SOFTWARE DEFINED RADIO

SDR

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Software-defined not software-controlled radio
Most of the complex signal handling uses DSP
User interface through the computer
Usually some form of direct conversion
- RF to baseband with no IF
- RF band pass filtering is required to avoid images and birdies
IF bandpass filtering equivalent, demodulation, amplification, detectors, noise reduction, noise blanking, etc. all done in software
Usually requires a PC to run software and control the “receiver/transmitter”
Typical HF Receiver

Ant

RF Amp/Bandpass → Mixer → First IF → Mixer

VFO → LO

2nd IF → Mixer → 3rd IF

Noise Reduction → Audio Power Amp

Audio Amp

Detector/Demodulator

Audio Out
I = In-phase component
Q = 90deg shifted component
(Quadrature)
Typical SDR Display

A typical SDR (Software Defined Radio) display showing various parameters and settings. The display includes options for gain, contrast, and other adjustments. The frequency is set at 0.007,268.41 kHz with a resolution of 107.5 Hz. The date and time are 6/26/2010 10:17:38 PM with a CPU load of 10.8 Hz.
SDR Advantages

- Very Flexible
  - Software and UI easily customized
  - New functions easy to implement
- Wide spectrum display
  - 48KHZ to several MHz
- Software filters
  - Very sharp cutoff
  - Easily tuned
  - Audio band shaping easy to implement
- DSP functions such as noise reduction, etc
- Various detection modes in software
  - AM, SSB, CW, ECSS
  - RTTY, PSK31 and all other data modes
- Simple design for modest performance
- RX and TX readily implemented
Disadvantages

- Simple designs have
  - Lower sensitivity
  - Reduced/only adequate image rejection
  - Higher noise
  - Lower Dynamic Range

- High performance designs more complex and costly
  - High speed A/D 100-200MHz required
  - Dedicated DSP processor
  - Cost similar to mid to higher-end receivers
Some Currently Available Receivers/Transceivers

- Softrock series
  - RX Ensemble II Receiver Kit $56
  - RX/TX Transceiver Kit (1W) $74
- Elektor $140
- LP-Pan Panadapter $225
- Winradio WR-G303i $500
- RFSpace SDR-IQ, SDR-14, SDR-IP $500-$2999+
- Flexradio $649-$2,699+
- Perseus $1200
1.8 – 30MHz and 180KHZ to 3 MHz
RX and RXTX
Inexpensive kits - $56 to $74
Requires computer with USB2 and soundcard
- Full capability needs high-end sound card
- 24bit, up to 192KHZ sampling, no channel imbalance
Sensitivity OK for most HF bands (~110-120dBm)
Dynamic range only about 75 to 80db
Strong signal image rejection only about 50db
- Suitable for most amateur SSB and CW
- Dependent upon sound card used (some high-end sound cards ~ 70db)
Software from several sources
- Winrad (several versions)
- SRD-Radio
- PowerSDR
Analog direct conversion suffers from severe image problems:
Quadrature sampling and digital signal processing reduces image by 40 to 70dB, while increasing desired signals by nearly 6dB compared to conventional mixers.
PC sound cards are not designed for the precision required for high performance
- 40dB of image rejection requires 1deg and 0.1 dB match between channels
- 60dB requires 0.1 deg and 0.01db

Sampling bit depth limits dynamic range
- 16bit yields a max of 96dB
- 24bit yield a max of 144dB
- Real word A/D is less than this, typically no more than 130dB – still pretty good
- Actual dynamic range well below modern analog receiver, on order of 75 to 80db

Spurious outputs near 0Hz
- Imbalance between channels also produces false signals at the center of the display band.
- For spectrum display and pan-adapters this is less important
Simple SDR radios like Softrock can be a great addition to an existing radio
- Second receiver
- Panaramic RF spectrum display
- Access to DSP for analog receivers

Requires only a first IF output prior to any roofing filters

Some radios require modification to bring out the IF or translate the IF to <30MHz
Typical setup – Yaesu FT-950

- RF Spectrum & Waterfall
- DSP Audio Processing

FT-950 → IF-2000 Internal IF interface → LP-Pan or Softrock → Computer Display

69.45MHz → 10.55MHz
Conclusions

- SDR has some refinement to go before replacing conventional analog receivers
- RF Spectrum and waterfall displays greatly enhance rapid signal finding
- Current top of the line receivers from ICOM and Yaesu, etc. already incorporate some of the digital processing technologies
- Simple SDR radio can serve as a second receiver or as a QRP transceiver

Experimenting with SDR is lots of fun!
References

- All about Softrocks - www.wb5rvz.com/sdr/ensemble
- All about Softrocks - www.wb5rvz.com