Implementation of Digital modulation schemes using FPGA

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Abstract- *The choice of digital modulation scheme will significantly affect the characteristics, performance and resulting physical realization of a communication system. There is no universal 'best' choice of scheme, but depending on the physical characteristics of the channel, required levels of performance and target hardware trade-offs, some will prove a better fit than others. Consideration must be given to the required data rate, acceptable level of latency, available bandwidth, anticipated link budget and target hardware cost, size and current consumption. The physical characteristics of the channel, will typically significantly affect the choice of optimum system.*

There must be some review, study of the key characteristics and salient features of the main digital modulation schemes used, including consideration of the receiver and transmitter requirements. Simulation is used to compare the performance and trade-offs of popular systems such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK). VLSI simulation of digital modulation scheme is considered with its implementation.

Keywords- Digital modulation, ASK, FSK, PSK, FPGA.

I. INTRODUCTION

Wireless engineering is an emerging field, which has seen an enormous growth in the last several years. New systems and standard are on the horizon which will enable broadband wireless communication in the office, at home, and "on move". In near future, a complete convergence of mobile phone technology, computing. Internet access and potentially much multimedia application such as video and high quality audio will be seen. The choice of digital modulation schemes will significantly affect the characteristics, performance and resulting physical realization of a communication system. There is no universal "best" choice of scheme, but depending on physical characteristics of the channel, required level of the performance and target hardware trade-offs, some will prove a better fit than other. Consideration must be given to the required data rate, acceptable level of latency, available bandwidth, anticipated link budget and target hardware cost, size and current consumption. The physical characteristics of the channel be it hardwired without the associated problems of fading, or a mobile communication system to racing car with fast changing multipath, will typically affect the choice of optimum system.

There must be some review, study of the key characteristics and silent features of the main digital modulation schemes used, including consideration of the receiver and transmitter requirements. Simulation is used to compare the performance and trade-offs of popular systems such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying(PSK).

II. LITERATURE SURVEY

It's Digital modulation schemes transform digital signals like the one shown below into waveforms that are compatible with the nature of the communication channel. There are two major categories of digital modulation. One category uses a constant amplitude carrier and the other carries the information in phase or frequency variations (FSK, PSK). The other category conveys the information in carrier amplitude variations and is known as amplitude shift keying (ASK).

The past few years has seen a major transition from the single amplitude modulation (AM) and frequency modulation (FM) to digital techniques such as Quadrate Plate Shift Keying (QPSK), Frequency Shift Keying (FSK), Minimum Shift Keying (MSK) and Quadrate Amplitude Modulation (QAM). For designers of digital terrestrial microwave radios, their highest priority is good bandwidth efficiency with low bit-error-rate. They have plenty of power available and are not concerned with power efficiency. They are no especially concerned with receiver cost or complexity because they do not have to build large numbers of them.

On the other hand, designers of hand-held cellular phones put a high priority on power efficiency because these phones need to run on a battery. Cost is also a high priority because cellular phones must be low-cost to encourage more users. Accordingly, these systems sacrifice some bandwidth efficiency to get power and cost-efficiency. Every time one of these efficiency parameters (bandwidth, power or cost) is increased, another one decreases, or becomes more complex or does not perform well in poor environment.

Cost is a dominant system priority. Low-cost radios will always be in demand. In the past, it was possible to make a radio low-cost by sacrificing power and bandwidth efficiency. This is no longer possible. The radio spectrum is very valuable and operators who do not use the spectrum efficiently could lose their existing licenses or lose out in the competition for new ones. These are the tradeoffs that must be considered in digital RF (Radio Frequency) communication design.

The techniques used to modulate digital information so that it can be transmitted via microwaves, satellite or down a cable pair is different to that of analogue transmission. The data transmitted via satellite or microwave is transmitted as an analogue signal. The techniques used to transmit analogue signals are used to transmit digital signals. The problem is to convert he digital signals to a form that can be treated as an analogue signal that is ten in the appropriate form to either be transmitted down a twisted cable pair or applied to the RF stage where is modulated to a frequency that can be transmitted via microwave or satellite. The equipment that is used to convert digital signals into analogue format is a modem. The word modem is made up of the words “modulator” and “demodulator”. A modem accepts a serial date stream and converts it into an analogue format that matches the transmission medium.

The move to digital modulation provides more information capacity, compatibility with digital data services, higher data security, better quality communication, and quicker system availability. Developers of communication systems face these constraints:

Available bandwidth
Permissible power
Inherent noise level of the system

III. DIGITAL MODULATIONS

The following Digital Modulation Schemes are evaluated using SIMULINK:
a) Amplitude Shift Keying Model (ASK)
b) Frequency Shift Keying Model (FSK)
c) Binary Phase Shift Keying Model (BPSK)

AMPLITUDE SHIFT KEYING:

Amplitude modulation in which the carrier is switched between two different carrier levels is known as Amplitude Shift Keying(ASK).A special form of ASK is one in which the carrier is simply switched on and off. The binary level turns the carrier on, and the binary 0 level turns the carrier off. This is called on-off keying (OOK).

The digital signal coming from a digital source is a unipolar NRZ signal which acts as the modulating signal.
d (t) =Data bit which can take values “1” or “0”.
Here the carrier is a SINE wave of frequency fc. We can represent the carrier signal mathematically as follows:-

$e_c = \sin(2\pi f_c t)$

The ASK modulator is nothing but a multiplier followed by a band pass filter. This multiplier will multiply the NRZ digital and the sinusoidal carrier signal to produce the binary ASK signal at its output. Due to multiplication, the ASK output will be present only when a binary “1” is to be transmitted.

There will be no such output for the value “0”.The ASK signal can be mathematically expressed as follows:

$$V_{ASK}(t) = \sin(2\pi f_c t) \text{ -------when } d(t) = 1$$
$$V_{ASK}(t) = 0 \text{ ------when } d(t) = 0$$

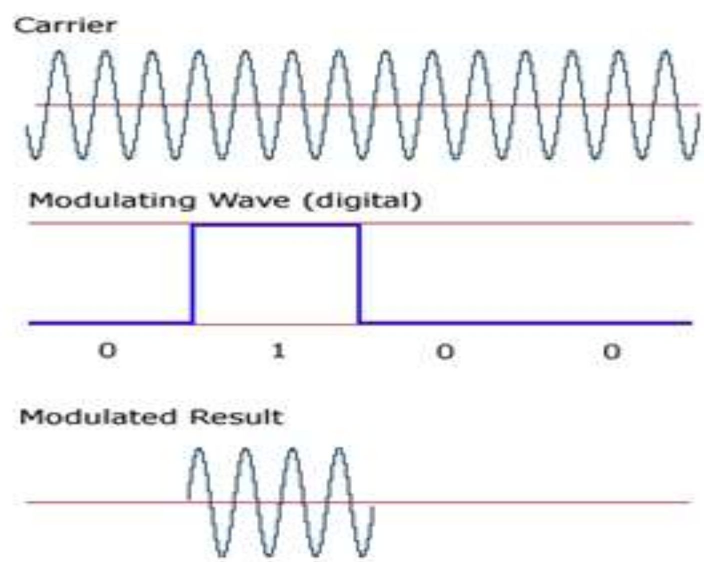

Figure 3.1: Waveform of ASK

FREQUENCY SHIFT KEYING:

In this method the frequency of the carrier is changed to two different frequencies depending on the logic state of the input bit stream. The typical output waveform of an FSK is shown in figure3.3.Notice that logic high causes centre frequency to increase to a maximum and a logic low causes the centre frequency to decrease to a minimum.

In binary FSK, the frequency of a constant amplitude carrier signal is switched between either of two values corresponding to binary symbols "0" and "1". A frequency shift keyed transmitter has its frequency shifted by the message . In this we are using binary sequence only hence only two frequencies are required. The word 'keyed' suggest that the message is of the 'on-off' variety, more likely in the present context, a binary sequence. Here amplitude and phase remains constant

As its name suggests, a frequency shift keyed transmitter has its frequency shifted by the message.

Although there could be more than two frequencies involved in an FSK signal, in this experiment the message will be a binary bit stream, and so only two frequencies will be involved.

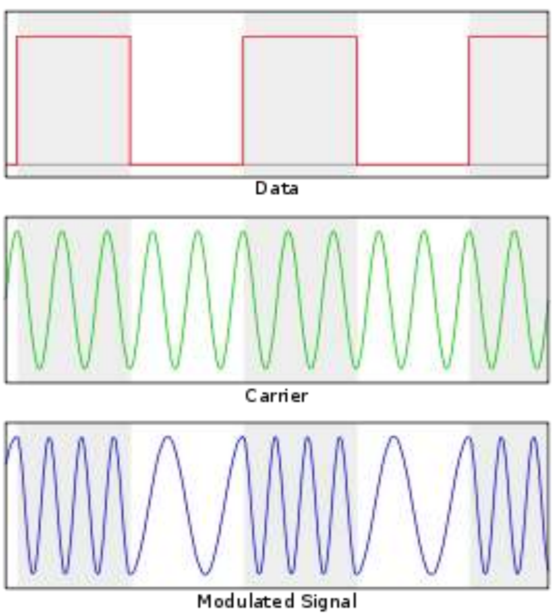

Figure 3.2: Waveform of FSK

BINARY PHASE SHIFT KEYING:

Binary Phase Shift Keying (BPSK) is most efficient of the three modulation methods, i.e. ASK, FSK, and PSK. It is used for high bit rates. The BPSK modulator is similar to the OOK modulator, the difference being that no dc component is present in the modulating waveform and therefore no carrier component is transmitted. In this modulation one has as possible results two exit phases for the carrier with a single frequency. An exit phase represents logic 1 and the other one a logic 0. The carrier phase is changed between 0° and 180° by the bipolar digital signal. A bipolar NRZ signal is used to represent the digital data coming from the digital source.

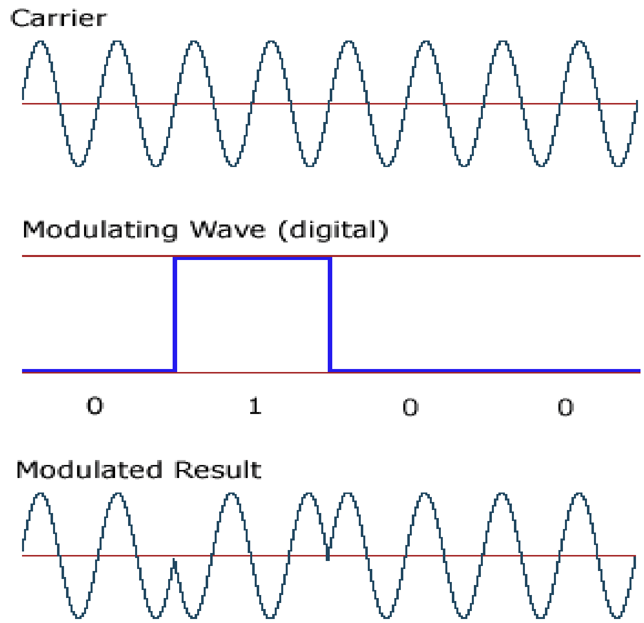

Figure 3.3: Waveform of BPSK

IV. RESULT

ASK Model in XILINX

Simulation result in the form of waveform:

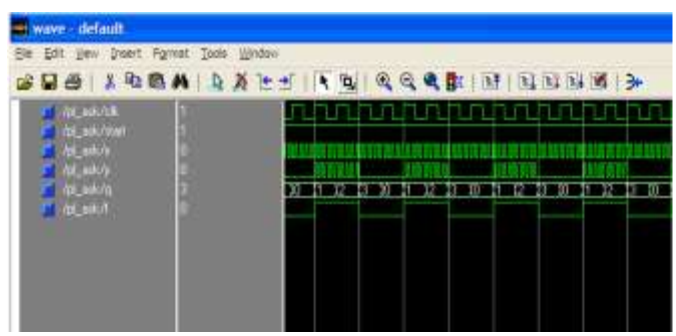

Figure 4.1: Simulation of ASK in XILINX

FSK Model in XILINX

Simulation result in the form of waveform:

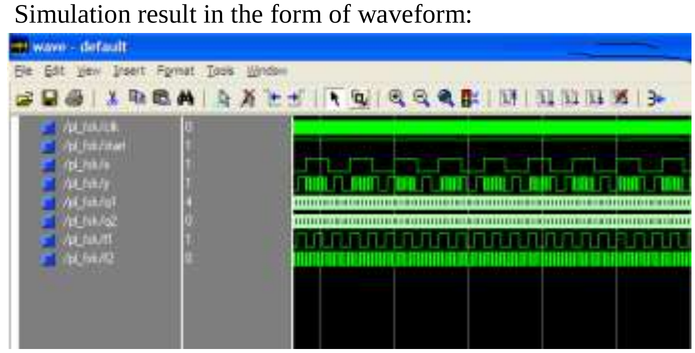

Figure 4.2: Simulation of FSK in XILINX

BPSK Model in XILINX

Simulation result in the form of waveform:

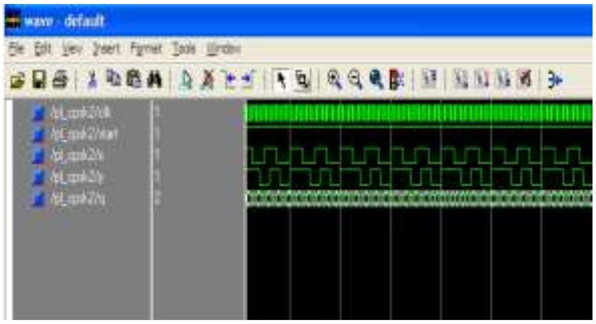

Figure 4.3: Simulation of BPSK in XILINX

ASK Model in SIMULINK

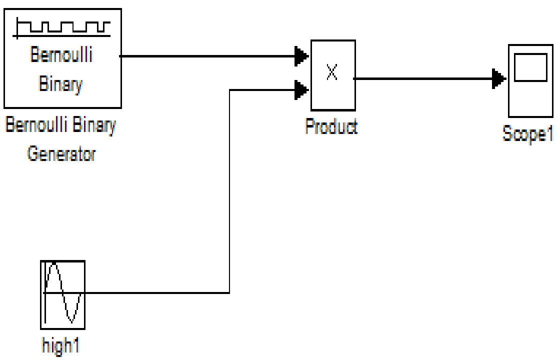

Figure 4.4: ASK Model in SIMULINK

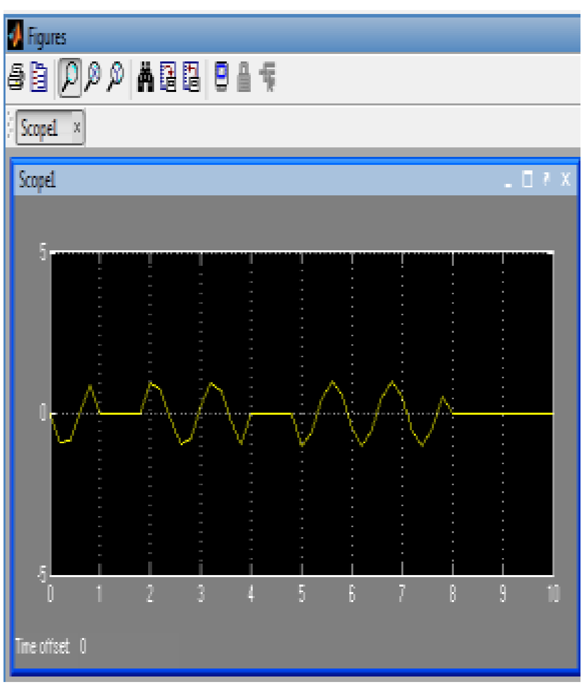

Figure 4.5:Output of ASK Model

FSK Model in Simulink

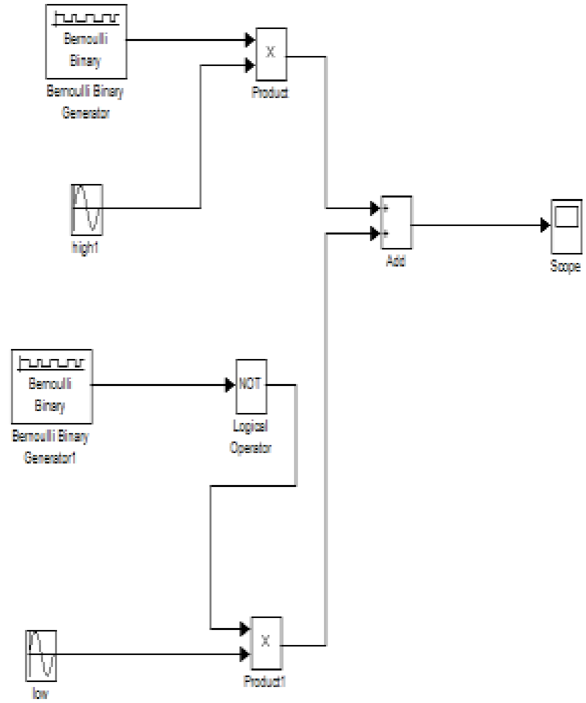

Figure 4.6: FSK Model in SIMULINK

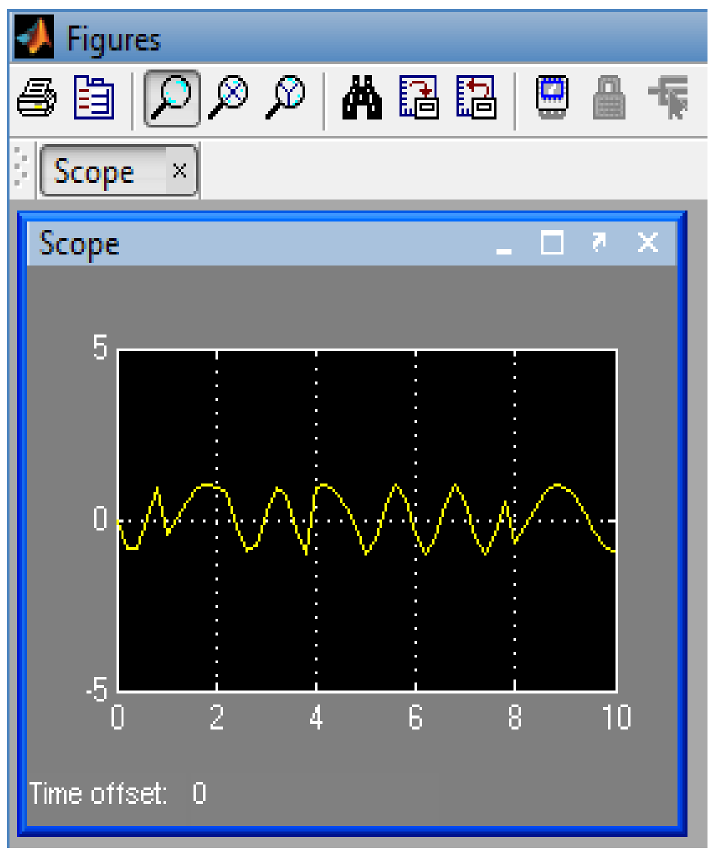

Figure 4.7:Output of FSK Model

F. BPSK Model in SIMULINK

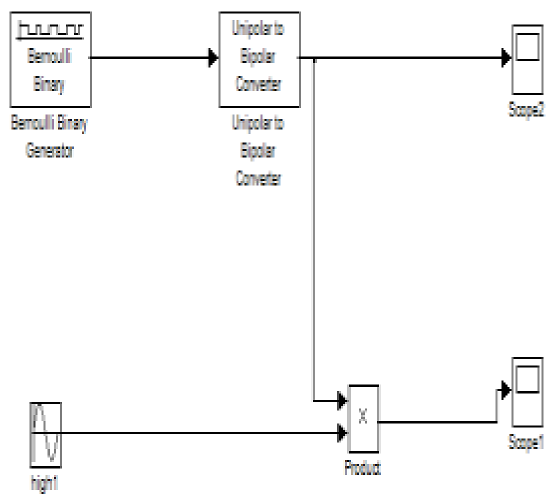

Figure 4.8: BPSK Model in SIMULINK

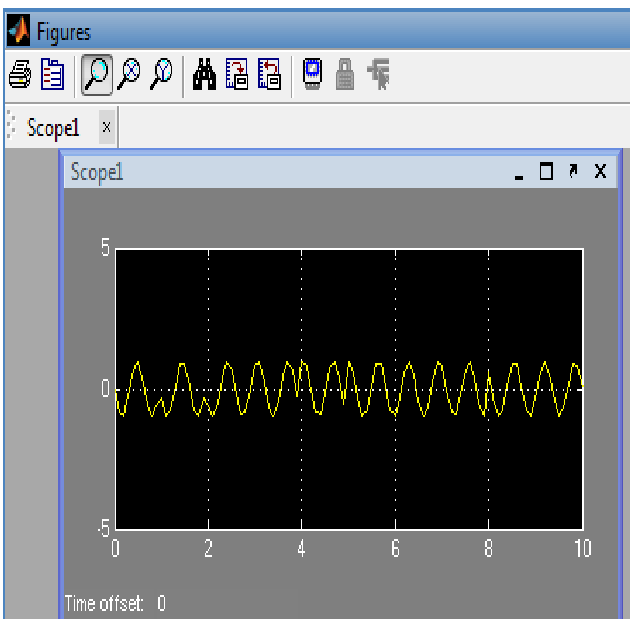

Figure 4.9:Output of BPSK Model

V. CONCLUSION

A In this work, successful design and simulation of a low power various digital modulation schemes with proper understanding are presented. We are using FPGA as it can control multiple inputs and multiple outputs concurrently.FPGA provides better power management as very less power is consumed by FPGA. Xilinx ISE tool is used for implementation of systems in FPGA. FPGA Implementation of digital modulation systems requires use of hardware configurable simulation. Since the results obtained in hardware are dependent of the design in software, it is much simpler to carry out changes in these results by means of the software, even after having finished the design and its implementation.This fact is considered one of the most important in the development of this type of designs.

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