DESIGN AND IMPLEMENTATION OF BPSK AND QPSK MODULATORS ON FPGA

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ABSTRACT—As we know, modulator is one of the important block in SDR implementation. This paper presents the PSK modulators (BPSK and QPSK) implementation on FPGA. Both modulators are designed in MATLAB simulink using system generator blocksets. The generated VHDL code is then implemented on Virtex 5 FPGA development board. The generated waveforms are observed using Xilinx ChipScope Pro Analyzer Tool.

KEYWORDS—BPSK, QPSK, FPGA etc

INTRODUCTION

A Software Defined Radio (SDR), is a system in which many typical communication blocks that have been implemented on hardware, are instead implemented in software. These blocks includes mixer, filters amplifiers, modulators, demodulators etc [1].

Modulation is the process of varying one or more properties of carrier signal with a modulating signal that contains the information to be transmitted[3]. Modulation process converts a baseband signal into a bandpass signal compatible with available transmission facilities. At the receiver end, demodulation must be accomplished to recognize the signals [3].

This paper describes the BPSK (Binary Phase Shift Keying) and QPSK (Qurdrature Phase Shift Keying) modulators design in MATLAB simulink environment. Then, these modulators are designed using Xilinx System Generator block sets and then implemented individually on Virtex-5 FPGA development board to analyze the generated waveforms.

PSK MODULATORS

The modulators which transmit the information signal by changing the phase of carrier signal are known as PSK modulators. The PSK modulators includes BPSK, QPSK, 8-PSK etc. In this paper, BPSK and QPSK modulators are considered.
A. BPSK
In BPSK, two phases are used. The carrier signal changes its phase by 180° when modulating signal changes its bit from 0 to 1 and vice-versa. Fig. 1 shows the BPSK modulator.

![Fig.1: BPSK Modulator](image)

In this, the carrier signal and modulating signal is given to the multiplier. The output of multiplier gives BPSK signal. The fig.2 shows BPSK waveforms.

![Fig.2: BPSK waveforms](image)

B. QPSK
The QPSK is also known as 4-PSK. In QPSK, two bits are transmitted per symbol. The carrier signal changes its phase by 45° for each symbol transmission. Fig.3 shows QPSK modulator.

In this, the incoming bit is divided into two components, even bits and odd bits. These two components are individually encoded and multiplied with cosine and sine carrier wave respectively. At the end, the output of both multipliers are added which gives QPSK signal.

![Fig.3: QPSK Modulator](image)
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PSK MODULATORS IN SYSTEM GENERATOR

A. BPSK

Fig.9 shows design of BPSK modulator using system generator tool in MATLAB simulink. The system generator block sets contain: gateway in blocks, and gateway out blocks to connect the system generator blocks with MATLAB blocks, mux blocks, LFSR block to generate modulating signal. DDS block is used to generate sine and inverted sine wave. Fig. 10 shows simulation waveforms generated by system generator block sets.
Fig. 9: BPSK modulator using system generator blocksets  

Fig. 10: Simulation waveforms

B. QPSK

The QPSK design contains gateway in blocks, mux blocks, gateway out blocks, LFSR block and two DDS compiler blocks. DDS compiler block is a direct digital synthesizer and it uses a lookup table scheme to generate sine and inverted sine waveform. TDM block divides the modulating signal into odd sequence I and even sequence Q. Fig. 11 and 12 shows QPSK model and simulation waveforms of QPSK modulator generated using system generator blocksets.

![QPSK Block Diagram](image)

Fig.11: QPSK modulator using system generator blocksets

![Simulation Waveforms](image)

Fig.12: Simulation waveforms

**EXPERIMENTAL RESULTS**

After simulating the designs using system generator blocks, the generated VHDL code is then implemented on Virtex 5 FPGA board and the waveforms are observed in Xilinx ChipScope Pro Analyzer tool. Figure 13 and 14 shows the observed waveforms of BPSK and QPSK modulator in ChipScope pro Analyzer Tool respectively.
CONCLUSION AND FUTURE SCOPE

In this paper, the BPSK and QPSK modulators are simulated in MATLAB simulink environment. The same modulators are implemented on Virtex 5 FPGA development board and the generated waveforms are observed using Xilinx chipScope pro analyzer tool. In future, we can implement both modulators simultaneously on FPGA to reduce resource utilization.

REFERENCES


