ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

Implementation of Digital Communication Laboratory on FPGA

MOLABANTI PRAVEEN KUMAR[1], T.S.R KRISHNA PRASAD[2], M .VIJAYA KUMAR[3]

M.Tech Student, ECE Department, Gudlavalleru Engineering College, Gudlavalleru[1]

Associate Professor[2], ECE Department, Gudlavalleru Engineering College, Gudlavalleru[2]

Assistant Professor[3], ECE Department, Gudlavalleru Engineering College, Gudlavalleru[3]

Abstract: This paper presents a method to describe all modulation techniques (like: BPSK, ASK, FSK, QPSK, QAM) on Field Programmable Gate Array (FPGA) development board which is widely available and inexpensive. To develop the system blocks Simulink environment and system generator version 13.1 are used under MATLAB version 7.11 (R2010B). To achieve simulation and synthesis of Spartan 3 FPGA tools from Xilinx ISE 13.1 are used. Very High Speed integrated circuit hardware description language (VHDL) is used for describing the hardware in system understanding language. Digital to Analog converter is used to interface both FPGA and CRO which is used to visualize the analog output of the digitally modulated signal.

Keywords: Amplitude Shift Keying (ASK),Binary Phase Shift Keying (BPSK),Frequency Shift Keying (FSK), Quadrature Phase Shift Keying (QPSK), Digital Communication, Field Programmable Gate Array (FPGA), Receivers, Transmitters.

I.INTRODUCTION

The main objective of the paper is to implement all the modulation techniques that are being used in digital communication, all the modulation techniques are Contained in a single configuration file that is loaded into the Field Programmable Gate Array (FPGA), no FPGA reconfiguration is necessary in order to change the modulation, but rather than only a user command. In the existing system [1], the Binary phase shift keying (BPSK) modulation technique is only discussed. In the proposed system we can include all possible modulation techniques along with BPSK. The developed FPGA board can also be used in courses for digital design, computer architecture and embedded system, the flash memories on the board are loaded with data for use in channel emulation, and the proposed laboratory can be implemented on Xilinx families of FPGA, like Spartan 3, FPGA's. Compared with the software simulation tool such a LABVIEW, which is quite expensive, the hardware implementation of communication laboratory is very less expensive.

II.IMPLEMENTATION

*A.*Binary Phase Shift Keying (BPSK)

Binary Phase Shift Keying (BPSK) [1], [4], [6], [7] demonstrates better performance than ASK and FSK. PSK can be expanded to M-array scheme, employing multiple phases and Amplitudes as different states. Filtering can be employed to avoid spectral spreading.

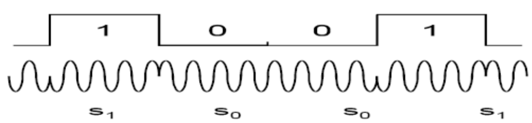


Fig. 1. BPSK modulation.

If the received data is logic 1, then the modulated signal has no phase shift, if the received data is logic 0, then the modulated signal has 180^0 phase shift as shown in figure 1[1], [6].

1. Simulink block diagram for BPSK using system generator

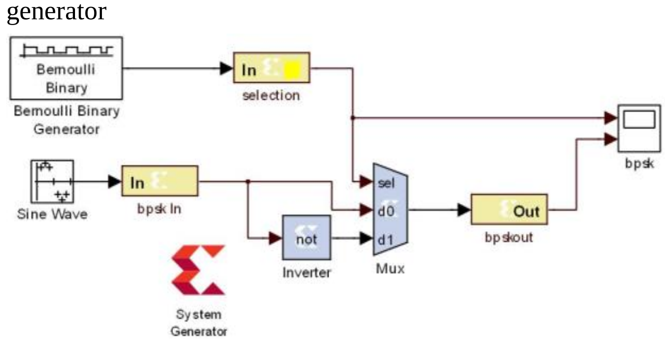


Fig. 2. BPSK modulator in the system generator.

In the Simulink/system generator environment, we have to configure each block with their corresponding parameters to get the accurate output as shown in figure 3 [1], [4].

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

2. **Scope result for BPSK**

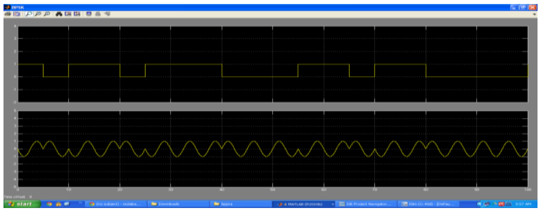


Fig. 3. The wave forms on the scope.

B. Amplitude Shift Keying(ASK)

Amplitude Shift Keying – ASK [2], [6] in the context of digital communications is a modulation process which imparts to a sinusoidal two or more discrete amplitude levels 1. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. Thus the modulated waveform consists of bursts of a sinusoidal signal [2], [6].Figure 4 illustrates an ASK signal (lower), together with the binary sequence which initiated it (upper).

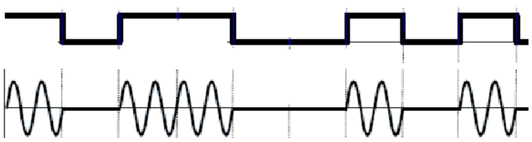


Fig. 4. An ASK modulation and the data.

If the received data is logic 1, then the modulated signal appears to be as carrier itself else if the received data is logic 0, then no signal will be there in its corresponding time period as shown in figure 6.

1. Simulink block diagram for ASK using system generator

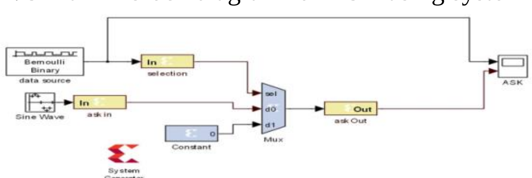


Fig. 5. ASK modulator in the system generator.

In the Simulink/system generator environment, we have to configure each block with their corresponding parameters to get the accurate output as shown in figure 5 [2], [6].

2. Scope result for ASK

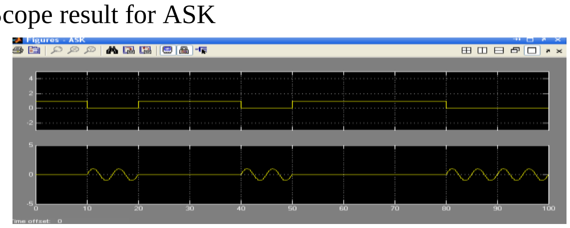


Fig. 6. The wave forms on the scope.

C. Frequency Shift Keying (FSK)

Frequency Shift Keying (FSK) [2], [5] carries the information signal by representing the transmitter alphabet with M symbols using carriers with M discrete frequencies. In general it is called M-array FSK. When M is 2 then it is called Binary-FSK with two carriers usually termed as the mark and space frequencies. The descriptive waveform example for Binary-FSK is given in the figure 7.

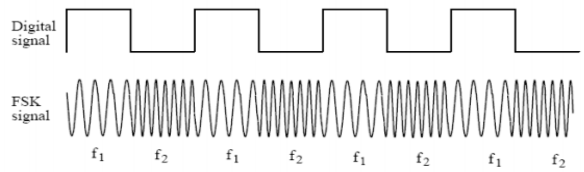


Fig. 7. FSK modulation.

In FSK, two carriers f1, f2 are used whose frequencies will differentiate between logic 1 and logic 0 as shown in figure 7. Single carrier can also be used for optimized system.

1. Simulink block diagram for FSK using system generator

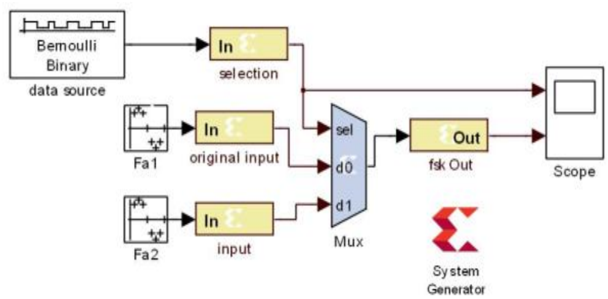


Fig. 8. FSK modulator in the system generator

In the Simulink/system generator environment, we have to configure each block with their corresponding parameters to get the accurate output as shown in figure 8 [13], [4].

2. Scope result for FSK

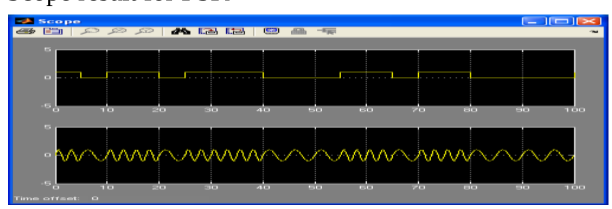


Fig. 9. The wave forms on the scope.

D. QPSK (Quadrature Phase Shift Keying**)**

Quadrature means the signal shifts among phase states that are separated by 90 degrees, The signal shifts in increments of 90 degrees from 45° to 135°, -45° (315°), or -135° (225°)

1. QPSK Constellation

Data transmitted	Carrier phase	Carrier amplitude
00	225^o	1.0
01	135^o	1.0
10	315^o	1.0
11	45^o	1.0

Table 1. QPSK phases.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

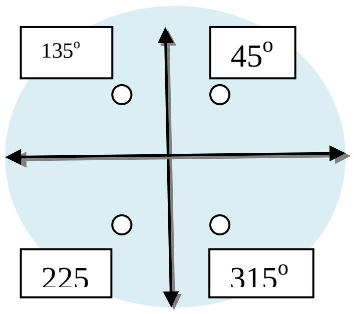


Fig. 10. QPSK constellation.

2. Simulink block diagram for QPSK using system generator

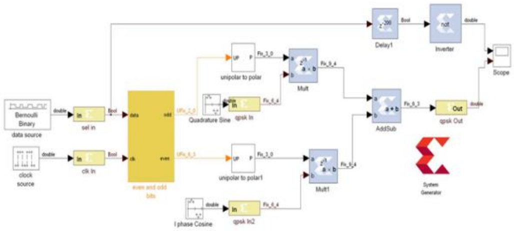


Fig. 11. QPSK Modulator in the system generator.

To get the accurate output as shown in figure 12, the parameters for each block must be configured precisely in the Simulink/system generator environment [2], [5].

3. Scope result for Quadrature Phase Shift-Keying-(QPSK)

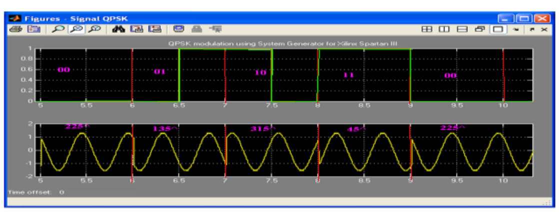


Fig. 12. The wave forms on the scope.

E.Control unit

In control unit , for controlling given data, the multiplexer is Used, if the given data is shown in table 2[3].

S. N	Action	BPSK	ASK	FSK	QPSK
1	Control bit	00	01	10	11
2	Information	180,0 phase	No change amp ,zero amp	Carries f_1,f_2	225,135, 315,45 phase
3	Parameter	Phase	Amplitude	Frequency	Quadrature phase
4	Carrier	one	One	two	Two

Table 2. Control Unit.

1.Simulink blockdiagram for control unit

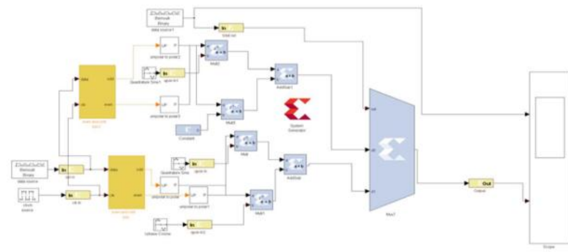


Fig. 13. Control unit in the system generator.

To get the accurate output as shown in figure 13, the parameters for each block must be configured precisely in the Simulink/system generator environment [3], [5].

2.scope result for control unit

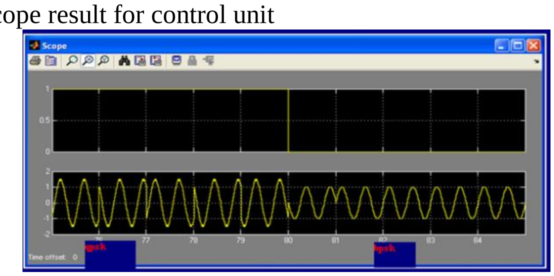
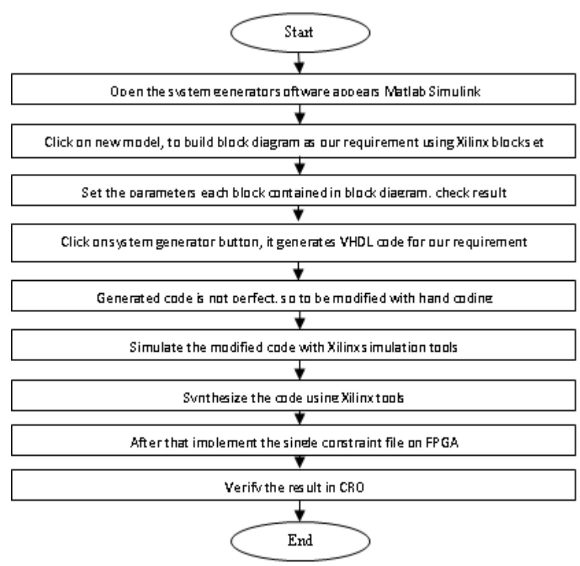


Fig. 14. The wave forms on the scope.

III. Design Flow



IV. SOFTWAREAND HARDWARE

A. Software

This project uses MATLAB/ Simulink environment particularly Simulink library to connect all the blocks to generate different modulations. Control unit in that simulation library selects different modulations according to data bits we have given.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

System generator tools [13] converts corresponding block diagram into VHDL code.
The ISE system edition [9] from Xilinx is a front-end FPGA design solution that offers HDL synthesis and simulation, implementation and used for interfacing programs, user constraint files.

B. Hardware

The complete lab measurement setup used for realizing all kind of modulators is illustrated in figures 15, 16. Some of the resources use there: Spartan 3 starter kit board [8], [10], Digital to Analog converter (NIFCO7A) with PQ28 package, Function generator, Regulated power supply from Aligent and Cathode Ray Oscilloscope.

C. Complete setup

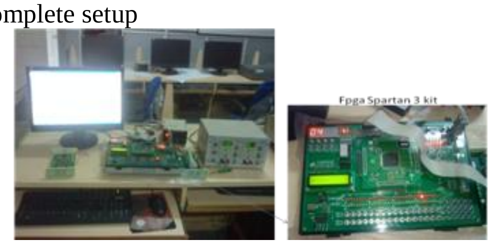


Fig. 15. Complete Setup.

In the complete setup shows the inter connections between personal computer, Field programmable gate array, cathode ray oscilloscope and regulated power supply.

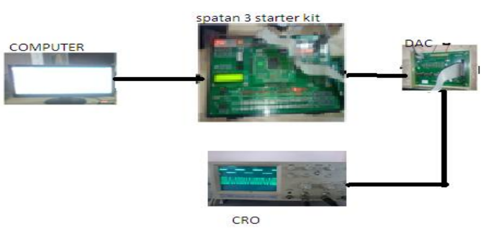
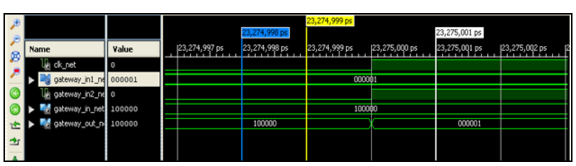


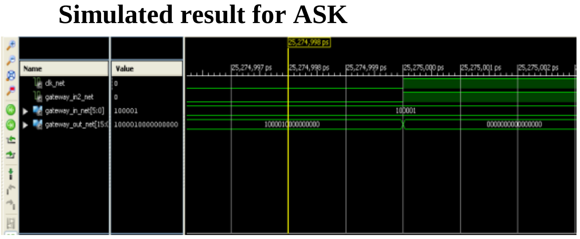
Fig. 16. The setup with Spartan 3 starter kit.

V. RESULT ANALYSIS

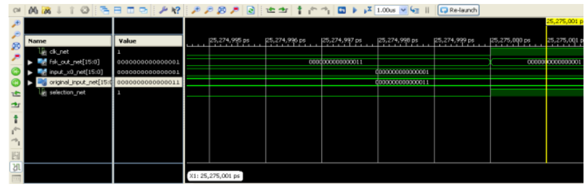
1. Simulated result for BPSK



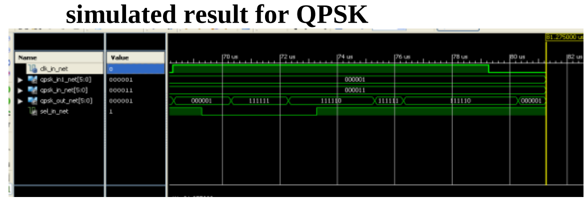
2. Simulated result for ASK



3. Simulated result for FSK



4. simulated result for QPSK



VI.CONCLUSION

The work can be conclude that the implemented four types of modulators in the Simulink environment, like BPSK, QPSK, ASK, FSK using system generator on FPGA. The will be like to extend my current work by implementing all modulation techniques thus whole digital laboratory can be done on a single kit.

REFERENCES

[1] Thotamesetty m Prasad, syed jahingir,"Simulation and implementation of a BPSK modulator on FPGA", ICECE- 16th September 2012.
[2] F.Xiong, "Digital Modulation Techniques", *Artech House*, UK, 2010.
[3] Swapan k samaddar, Atri sanyal,"FPGA based generalized architecture for Modulation and Demodulation techniques", JCT journals, August 2012.
[4] Popescu, S. O.; Gontean, A.-S.; Budura, G., "Simulation and implementation of a BPSK modulator on FPGA," Applied Computational Intelligence and Informatics (SACI), 2011 6th IEEE International Symposium on, vol., no., pp.459, 463, 19-21 May 2011.
[5] Linn, Y., "An Ultra Low Cost Wireless Communications Laboratory for Education and Research," Education, IEEE Transactions on, vol.55, no.2, pp.169, 179, May 2012
[6] Lopez-Villegas, J.M.; Macias-Montero, J.G.; Osorio, J.A.; Cabanillas, J.; Vidal, N.; Samitier, J., "BPSK to ASK signal conversion using injection-locked oscillators-part II: experiment," Microwave Theory and Techniques, IEEE Transactions on , vol.54, no.1, pp.226,234, Jan. 2006".
[7] Kikkert, C.J.; Blackburn, C., "Demodulating binary phase shift keyed signals using programmable logic devices," Signal Processing and Its Applications, 1999. ISSPA '99. Proceedings of the Fifth International Symposium on, vol.2, no., pp.689, 692, vol.2, 1999
[8] Spartan 3 FPGA Starter Kit board. User guide. *Xilinx*. 2011.
[9] ISE 13.1 Quick Start Tutorial, Xilinx, 2010.
[10] Spartan-3 FPGA Family Data Sheet. *Xilinx* . 2010.
[11] S.T.Karris, "Introduction to Simulink with Engineering Applications" Orchard *Publications*, USA, 2006.
[12]http://www.ece.unm.edu/xup/docs/collaboration/BPSK_Mo-dulator.pdf
[13] System Generator for DSP. Getting Started Guide. *Xilinx*. 2010.
[14]Banerjee, P.; Haldar, M.;Nayak, D.; Anderson, R.; Uribe, J.R., "Overview of a compiler for synthesizing MATLAB programs onto FPGAs," Very Large Scale Integration (VLSI) Systems, IEEE Transactions on , vol.12, no.3, pp.312,324, March 2004.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

BIOGRAPHIES

M.Praveen Kumar has completed B.Tech (ECE) in 2011 and is pursuing M.Tech (ES) in Gudlavalleru Engineering College, AP, INDIA

S.Rama Krishna Prasad.T is working as Associate Professor in Gudlavalleru Engineering College, AP. So far he has 11 years of teaching experience and published 2 IJ paper and 4 IC papers and 3 NC papers

Vijaya Kumar Munagala is working as Assistant Professor in Gudlavalleru Engineering College, AP. So far he has 2 years of teaching experience and published 0 IJ paper and 1 IC papers and 1 NC papers