

# My (simplistic) Understanding of SDR Concept

Submitted by WB5RVZ on Tue, 09/04/2007 - 11:32.

Best I can figure (and even this is subject to correction - please feel free to do so wherever you find me in error) about the theory and operation of the Softrock receivers is:

## 1. Chunk of Spectrum Arrives at Antenna and is Filtered.

The antenna provides as much of the RF spectrum as is electronically possible. Incoming RF is run through a bandpass filter. This limits the chunk of spectrum upon which the SDR will operate.

## 2. The "Mixer".

The resultant "chunk" of spectrum is fed into each of two separate switches. In the softrock, this is the FST3253 Dual 4:1 Multiplexer/Demultiplexer Bus Switch (U7 in the RXTX V6.2).

## 3. The LO Signal.

Each of the two switches also receives one of two local oscillator signals that are identical, but are 90 degrees out of phase.

## 4. The Chunk is Down-Converted to AF.

- a. Each switch, acting as a mixer would in a traditional direct conversion architecture, "mixes" the incoming RF spectrum "chunk" and local oscillator signals to produce (sum and) difference signals in the audio frequency baseband. The sum signals are normally well beyond the baseband's practical limits
- b. The difference signals (above and below the zero difference) are in the same 90 degree phase relationship as are the corresponding local oscillator signals.

## 5. I and Q Outputs.

The resultant baseband (AF) signals are amplified and appear at the I (In-Phase) and Q (Quadrature) outputs, identical to each other, but 90 degrees out of phase.

All signals appear on both I and Q signals, the difference between them is the phase of the signal components, in some signals I leads Q and other signals Q lead I depending on what frequency they are on. Because of the phase differences between I and Q signals the two signals have different appearance yet they both contain all the same signals.

The I and Q signals are combined to create a complex signal, then the FFT that is run on that data is able to find all the signals and their frequency components, both real and imaginary (negative frequencies). This operation identifies where the various signals are located on the frequency spectrum based on the original frequency and phase information found in the I and Q signals coming out of the SoftRock.

## 6. The "Software" Part of "Software Defined Radio".

- a. The Soundcard digitizes the I and Q signals and the software takes over from there to demodulate, filter, massage, and all the other magic that happens in the black box (Rocky, Winrad, KGKSDR, etc.)
- b. That black box magic is covered in some detail in a January 2007 Radcom article, "Watch your Is and Qs (Why I and Q signals are necessary in SDR)", by Phil Harman VK6APH. The article can be found in the Softrock40 Yahoo Group (in Phil's files section in that group). In that excellent article, he explains how Digital Signals Processing demodulates and filters AM, L/USB, FM, and CW from the results of I and Q digitization.
- c. Some of the charts he uses in that article are in a set of Excel spreadsheets and a Powerpoint Phil used to present the concepts at Dayton in 2006 (<http://www.hamsdr.com/dnld.aspx?id=572>).

I am still trying to get the software part between my ears. Hopefully, at least at a basic level, I have managed to get the hardware part straight. If not, maybe some of the smart folks out there can correct any misunderstandings and/or excessive oversimplifications I have made herein.

73 de Robby WB5RVZ