WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 4, April., 2022

SDR, SPECIFICITY AND APPLICATION

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Annotation

The author makes a review of the SDR (Software Defined Radio) technology, including hardware schemes and application fields. A low performance device is presented and several tests are executed with it using free software. With the acquired experience, SDR employment opportunities are identified for low-cost solutions that can solve significant problems. In addition, a list of the most important frameworks related to the technology developed in the last years is offered, recommending the use of three of them.

Keywords: Software Defined Radio (SDR), radiofrequencies receiver, radiofrequencies transmitter, radio development frameworks, superheterodyne receiver, SDR hardware devices, SDR-Sharp, RTLSDR-Scanner.

Introduction

The Software Defined Radio (SDR) is a design paradigm for wireless communications devices. Its creator, Joseph Mitola, defined the term in the early90s as an identifier of a class of radios that could be reprogrammed and reconfigured through software. Mitola envisioned an ideal Software Defined Radio, whose physical components were only an antenna and an Analog Digital Converter (ADC) on the receiver side. Likewise, the transmitter would have a Digital Analog Converter (DAC) and a transmitting antenna. The rest of the functions would be handled by reprogrammable processors.

As the idea conceived in the 90sis still not achievable, and a sit will not be likely for some time, the term SDR is used to describe a viable device that is primarily defined by software, but includes significant hardware components. Even with these components, the SDR receiver is quite different from a traditional receiver.

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Main Part

A traditional or typical receiver, besides the classic demodulation, performs three other operations: (1) carrier frequency tuning to select the desired signal, (2) filter to separate it from others received, and (3) amplification to compensate transmission losses. Moreover, an amplification step is commonly placed before the demodulation block to carry the signal to an acceptable level for the demodulator circuitry.

Most traditional receivers have used conventional heterodyne schemes for almost a century. The superheterodyne internals blocks are shown in Fig. 1. A basic understanding of the structure is necessary to distinguish this conception from the new SDR receiver.

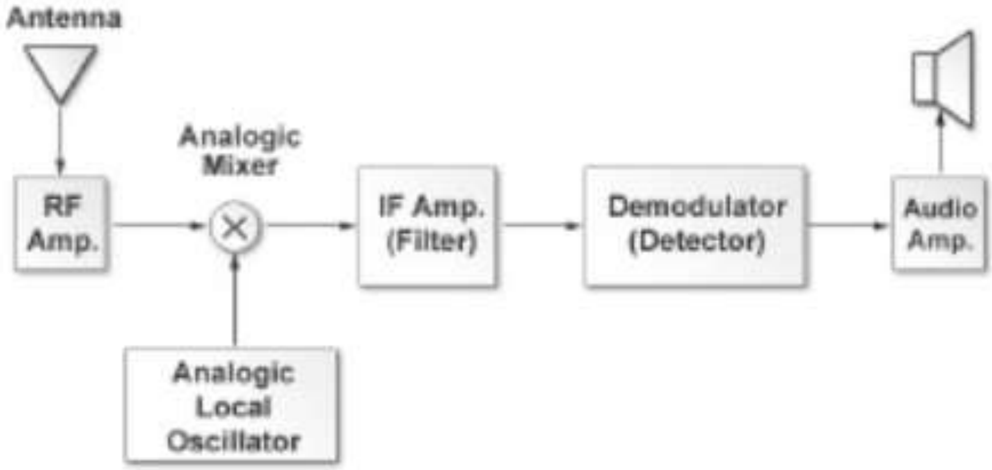

Fig 1. Superheterodyne Receiver`s Internal blocks

In the previous scheme, after the signal enters through the antenna, it is typically amplified by an RF stage that operates only in the frequencies of interest region. Then, the signal is passed to the mixer which receives the local oscillator contribution by its other input. The local oscillator's frequency is set by the radio's tuning control. The mixer is in charge of translating the signal to the Intermediate Frequency (IF).

Typically, the oscillator's frequency is set to a value that ensures that its difference from the desired signal's frequency is equal to the IF. For example, if someone would like to receive a FM station at 100.7MHz and the IF were 10.7MHz, the local oscillator should be placed at 90MHz.The operation is known as downconversion.

The next stage is a bandpass filter that attenuates every signal except a specific portion of the spectrum. The bandwidth of this stage limits the band width of the signal that's being received. Common center frequencies for the IF stage are 455 kHz and 10.7 MHz for commercial AM and FM respectively. Likewise, for commercial FM, the bandwidth is approximately 100 kHz and for AM is above 5 kHz, consistent with the channel spacing that's 200kHz for AM and 10 kHz for FM.

At the end, the demodulator recovers the original modulating signal from the IF amplifier's output employing one of several alternatives. For example, for AM an envelope detector is used, and for FM a frequencies discriminator. Further processing of the signal depends on the purpose for which the receiver is intended. In a common home radio, the demodulated output is passed to an audio amplifier that is connected to a speaker.

SDR Receiver

Fig. 2 shows the block diagram of a SDR receiver. At first, the RF tuner converts the analog signal to IF, performing the same operation that the first three blocks of the superheterodyne receiver. Up to this point the two schemes converge .

Next, the IF signal is passed to the ADC converter in charge of changing the signal's domain, offering digital samples at its output. The samples are feed to the following stage's input which is a Digital Down Converter (DDC). The DDC is commonly a monolithic chip and it stands as the key part of the SDR system. It consists of three main components: (1) a digital mixer, (2) a digital local oscillator, and (3) a Finite Impulse Response (FIR) low-pass filter.

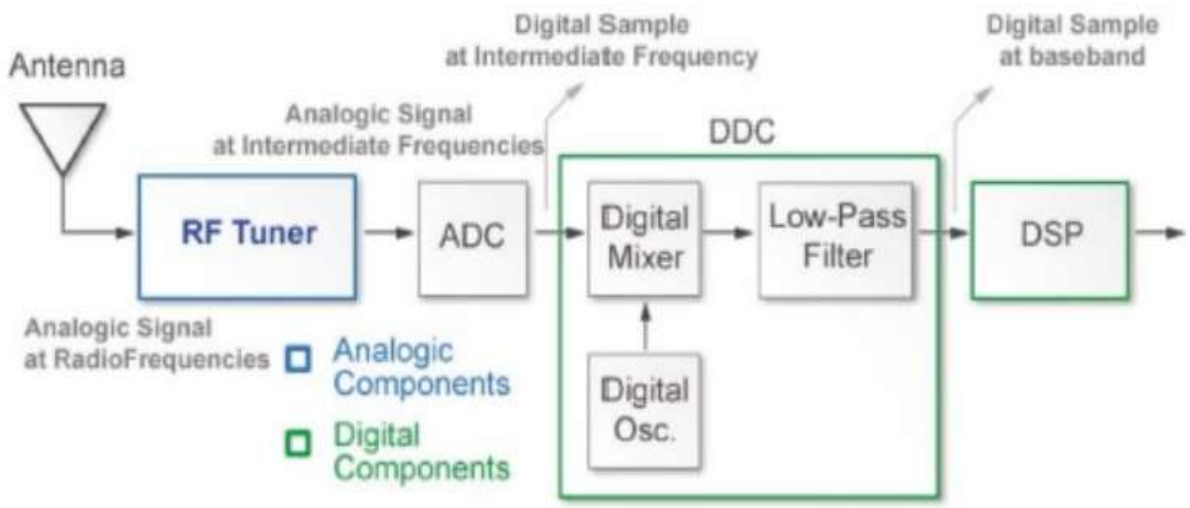

Fig 2. Block diagram of the SDR receiver

The components operation is similar to their analog counterparts. The digital mixer and the local oscillator shift the IF digital samples to baseband, while the FIR low-pass filter limits the bandwidth of the final signal. For the implementation of each of its parts, the DDC includes a high number of multipliers, adders and shift registers.

Observe that the signals are transferred to their baseband equivalent at the digital mixer's output by the disintegration into the I and Q counter phase components. If the tuning of the digital local oscillator is modified, the desired signal can be shifted away or towards the point where it reaches 0Hz. This variation, together with the bandwidth adjustment of the low-pass filter, defines which part of the reception is treated as a useful signal.

SDR Software

While the hardware components are essentials in the SDR conception, the definition of the paradigm it-self points out the necessity of complementary dedicated software. In this section, a description of the main software tools that allows the SDR signal manipulation is offered.

Fig 3. RTL2831 SDR Device

Conclusion

SDR technology has many applications in radio environments and is becoming increasingly popular among all type of users. While the first projects were unstable, there are currently a lot of frameworks that allow the manipulation of radio signals only with a personal computer and an inexpensive SDR device such as the Teratec RTL2831U. The applications are multiple. Besides providing a very cheap radio receiver, SDR devices can be combined with free software to facilitate examination of the spectrum, detection of interferences, assigning of frequency distributions in an efficient manner, testing repeater systems' operation and measuring their electrical parameters, identifying spectrum intruders and characterization of noise by bands and regions of the world.

In addition, SDR versatility envisions its possible application in the improvement of shortwave communications. Similarly, the continued growth of the SDR with worldwide available receiving points announces the formation, in a not too distant future, of a vast network through which it will be possible to listen to radio broadcast on any part of the world by using Internet.

ISSN: 2776-0979, Volume 3, Issue 4, April., 2022

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