Complete System Level Block Diagram

Design and Implementation of Orthogonal Frequency Division Multiplexing (OFDM) Signaling

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This project consists of MATLAB simulation and DSP implementation. Using a graphical DSP design tool such as System View or dSpace, a real time OFDM transmitter will be built. Figure 1 shows the flowchart of the MATLAB simulation code.
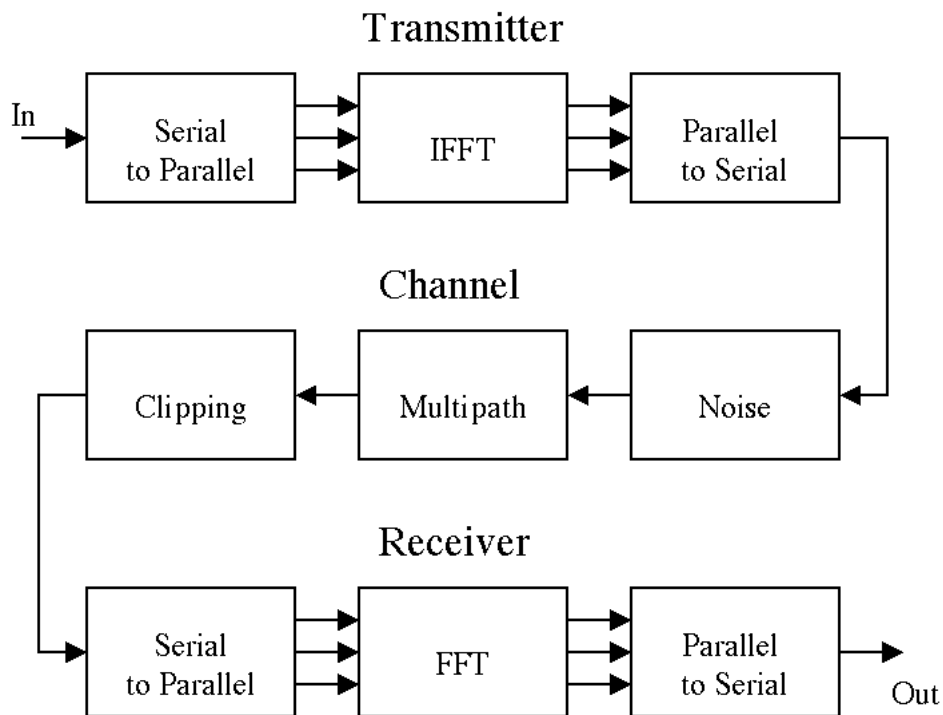

Figure 1: OFDM Simulation Flowchart

The transmitter first converts the input data from a serial stream to parallel sets. Each set of data contains one symbol, S_i, for each subcarrier. For example, a set of four data would be $[S_0\ S_1\ S_2\ S_3]$.

Before performing the Inverse Fast Fourier Transform (IFFT), this example data set is arranged on the horizontal axis in the frequency domain as shown in Figure 2. This symmetrical arrangement about the vertical axis is necessary for using the IFFT to manipulate this data.
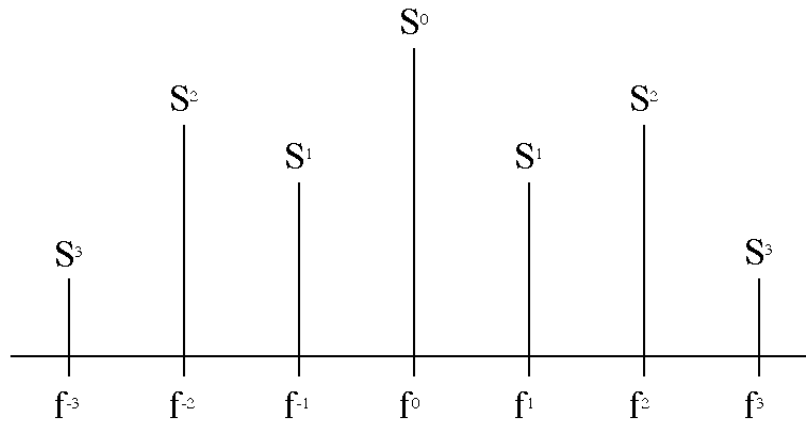
Figure 2: Frequency Domain Distribution of Symbols

An inverse Fourier transform converts the frequency domain data set into samples of the corresponding time domain representation of this data. Specifically, the IFFT is useful for OFDM because it generates samples of a waveform with orthogonal frequency components.

Then, the parallel to serial block creates the OFDM signal by sequentially outputting the time domain samples.

The channel simulation will allow examination of the effects of noise, multipath, and clipping. By adding random data to the transmitted signal, simple noise can be simulated. Multipath simulation involves adding attenuated and delayed copies of the transmitted signal to the original. This simulates the problem in wireless communication when the signal propagates on many paths. For example, a receiver may see a signal via a direct path as well as a path that bounces off a building. Finally, clipping simulates the problem of amplifier saturation. This addresses a practical implementation problem in OFDM where the peak to average power ratio is high.

The receiver performs the inverse of the transmitter. First, the OFDM data are split from a serial stream into parallel sets. The Fast Fourier Transform (FFT) converts the time domain samples back into a frequency domain representation. The magnitudes of the frequency components correspond to the original data. Finally, the parallel to serial block converts this parallel data into a serial stream to recover the original input data.