Software Defined Radio

A simple introduction to SDR.
Conventional Receiver

- Complex construction & design
- Big & heavy - chassis / cabinet / shielding.
- Multiple stages of conversion.
- Design dictates radio’s capabilities.
- Cost $300 to $1000 and more.
Software Defined Radio

- Simple construction & design.
- Small with little or no shielding.
- Single conversion to base band audio.
- PC with stereo sound card required.
- Software defines the radio’s capabilities.
- Cost under $100 for basic unit (plus PC).
Quadrature Sampling Detector

- **Quadrature**: Separated in phase by 90°.
- Similar to direct conversion receiver.
- L.O. has two outputs in quadrature.
- Mixer produces Q & I signal at output.
- Q & I are audio signal in quadrature.
- Software processes Q & I signals into received audio.
- Pan adapter or band scope display.
- Width of display ≈ sound card sample rate.
Theory of Operation

- This receiver is patterned on the classic "direct conversion" receiver, in that it mixes incoming RF down to audio frequencies by beating the RF against a Local oscillator such that the mixer products are in the audio frequency range.

- Unlike the traditional DC receiver, the SDR does not "tune" the local oscillator's frequency to beat up against a desired RF signal. Instead, the local oscillator is at a fixed frequency. This fixed oscillator frequency is referred to as the "center frequency".
Theory of Operation

- As a result, the mixer products can vary in audio frequency from zero to +/- some theoretically high audio frequency. In fact, the practical limit is one-half the soundcard's maximum sampling rate.

- The "tuning" (and demodulation and AFC and other neat radio things) happen in the software part of the Software Defined Radio. It is the magic of Software that makes for the extraordinarily high selectivity in the direct conversion hardware (which is notorious for great sensitivity but terrible selectivity).
The software requires the AF mixer products to be provided to the PC as two separate signals, each identical to the other, except that they are 90 degrees apart in phase ("in quadrature"). The SDR receivers achieves this by setting the local oscillator to a frequency that is 4 times the desired center frequency and then dividing that frequency 4 times (with attendant phase shifts to achieve quadrature).

The output of the divider chain is two versions of the center frequency, identical in all respects but phase.
Theory of Operation

- The two center frequency signals are in quadrature and are fed into the mixer stage, which mixes the RF down to two audio signals that are also in quadrature.
- These two signals are provided to an amplifier stage where they are amplified to levels acceptable to the PC's soundcard stereo line-in inputs.
- A soundcard which can sample 48 kHz, can digitize an incoming "chunk" of audio frequency from 0 to 24 kHz. Such a soundcard, using its stereo line-in inputs for the I and Q signals, will yield an effective bandwidth of 48 kHz: 24 kHz above the center frequency and 24 kHz below the center frequency. The SDR software in the PC manipulates the digitized I and Q signals to deliver, demodulate, condition, and filter signals within this bandwidth.
Sound card requirements for SDR

- SDR requires a good stereo sound card.
- The higher the sample rate the better.
- Most cards will sample to 48kHz.
- Better card sample to 96kHz or 192kHz.
- Lower sample rates do not affect audio quality.
- The sample rate limits the width of the pan adapter display.
Soft Rock 40

- Single band receiver designed for 40m.
- Crystal Oscillator @ 4x RX frequency
Soft Rock Ensemble II RX

- Full coverage HF receiver
- Auto switched band pass filter
  - 160m
  - 80m & 40m
  - 30m, 20m & 17m
  - 15m, 12m & 10m
- Si 570 digital frequency synthesizer
- Atmel ATTiny85 micro controller
Soft Rock Ensemble II RX

Ensemble RX Block Diagram

USB Power Supply
MPU (firmware)

5V Power Supply
Quadrature Clock Generator

Ant
Band pass Filters

QSD

Op

Amps

PC SDR Program

PC Line IN (stereo)
Soft Rock Ensemble II RX

Band Select
Soft Rock Ensemble II RX
RF from band pass filter

QSD CIRCUIT
SDR Software – The original Rocky
SDR Software - SDRadio
SDR Software - PowerSDR IQ
Questions?
Time to listen
But wait, there’s more!

- Full HDTV with FM & DAB receiver.
- Basic spectrum analyzer.
- Monitor the IF of an existing receiver or transmitter.
- An SDR IQ transceiver is available.
Soft Rock kits

- Designed by Tony Parks KB9YIG
- Construction guides at WB5RVZ
- Use ChangeDetection.Com or similar service to get email alerts when kits become available.
That's all Folks!