System Block Diagram for Software Defined Radio

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Overview

A software defined radio is a radio transmitter/receiver that uses digital signal processing (DSP) for coding/decoding and modulation/demodulation. This allows much more power and flexibility when choosing and designing modulation and coding techniques. The C6700 series of digital signal processors have been chosen for this project. More specifically the TMDSK6713 evaluation board with the TMS320C6713 DSP chip will be used.

Due to hardware availability, both the transmitter and receiver will be implemented on the same DSP evaluation board. The system will be constructed and programmed entirely in Simulink using the embedded target TI C6000 Simulink library. Simulink will generate the code based off of the model designed and will then download it to the board through TI Code Composer Studio for testing.

Overall System Block Diagram

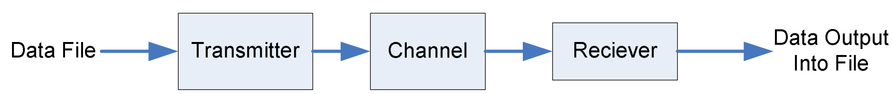

Figure 1: System Breakdown of a Software Radio

The input to the system will be digital data in a computer file. This data will be modulated by the transmitter and sent to the channel. The channel will cause interference to the signal in the form of attenuation, phase delay, and noise. At the receiver side, the signal will be demodulated and reconstructed to produce the original transmitted message.

Transmitter

The transmitter shown in Figure 2 will generate the signal that will be transmitted through the channel. Demultiplexing, quadrature amplitude modulation (QAM) and orthogonal frequency division multiplexing (OFDM), and up mixing work together to create the transmitter signal output.

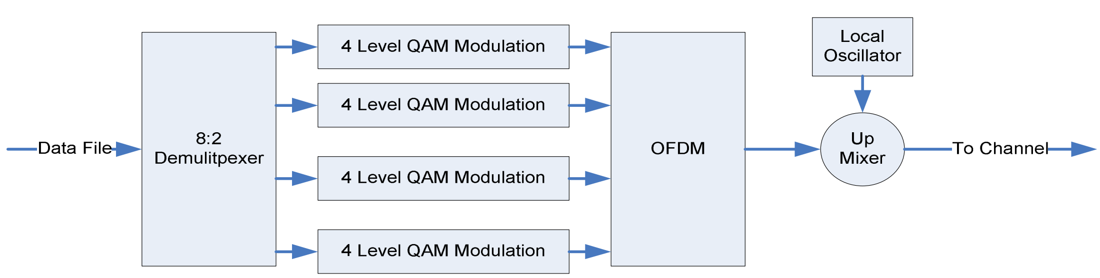

Figure 2: Transmitter Subsystem Detailed Diagram

Demultiplexing & Modulation

The demultiplexing block will take 8 bits of binary data and then break the 8-bit stream into four 2-bit streams. These 2-bit streams will each be fed into a QAM modulation channel. Once the QAM channels have modulated the input data, they will be passed into the OFDM block. The OFDM system will multiplex the QAM signals together to produce the final modulated output.

Up Mixer

Mixing is done to meet the bandwidth requirements of the channel. The up mixer will increase the frequency of the OFDM signal by multiplying it by a greater carrier frequency. The OFDM signal will be imbedded in the carrier signal that the local oscillator produces. The output of the mixer will be in bandwidth of the channel.

Channel

Figure 3 shows the detail of the channel block from figure 1. The channel block will implement a model of an actual transmission channel. Different parts of the channel will model different channel effects on the output of the transmitter. These are channel gain, multi-path interference, and noise.

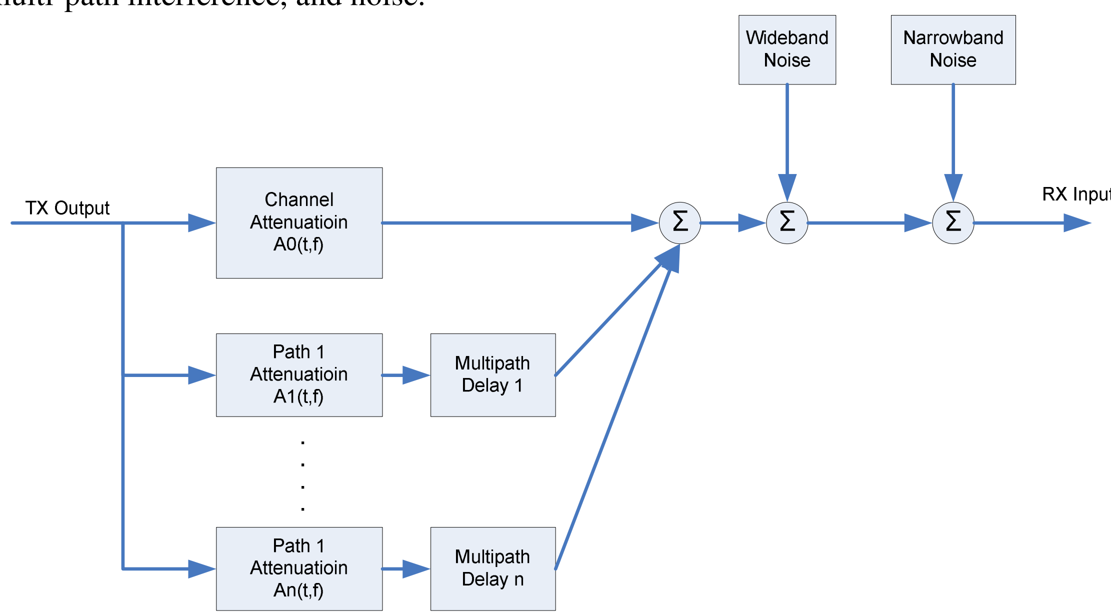

Figure 3 - Detail of Channel

Channel Attenuation

The channel attenuation will model the attenuation or possibly the gain effect that the channel will have on the transmitted signal. It this gain can vary with frequency and/or time.

Multi-path interference

The multi-path interference will model reflections of the transmitted signal. These reflections will arrive at the receiver at different times. Each one of these paths can have its own attenuation that can vary with time and frequency.

Noise

Noise will also be introduced into the signal. This noise is either specific to a limited frequency range (narrow band noise) or affects the whole spectrum of the transmitted signal.

Receiver

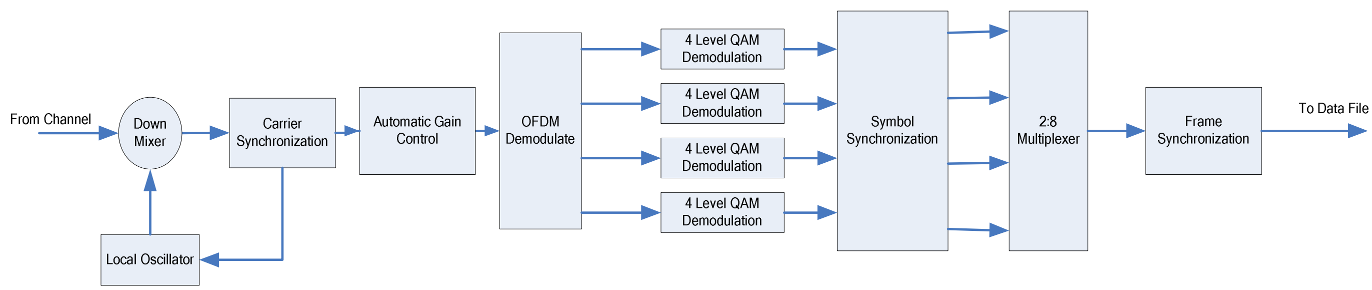

Figure 4 – Receiver Subsystem Detail

The receiver subsystem shown in figure 4 will recover the sent message. To do this it needs to extract the carrier, symbol, and frame timing from the signal. It then will use this information to extract the message from the phase, frequency, and amplitude noise of the channel. The receiver has the following main parts: carrier synchronization, automatic gain control, demodulation, symbol synchronization, and frame synchronization.

Carrier synchronization

The carrier synchronization subsystem will correct for frequency differences between the transmitter and the receiver. It will also correct for the phase delay introduced by the channel. It will do this using a phased locked loop (PLL) technique.

Automatic Gain Control

The automatic gain control system will correct for the time varying differences in channel attenuation. It will do this by adjusting the average power of the input signal to a known value.

Demodulation

The demodulation system consists of two parts: OFDM demodulation and QAM demodulation. The OFDM demodulation will demodulate the signal into its constituent QAM sub signals. The QAM demodulation will demodulate the QAM carriers back into the pulses that were used to modulate it.

Symbol Synchronization
The symbol synchronization will figure out the most appropriate time to sample the pulses coming from the QAM modulation. This will allow the most accurate information to be extracted from the pulse stream. The output of this block will then be fed into a multiplexer. The output of the multiplexer will be the digital data that was fed into the system to begin with.

Frame Synchronization
The frame synchronization will synchronize the data frames of the system. This will align the start time of the message so that the digital data can be interpreted correctly. This will allow the compute file or message to be translated back into its original form.