Amplitude Modulated Audio File Transmission using GNURadio and USRP B200

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CONTENTS

Software Defined Radio

In SDR there are certain stages in receiving and transmission chain where signal is digitized and using software techniques computation is done on digital radio signal. The main aim of this SDR is to convert almost all hardware system problem into digital domain problems so it can be easily modified and problems can be solved easily.

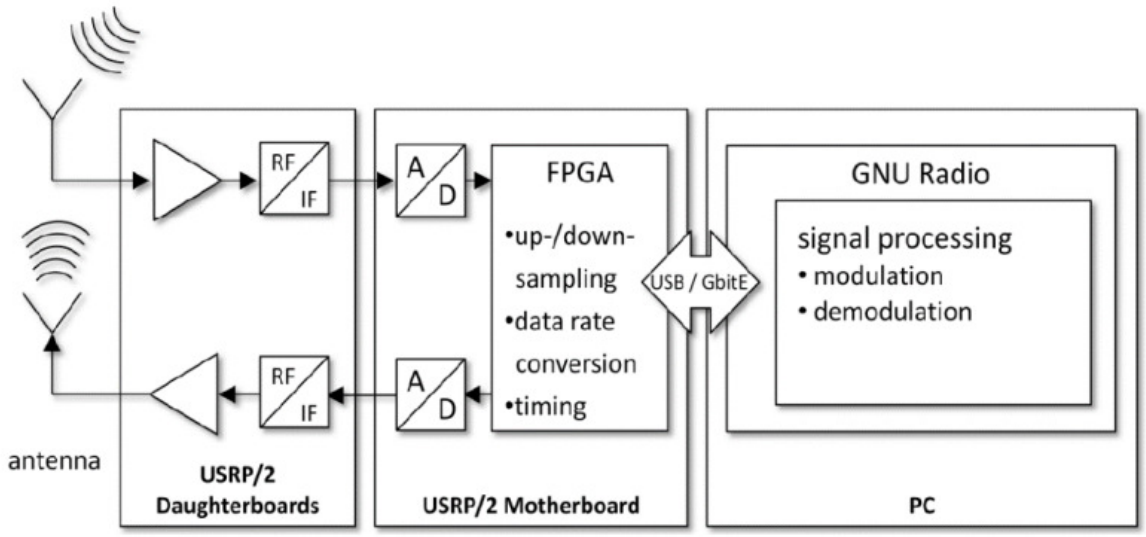


Figure1: Software Defined Radio Block Diagram

Universal Software Radio Peripheral (USRP)

Universal Software Radio Peripheral (USRP) is a software defined radio. The USRP product family is intended to be a comparatively inexpensive hardware platform for software radio. USRP connect to a host computer through a high-speed link, which the host-based software uses to control the USRP hardware and transmit/receive data.

Practical Implementation using AM Modulation/Demodulation Scheme

Sampling: Sampling in GNURadio has varied significance. The hardware level sampling of an audio signal and the sampling rate between various systems are some examples. Audio files are essentially digitally sampled data of an analog audio signal with sampling rate satisfying Nyquist criteria (sampling rate greater than twice bandwidth of audio signal). When multiple hardware is used in the system, we have to think of the sampling rate as a matching problem when resampling. When meeting data streams between any hardware systems, we have to make sure that all resampling done leads to the same sampling rate when they meet.

Rational Resampler: This block is used to convert one sample rate to another as long as they can be related by a ratio. It is to be noted that all blocks following this block in the flowgraph should expect the output sample rate. It specifies the data type of the input and output streams. For complex streams it also specifies the type of filter that can be applied.

Throttle: It is a block that limits the data throughput to the specified sampling rate. This prevents GNURadio from consuming all CPU resources when the flowgraph is not being regulated by external hardware and essentially is used to minimize computational power.

Amplitude Modulation: It is an analog modulation technique where a message signal is superimposed on a high frequency carrier wave (with frequency relatively greater than bandwidth of audio signal). In amplitude modulation, the amplitude (signal strength) of the carrier wave is varied in proportion to that of the message signal being transmitted.

Amplitude Demodulation: It is the demodulation technique to extract the message signal, digital audio file in this case, from the amplitude modulated signal. Various techniques have been suggested for this purpose, including coherent detection and envelope detection (using RC filtering circuits).

In this report we have used generalized amplitude modulation scheme to generate amplitude modulated signal from digital audio file and a high frequency carrier wave, as shown in the following block representation. The signal was sent over the USRP antenna. After receiving the AM signal it was processed using an amplitude demodulator (designed as shown in the following block representation) to extract the resampled audio file.

FLOW GRAPHS

Transmitter Block Representation

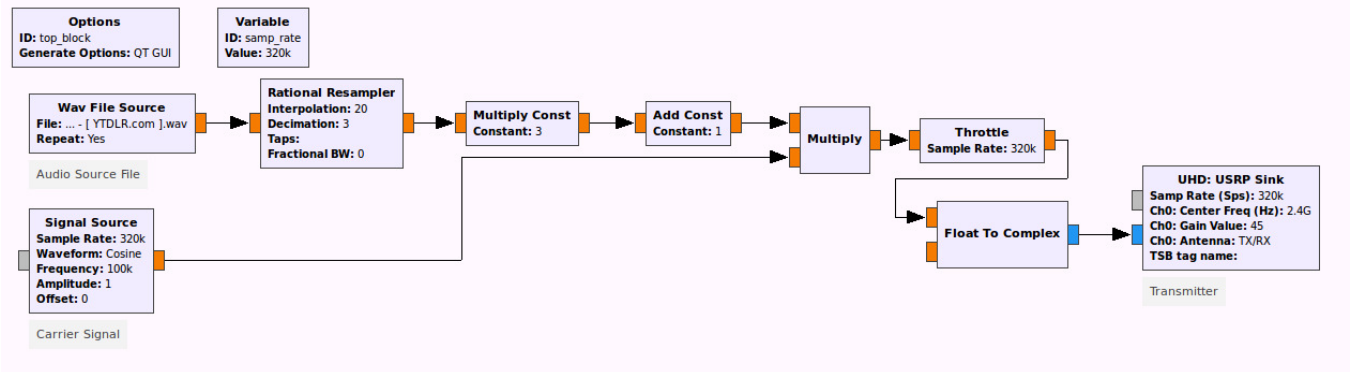


Figure2: Flow Graph of AM Modulation

Receiver Block Representation

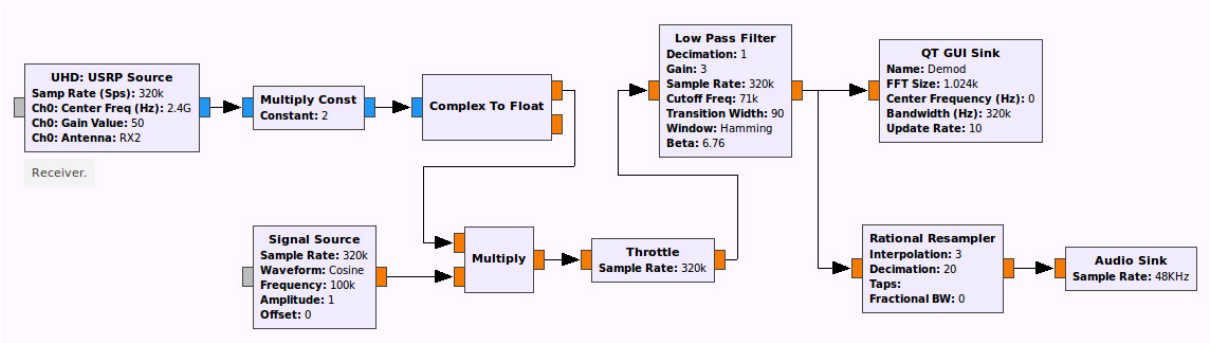
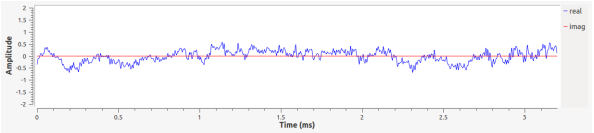


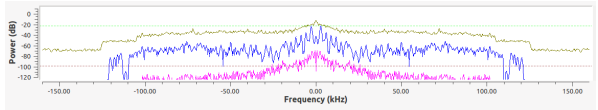
Figure3: Flow Graph of AM Demodulation

Wave Form of Signals

Message Signal

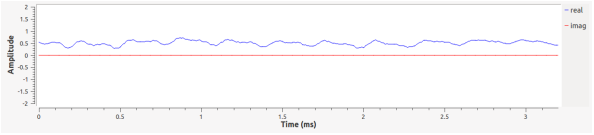


Time Domain



Frequency Domain

Modulated Signal



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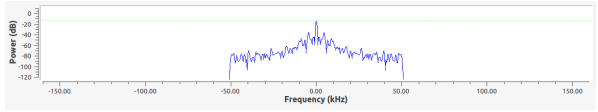
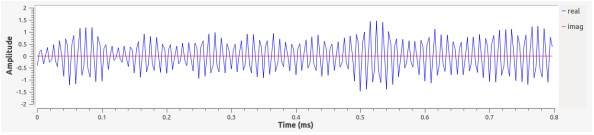


Frequency Domain

Demodulated Signal



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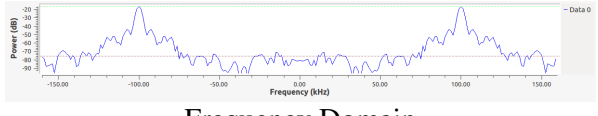

Frequency Domain