31 (BPSK) and QPSK digital modulation, etc. The advantage has been provided by DSP processor chips that are very fast at performing mathematical equations called Fast Fourier Transforms (FFT's). (NOTE – relax! -- no heavy math is included in this article). So by doing these FFT equations on a processor, you can eliminate many old electrical components (like inductors and tuning capacitors and crystal filters) and perform their functions better in software. Get it? – software defined radios!!

Let's look at the basic concepts of a SDR receiver. I will make a three-step journey to reach a true SDR receiver. In **Fig 1**, the RF signal at 14.001 MHz mixes with the tunable Local Oscillator (LO) frequency of 14.000 MHZ to produce a difference frequency of 1 KHz. All of the other signals coming out of the mixer are filtered out by a Low Pass Filter (LPF). In this case the mixer is an analog RF front-end.

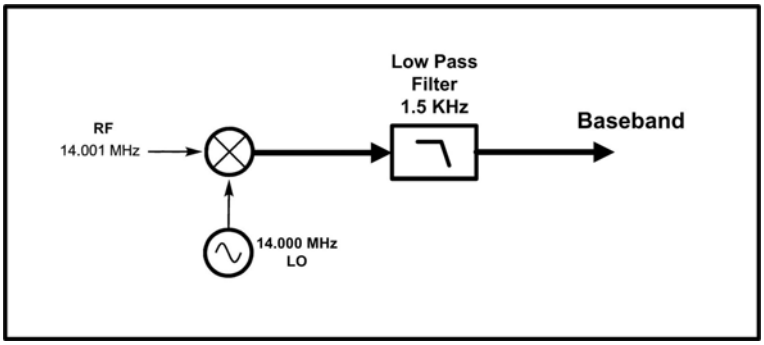

Figure 1 – A simple analog direct-conversion receiver using a mixer to obtain baseband audio

In **Fig 2** I introduce the concept of sampling the RF signal in "quadrature"…which sort of means two RF voltage samples that are 90 degrees of phase apart from each other.

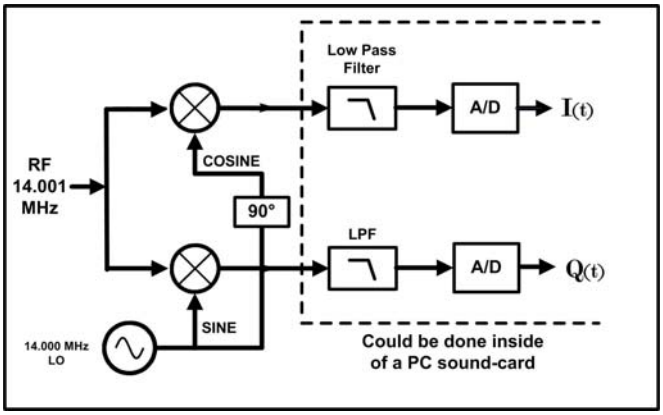

Figure 2 – Two analog mixers have the LO signal shifted by 90 degrees. The output of the mixers can create I and Q streams.

In **Fig 2**, the I and Q audio streams can be used by a DSP processor in a soundcard to perform the necessary Fast Fourier Transform math to produce the correct output.

Finally in **Fig 3** there is a block diagram of a typical modern SDR receiver. The heart of this design is to

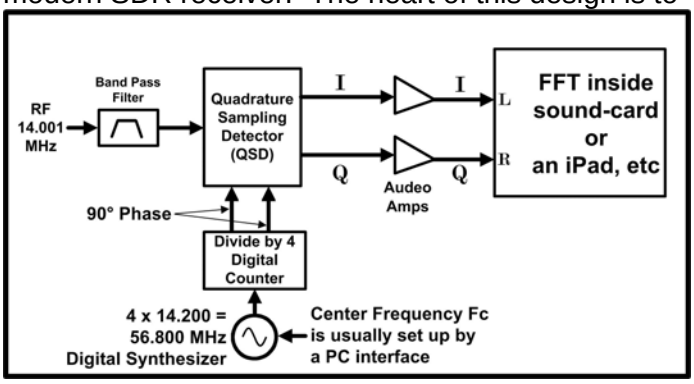

Figure 3 – A fully digital SDR receiver using a QSD RF detector and full FFT processing of IQ datastream

use a digital RF sampling chip, called a Quadrature Sampling Detector (QSD) that was invented by Dan Tayloe N7VE, who was working for Motorola. Inside the chip are four "sample-and-hold" circuits that charge a cap to hold the voltage of the RF signal, when the sample was taken. Each of the samples are 90 degrees apart at the center sampling frequency, Fc. This simple detector then outputs two baseband audio streams (I for "in phase" and Q for "quadrature phase" – aka 90 degrees) to a circuit ready to perform FFT processing. As **Fig 3** shows, the FFT processing can be performed by a DSP processor inside a soundcard or as we will see below by an iPad.

There are even more approaches to SDR, like the HPSDR ham project (Hi Performance SDR) where the RF signal is sampled at 2X the frequency by an Analog-to-Digital Converter (ADC), directly at the antenna.

Free iSDR app on iTunes

Charles Scharlau, NZØI, of Digital Confections has provided an app called **iSDR** free of charge as a gift to the Amateur Radio community! The iSDR app will run on an iPhone, iPad or iPod Touch. The iSDR app can be downloaded (free) from the Apple iTunes Store at:

http://itunes.apple.com/us/app/isdr/id480077371?mt=8

Fig 4 is a block diagram showing a complete SDR receiver using the iSDR app on your iPad or iPhone. The "front end" RF unit shown can be a low cost-SDR kit

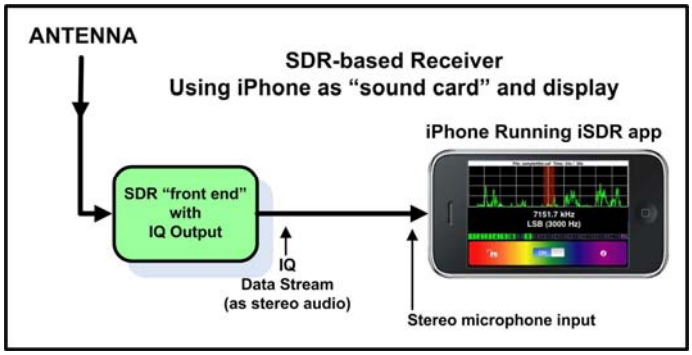

Figure 4 – Block Diagram for complete SDR Receiver using iPhone as "sound card" and Display

like the SoftRock-Lite-40 SDR 40M receiver kit ($19) from Tony Parks KB9YIG or the model LD-1A ($287) assembled SDR receiver from Lazy Dog Engineering (links are at the end of this article). It is interesting to note that the iPad and iPhone do NOT contain a DSP chip for sound. All of the Fast Fourier Transform processing is performed executing the FFT algorithms on the standard Apple processor. Just plug the stereo IQ audio stream into the microphone jack.

Fig 5 and **Fig 6** show the Spectrum View and the

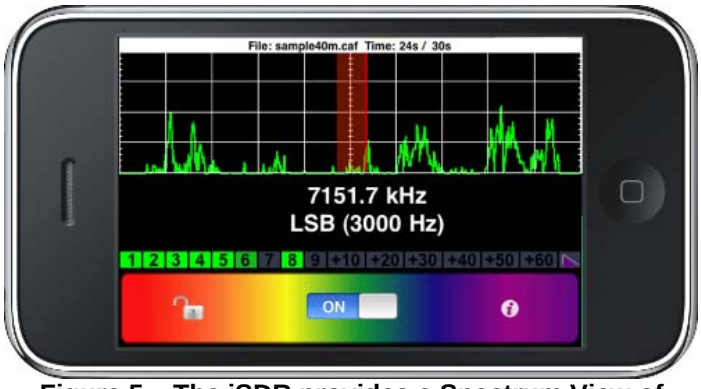

Figure 5 – The iSDR provides a Spectrum View of Received Signals with built-in S-meter.

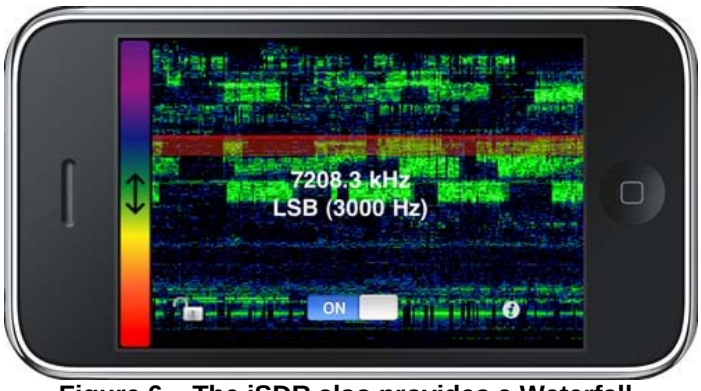

Figure 6 – The iSDR also provides a Waterfall View of Received Signals.

Waterfall View available with the iSDR app. You can use the iPhone touch screen to "tune" to the signal that you are interested in hearing. Finally, **Fig 7** shows a complete station that uses the iSDR approach. Item 1 in **Fig 7** is a custom-made 80m direction finding antenna and Item 2 is the SoftRock v6.2 Lite 80M receiver.

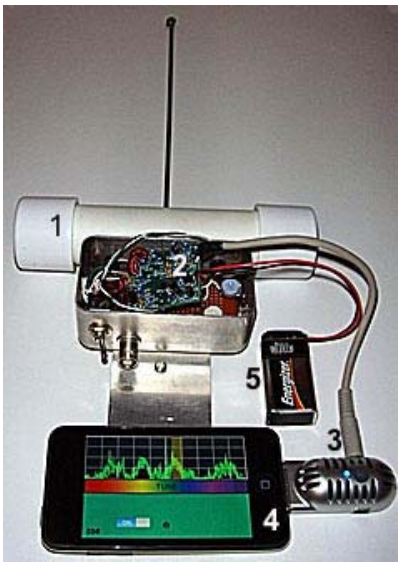

Fig 7 - Could this be the smallest complete QSD-type software-defined receiving station in the world? (Courtesy of Charles NZØI)

Some iSDR Limitations

Because iSDR uses the internal Apple processor, be aware that older Apple products had slower processors. iSDR **is NOT RECOMMENDED** for use on the older iPhone 3G or iPod touch 2nd Gen - Although iSDR will install and launch successfully on those devices, they do not have the processing horsepower to keep up with the demands that iSDR places on the CPU. Sluggish performance and severe audio distortion may result.

Currently, iSDR allows six receive mode settings: USB, LSB, CW, AM, FM and Binaural. However, FM mode is not supported for monaural signals, and will not appear as a mode selection unless stereo audio (live or recorded) is available. Narrow band FM only: 16 kHz or 11.2 kHz bandwidth.

Conclusion

I think the iSDR is a terrific example of the new types of digital technologies that will be available to ham radio in the near future. I hope the Software Defined Radio overview gave you a hint of how SDR works. You will see more SDR products coming your way. Special thanks to Charles G4GUO for helping to clear up some of my SDR concept uncertainties.

Interesting SDR Links

- Apple iTunes link for iSDR App
  http://itunes.apple.com/us/app/isdr/id480077371?mt=8
- Digital Confections internet forum for the iSDR App
  www.digitalconfections.com/index.php?option=com_kunena&Itemid=61
- SDR Tutorials – Youngblood series in 2002 QEX magazine
  www.Flex-Radio.com/data/doc/qex1.pdf
- SDR Tutorials – The Garage Shoppe “Fists of Fourier” series
  http://garage-shoppe.com/wordpress/?p=488
- KB9YIG vendor site for SoftRock SDR radios
  www.KB9YIG.com
- Lazy Dog vendor site of LD-1A SDR radios
  http://garage-shoppe.com/wordpress/?page_id=40
- TAPR-sponsored HPSDR (High Performance SDR) Project
  http://openHPSDR.org/