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Development of Fhss Transmitter Using BPSK Modulation in VHDL

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Abstract: To reduce the interference, jamming and increase the security TDMA technique is employed. In TDMA, FHSS is identified to reduce the eavesdropping. Also, the system employs the BPSK modulation to transmit the data over longer distance without fading. The paper explains the simulation of the entire system which is coded in VHDL and simulated and verified using Xilinx and Matlab. The simulation results also compare the FHSS with the DSSS system interms of power spectral density and BER. The comparison shows that FHSS is comparatively high securing than DSSS. The transmitted signal power for the FHSS system is 2mW and for DSSS, it is 13mW.

Key words: FHSS · BPSK · FH/BPSK transmitter · VHDL · FPGA

INTRODUCTION

The short-range wireless communication can be improved, by limiting the interference and multi-path fading in the channel. Frequency hopping spread spectrum (FHSS) is a transmission technique where the carrier hops from frequency to frequency. The transmitting data should have a clear channel and avoid congested channels, by having its own frequency hopping mechanism. Adaptive frequency hopping is a system is to avoid congested frequency channels in hopping sequence to improve immunity toward frequency interference. The certain applicationsare needs to transmit the original information without a loss of information and make it difficult to receive the original information by the unwanted users. This is called secure communication. Such communication is very important in military applications where technique called spread spectrum modulation is used. The interference in the transmission channel may be unintentional interference formed because the user uses the same channel for transmitting. Sometimes the hostile transmitter will also create the interference to 'jam' the transmission. Those problems can be solved using spread spectrum modulation. Spread spectrum is the techniques in which it spread the narrow band signal over wide frequency band and at the receiver by de-spreading the signal we get original signal [1].

The three main advantage of spread spectrum transmission are:

- Avoids narrow band interference
- Difficult to intercept.
- Provides minimal interference.

The spread spectrum transmission techniques are frequency hopping spread spectrum (FHSS) and direct sequence spread spectrum (DSSS) [2].

The paper is used for different wireless communication system for transmitter; depending upon the application the different bandwidth and the carrier frequency are used. It is a secure communication so it widely used for military applications.

About FHSS: A spread spectrum system shouldfulfill the following requirements.

- The minimum bandwidth is necessary to send the data than the modulated signal bandwidth.
- The wideband spread signal is used in spectrum spreading, often called a code signal, which is independent of data.
- At the receiver, the same code sequence synchronism operating with the transmitter is used for de-spreading [2].

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Overview: In FHSS synchronization the transmitter and receiver is necessary. In this case, due to any reasons the receiver is not synchronized with the transmitter, so from its spread spectrum the recovery of the original information is merely impossible. To overcome this technique, the code is combined and sent with the modulated signal before using the spreading technique. Using this transmission code at any instant of time they can synchronize the receiver with the transmitter. In this proposed work the system is for analog communication and this project is implemented using MATLAB simulink [3].

The cooperative communication technique and exploits frequency utilizes collaborative broadcast scheme, multiuser and spatial diversities is used to resist jamming and enhance efficiency. UFH-based source node provides channel uncertainty is the major demerits of this system [4].

In this paper, the design, the applications and performance of jamming systems for frequency-hopped communication countermeasure based on the background link the Armored Vehicles are investigated with the simulation system for communication countermeasure with the MATLAB-Simulink toolbox. The disadvantage is, if the interference duration must satisfy chip time limit then the signal propagation and processing time will be limited [5].

The Dynamic Frequency Hopping(DFH) technique is used to increase the bandwidth efficiency and enhancement blocking probability in the cellular system and where data transmission of the wireless regional area network system are performed without any interruption by using parallel with spectrum sensing. The demerit is, DFH relaying on the measurement based approach require signaling overhead for communication. This desired application was implemented using MATLAB programming language [6].

In existing paper they have simulated and analyzed the bit error rate (BER) performance in FH/FSK system platform with narrow-band jamming. The artificial noise jamming only in the large error rate conditions (when the error rate is above 0.1) are ineffective than noise jamming [7].

FH/BPSK Transmitter Architecture: In FH/BPSK transmitter, the input to the system is digital data, which is transmitted by varying its characteristics to the intended receiver. FH/BPSK transmitter architecture is shown in figure 1. The block describes the entire FH/BPSK system of the FHSS spreading and modulation the incoming signal to pass overr a analog channel. The FHSS transmitter architecture has four stages. At first, the digital data is taken as input the FH/BPSK system and makes synchronization with the clock signal. In order to reduce the atteneuation, the incoming signal is processed with the carrier frequency to modulate. Then FHSS spreading is carried out for the modulated signal with the help of spreading frequency. Finally, FHSS spreaded signal is send over a channel with the help of transmitter.

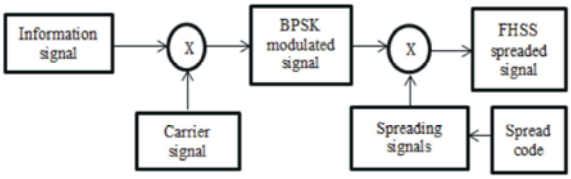

Fig. 1: FHSS transmitter

BPSK Modulation: Initial stage of the FH/BPSK transmitter is the BPSK modulation. In BPSK, the message signal with low data rate is modulated with a high frequency analog (carrier) signal to send a signal over a longer distance without attenuation. Figure 2 shows the logic to implement the BPSK modulation using the multiplexer in VHDL. The characteristics of carrier signal are changed according to the information is done with the help of multiplexer.

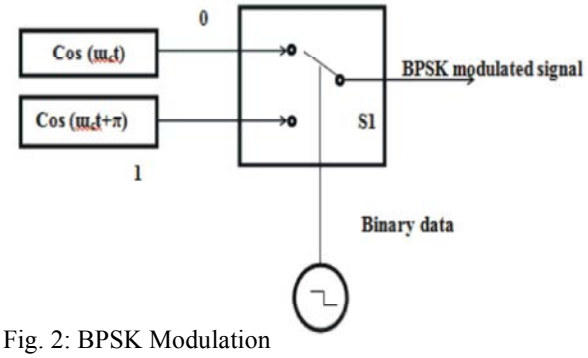

Fig. 2: BPSK Modulation

FHSS Spreading: Spreading the information is takes place at the end of the BPSK modulation. Modulated signal is the input for the FHSS system. It consists of several carrier frequencies, which are hopped among them using randomly generated spread code. The FHSS transmitter logic using multiplexer in VHDL is shows in the Figure 3. Now the carrier frequency is varied by spread code, which as a select line, to change frequency according to the spread code. Now the spreading frequency is multiplied with the BPSK modulated signal to make signal compatible for a FHSS transmitter.

Design Flow of FH/BPSK Transmitter: The following specifications are considered for design of FH/BPSK transmitter.

- PN sequence: LFSR
- Spreading frequency: LUT based DDFS
- Type of modulation: BPSK
- Front end design: VHDL

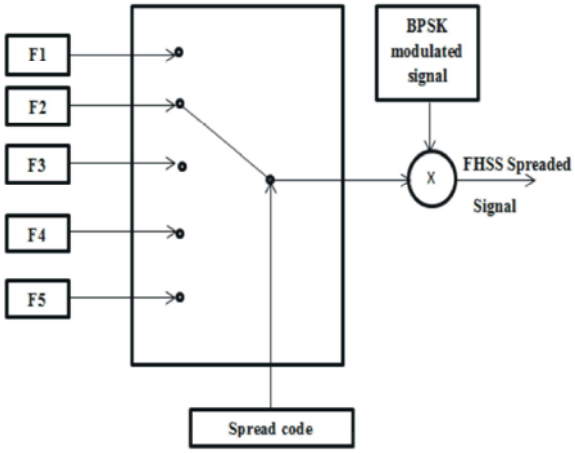

Fig. 3: FHSS Transmitter

PN Sequence Generation: Spread code generator in FH/BPSK is the major block to spread the signal delibrately over a wide bandwidth. The method adopted for generation of PN sequence is LFSR. The possible length of PN code depends on the number of Flipflops in the circuit.

Carrier Signal: Carrier signal is needed for both BPSK and FHSS signal. For BPSK the carrier is generated using LUT. In case of FHSS, the spreading frequecny is formed by hopping among the different carrier frequencies with the help of spread code (PN code). Different carrier frequencies is generated using LUT method.

FH/BPSK Transmitter: BPSK modulator takes the incoming bits and it mulitplied with carrier signal to vary its characteristics. FHSS spreader also receives incoming signal and mulitplied with spreading frequency to spread the signal over a wide-band.FH/BPSK transmitter block acquires the incoming data bit. First, modulation is performed for the incoming bit using carrier frequency. Then modulated signal is mulitiplied with spreading frequency to spread the signal.

Simulation Analysis: Proceeding to the FPGA implementation, the designed BPSK, FHSS and FH/BPSK were simulated using Xilinx and verified using Matlab. In VHDL, the carrierr signal are generated through LUT, which can have 'n' number of sampled values and ;'m' number of bit for accurate representation.

Simulation of FH/BPSK Transmitter:

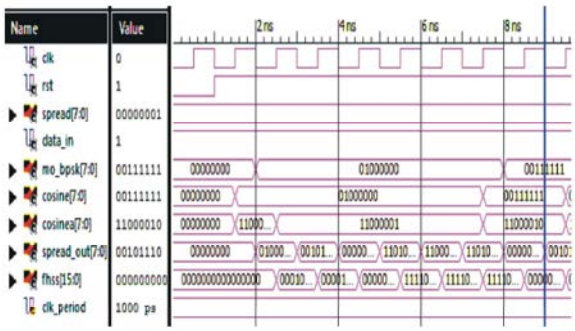

Fig. 4: Simulation of FH/BPSKtransmitter using Xilinx

Figure 4, presents a FH/BPSK transmitterin Xilinx. The FH/BPSK transmitter takes the bit sequence as the input. The carrier signals required for transmitter side is spreading frequency and carrier signal. The incoming bit sequence is multipled with carrier signal. The master clock has a frequency of 1MHz. The generated carrier signal has frequency of 0.55MHz. BPSK modulated signal is taken for second stage of FHSS process. The spreading frequency is generated with the help of spread code, hopping among different carrier frequencies. The carrier frequencies are generated using LUT. Now, the modulated signal is spreaded using spreading frequency.

Figure 5 depicts the FH/BPSK receiver in VHDL. FH/BPSK signal is shown in Figure 5(c). The input bit sequence is shown in Figure 5(a). According to the bit, carrier signal varied its phase characteristics in BPSK modulation is shown in Figure 5(b). Now, BPSK modualted signal is multiplied with spreading frequency to spread the signal is shown in Figure 5(c).

Figure 6 represents the power spectral density of the FH/BPSK signal for each and every intermediate stage. Figure shows the frequency component of the FH/BPSK signal. The signal has the peak power of 3.9mW with frequency components spread over a range of 44MHz.

Figure 7 shows the performance comparison of the FHSS and DSSS signal. Bit Error Rate (BER) comparison is shown in figure 7(a). It states that the BER is low for the FHSS signal. Figure 7(b) shows that the PSD of the FHSS signal is very low compare to DSSS. It is analyzed by giving the same set of data sequence as input to both the system.

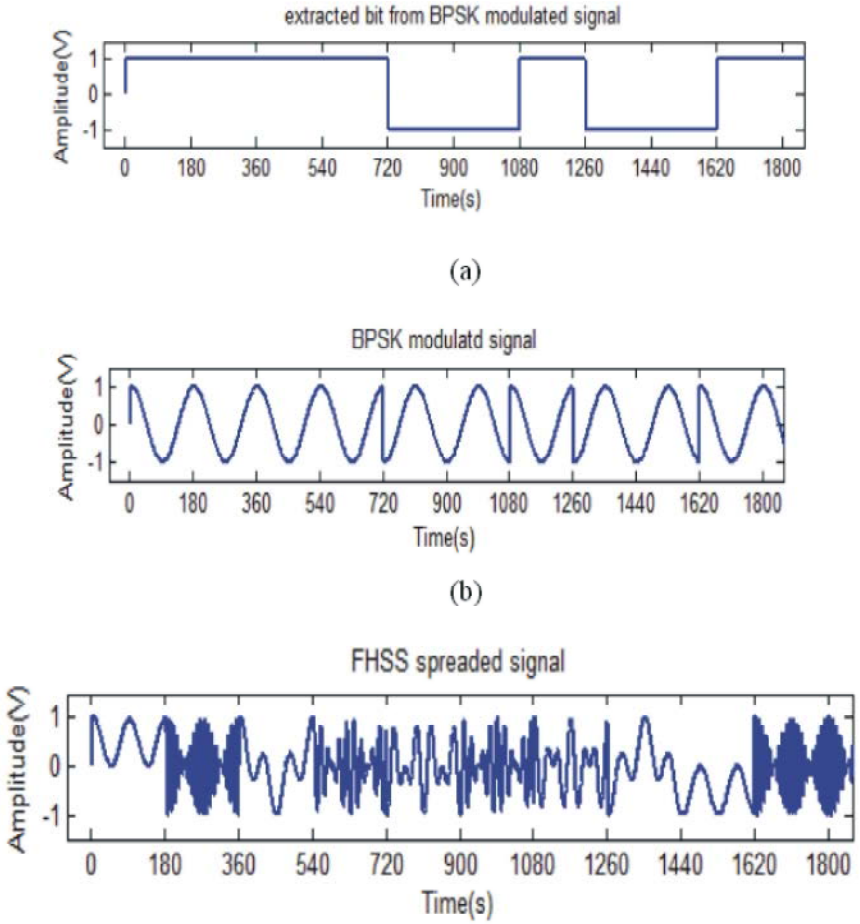

Fig. 5: (a), (b) and (c) Simulation of FH/BPSK transmitter

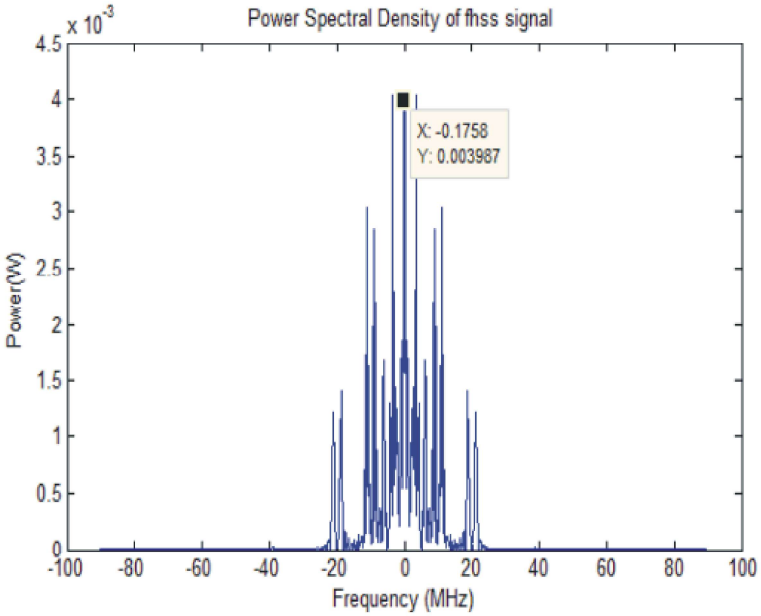

Fig. 6: PSD ofFH/BPSK signal using matlab

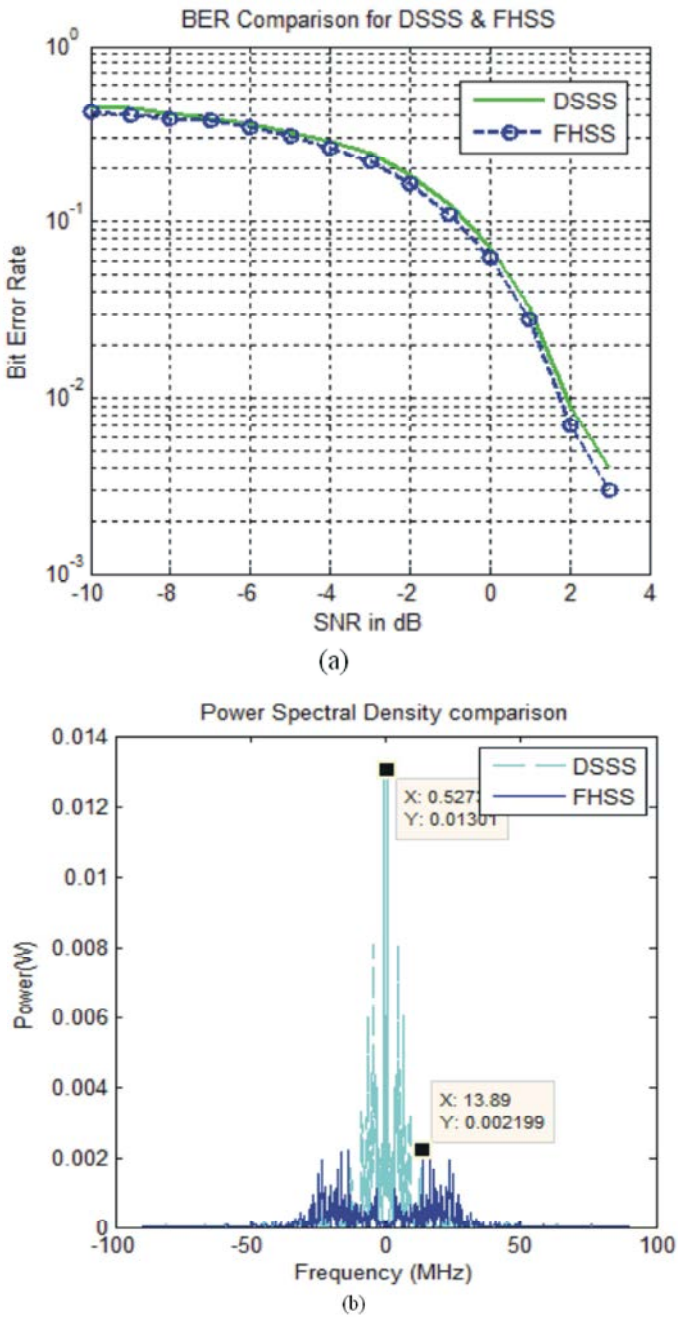

Fig. 7: Performance comparison FHSS and DSSS (a)SNRvs BER (b) PSD

CONCLUSION

In this paper, it is proposed and investigated a FHSS transmitter using BPSK modulation in VHDL. The functionality of the paper was demonstrated though simulations using the Xilinx system edition and Matlab simulation and its results were discussed. It is observed that FH/BPSK transmitter signal has low PSD of 3.98 mW. The FH/BPSK signal is compared with the DSSS signal interms of BER and PSD. Further it can be design through PCB and its implemented using Spartan family.

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