FPGA BASED OFDM-FH COMMUNICATION RADIO SYSTEM

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Abstract*— OFDM is a special case of multi carrier transmission, where a single data stream is transmitted over a number of lower data sub carriers. The basic principle of OFDM is to split a high data rate stream into a number of low data streams that are transmitted simultaneously over a number of sub carriers. Frequency hopping (FH) communication system has stronger Anti-interference, Anti multipath multiple access networking capability, and finds a wide range of applications in the military radio. To get the combined advantage of OFDM and FH a hybrid scheme with both the techniques shall be implemented. OFDM-FH technology can significantly improve the channel capacity and transmission efficiency of wireless communication system and can be effectively resistant to multipath fading and inhibition of human interference.In the first phase of project simulation studies shall be carried in by MATLAB and the performance of the hybrid scheme analyzed. The second phase involves implementation of code in VHDL followed by porting of the software on the target hardware. The hardware architecture includes DSP board, FPGA module, Power modules, interfaces, DAC module at transmitter side and ADC module at receiver side.*

IndexTerms— OFDM (orthogonal frequency division multiplexing), Anti interference, Anti multipath multiple access networking capability, FH (Frequency hopping)

1.INTRODUCTION:

Now a days demand for wireless communications are more in all over the world, due to improvement of the technology. Recently, a worldwide convergence has occurred for the use of orthogonal frequency division multiplexing (OFDM) as an emerging technology for high data rates. In particular, many wireless standards (Wi-Max, IEEE802.11a, LTE, and DVB) have an adopted the OFDM technology as a mean to increase future wireless communications. OFDM is the major key Component of these wireless communications. Since they provide wireless communication between user and outside world. The basic idea of OFDM is using a large number of parallel narrow band subcarriers instead of a single wideband subcarrier to transport the information. The advantage of OFDM is very easy and efficient in dealing with multipath and robust against narrow band interference. The disadvantage of OFDM is sensitive to frequency offset and phase noise and another one is peak to average problem reduces the power efficiency of RF amplifier at the transmitter. In this OFDM at high data rates we require large bandwidth of signal. But here in defined bandwidth we require large bandwidth of signal. But here in defined bandwidth we propagate high data rate signals. Resource allocation in OFDM by performing frequency hopping at subcarrier units or sub channel (which consists of multiple sub carriers) as shown in below OFDM-FH is a technique that randomizes radio figure. This technique realizes 1-cell reuse by adopting different hopping patterns for each base station. The advantage OFDM-FH is, to make intercell interference to be regarded as white noise by frequency hopping, and realize 1-cell reuse without requiring any complex processing such as Dynamic channel assignment (DCA), Also by making the number of allocated subcarriers variable according to the traffic loading, the effects of fractional loading can be achieved. OFDM-FH is a new design

technology and it is mainly used in enhance the performance of OFDM system. Below figure shows the transmitter where the important part of frequency hopping is a PN generator and frequency synthesizer. The OFDM-FH signal is generated when mixing the two signals (OFDM & FH). The channel is assumed to be AWGN channel with noise n (t) having two sided power spectral density N0/2. The received noisy signal is applied to the receiver as shown in figure. Where it consists of two stages. The first stage is frequency dehopping. This stage has same structure as the transmitting hopping section (PN generator and frequency synthesizer) besides of other blocks to detect the original signal. In this work it is assumed that there are no losses due to the hopping and dehopping process. Various methods of combining OFDM with multiple access concepts such as Code division multiple access (CDMA) have been investigated; among them, multi-carrier CDMA (MC-CDMA) and OFDM frequency hopping (OFDM-FH) are two most promising candidates for 4th -generation mobile communications. OFDM-FH also provides the multiple access bases for both the IEEE802.11a local area network (LAN) standard and the IEEE 802.16a metropolitan area network (MAN) standard.

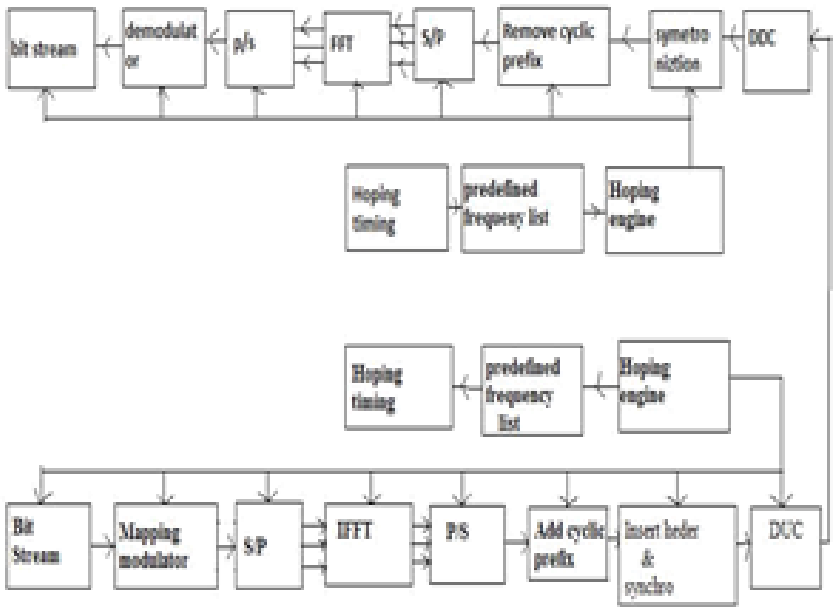


Fig 1: Block diagram of OFDM-FH transceiver

II. Design specifications

To design an orthogonal frequency division multiplexing-frequency hopping (OFDM-FH) using matlab simulation, and VHDL. Need FFT size or total number of subcarriers (used+unused)N=64; Number of data subcarriers=48; Number of pilot subcarriers=4; and OFDM bandwidth=20*10^6;

i.Simulated parameters

DeltaF=.OFDM bandwidth/N;

i.e., deltaF=bandwidth for each subcarrier-include all used and unused.

ii. *Subcarriers*

Tfft=1/delta; IFFT or FFTperiod=3.2us

Tgi=Tfft/4; Tsignal=Tfft+Tgi;

Ncp=N*Tgi/Tfft; Nst=Nsd+Nsp;

iii.***Calculate Es/N0 or Eb/N0***

Required noise=$10^{\frac{-E_S\ 1}{N_0\ 20}} * noise; E_s = (\frac{N}{N+N_{cp}})E_b;$

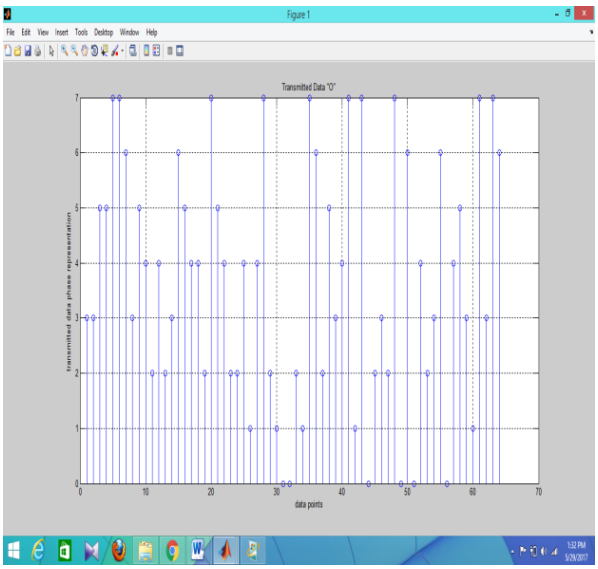
$$\left(\frac{E_S}{N_0}\right) db = \left(\frac{N}{N+N_{cp}}\right) db + \left(\frac{N_{st}}{N}\right) db + \left(\frac{E_b}{N_0}\right) db$$

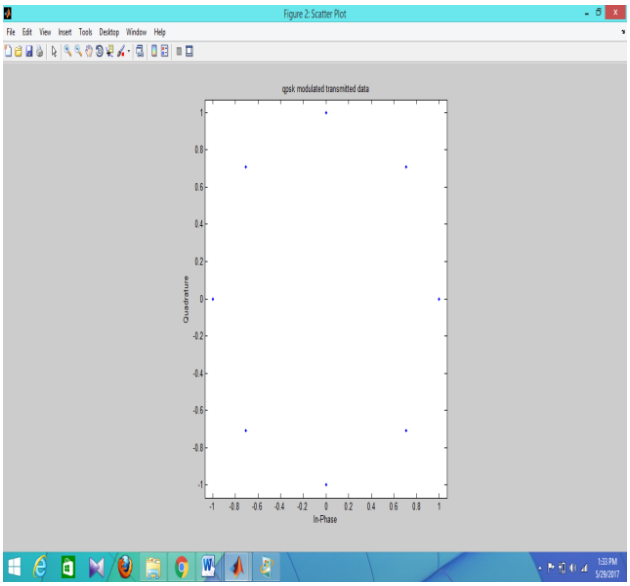
III. Analysis of ofdm and frequency hopping and (ofdm-fh) orthogonal frequency division multiplexing frequency hopping:

The OFDM is designed on simulation with number of subcarriers and some parameters. Parameters specifications of OFDM communication systems are shown as mentioned above.

(i)Design of OFDM signal transmission

Matlab Software is used to design and simulate OFDM signal transmission. The designed OFDM with scatterplot is shown in figure 2.





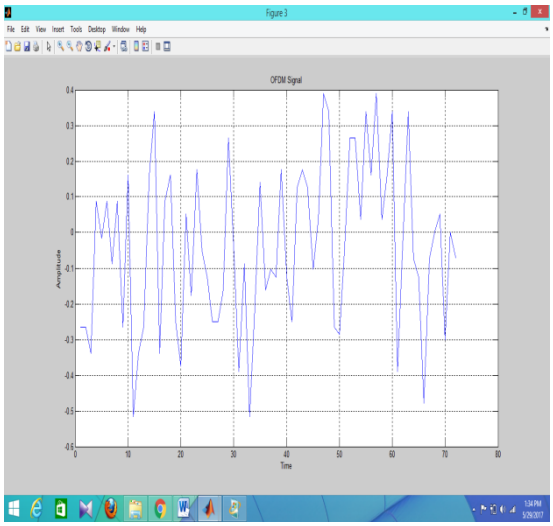


Figure 2: Design of OFDM signal transmission

(ii) Design of OFDM signal receiver:

Matlab Software is used to design and simulate OFDM receiver signal. The designed OFDM signal receiver is shown in figure 3

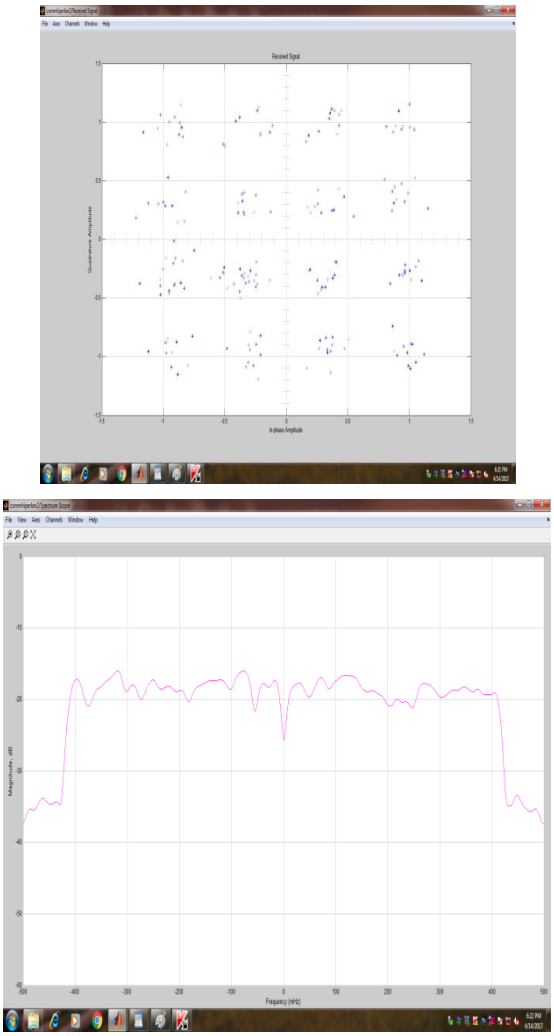


Figure 3: Design of OFDM signal receiver

(iii) Design of frequency hopped spread spectrum signal and it's FFT

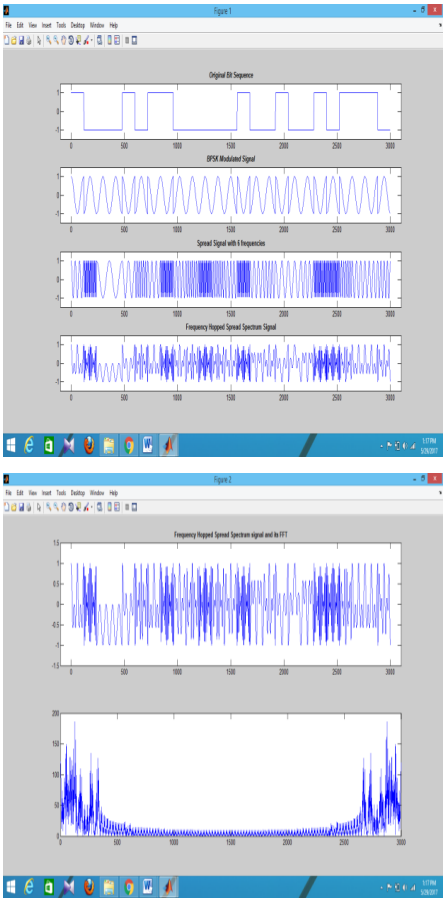
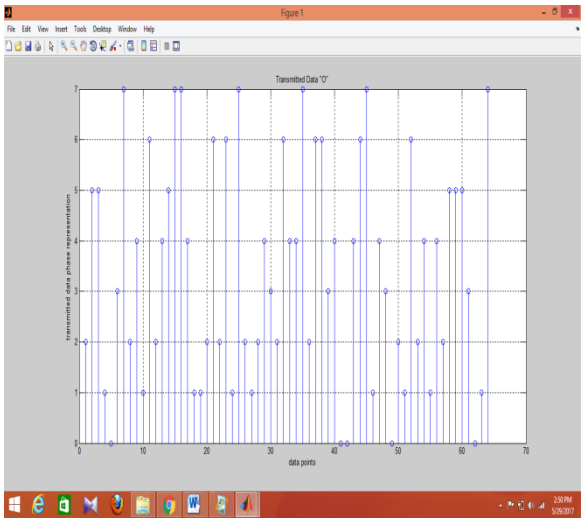
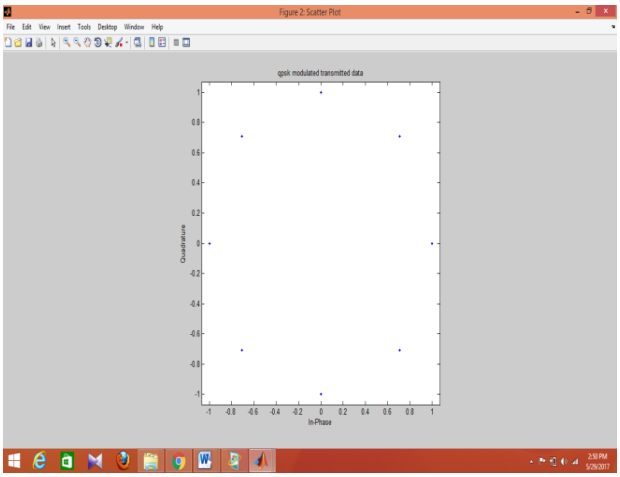


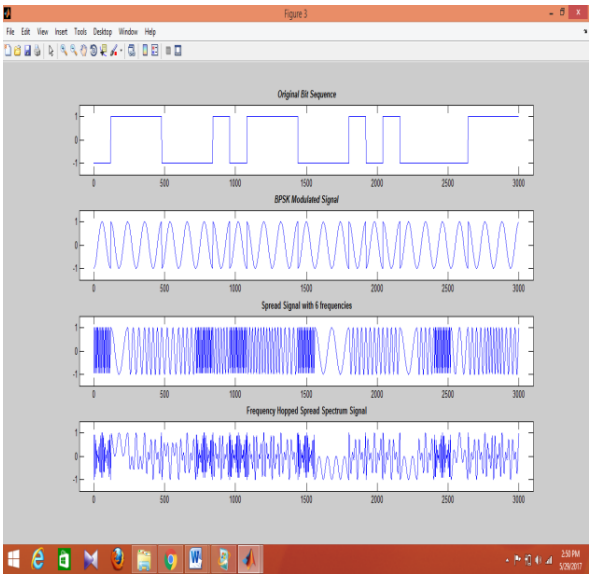
Figure 4: Design of normal frequency hopped signal

(iv) OFDM-FH

After simulation, the gain and bandwidth of OFDM-FH system s shown in below figure 5.







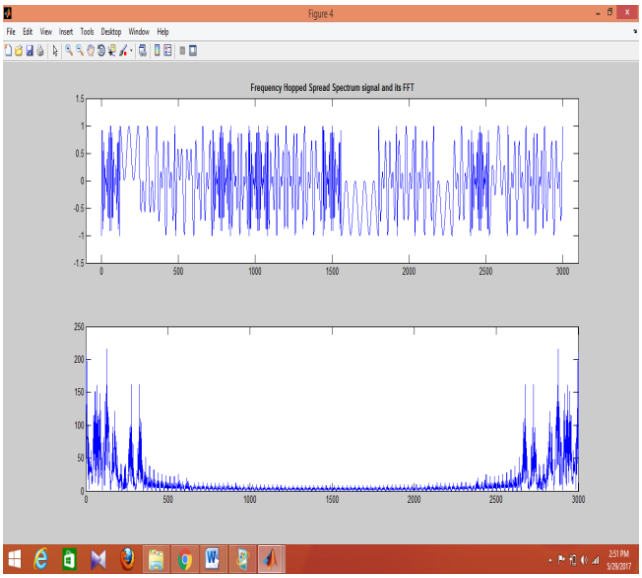


Figure 5: Design of the OFDM-FH signal.

(v) Simulink results

After simulated the OFDM transmitted and received signal, the signal is converted into VHDL using XILINX ISE. The Simulink results are shown in the below figure.

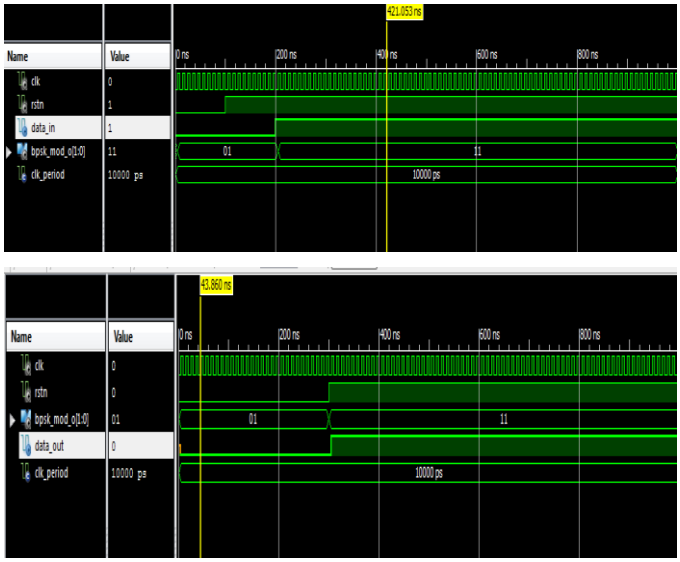


Figure 6: Simulink results for OFDM transmitter and receiver

The Simulink results for OFDM transmitter placed into the hardware kit, then, the resulted OFDM signal is shown in below figure.

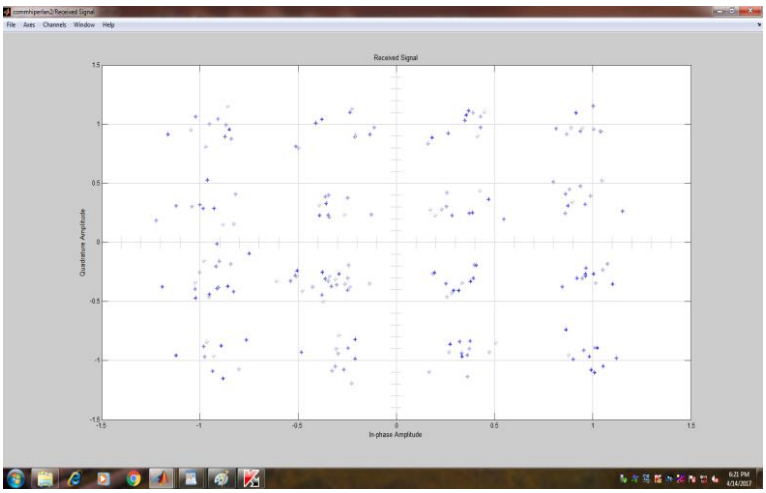


Figure 8: OFDM receiver signal

Table 1: Comparison of Results

parameter	datarate	Operating frequency	Bandwidth	Gain
OFDM	high	1Mhz	large	low
OFDM-FH	high	1Mhz	defined	high

Table 1: Comparison of OFDM and OFDMFH

CONCLUSION AND FUTURE SCOPE

OFDM-FH is designed and simulated using Matlab software and different parameters like bandwidth, gain are determined at 1 MHz frequency band. By using Kintex-7 kit in hardware design and in defined bandwidth we propagate high data rate signals. The proposed OFDM-FH communication system has achieved better gain and bandwidth. The simulated results show that the obtained orthogonal signal and bandwidth. So, this communication system can be used in wireless applications. Project main aim is at high data rates we require large bandwidth of the signals. But here, in defined bandwidth we propagate large data rate signals.

The signals data rate can be additionally increased by defined (low) bandwidth by implementing more hybrid schemes, the bandwidth of the wireless communication system reduced and increase the data rates like gain, frequency, and number of users. In present work OFDM-CDMA and OFDM-MIMO are designed using many wireless devices. In future reduce the bandwidth of signals for high data rates.

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