CARRIER SYNCHRONIZATION IN SOFTWARE DEFINED RADIO FOR 8PSK

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Abstract - The main aim behind the growth of software defined radio is the skill to reconfigure radios, thereby increasing the efficiency in the usage of radio resources. In wireless communication the multipath effect produce interference and also changes in the phase of the signal. In order to correctly recover the transmitted data with minimum error, carrier synchronization is essential. One of the challenging tasks in a communication system is synchronization of the carrier signal. In this paper 8PSK modulation scheme is used for data transmission. Since 8PSK achieves high data rate, the probability of actual signal recovery is quite difficult. Here the carrier recovery for 8PSK modulation has been performed.

Keywords: software defined radio, 8PSK

I. INTRODUCTION

The Software defined radio or SDR, sometimes software radio has been the aim of many radio developments. In military and civilian radio application digital radios are used instead of analog radios. SDR is also defined as "Radio in which some or all of the physical layer functions are software defined". Using software techniques the digital signals are handled in SDR. Software defined radio offers software control of different types of modulation and demodulation, filtering, coding, link layer protocols etc.

An antenna is used to select the signal in SDR. Then the analog signal is transformed into digital signal. Then in the software, the digital signal values are processed. Then the output is converted into an audio signal or video signal.

SDR technology implements the radio functionality as a software module to resolve troubles for instance, stable evolution of link-layer protocol standards (2.5G, 3G, and 4G), global roaming deployment due to the existence of incompatible wireless network technologies and problems by reason of the presence of legacy subscriber handsets by operating on the generic hardware platform.

Flexible mobile applications are in need to increase the design productivity and flexibility which becomes a demand as a result of mounting bandwidth of radio standards. These can be fulfilled with the role of software techniques [3,4]. Different types of modulation schemes are used for data transmission in SDR, which are QAM, BPSK, QPSK, 8PSK etc.

In this paper carrier synchronization in software defined radio is implemented using Matlab and the sections are devised as follows. Section II discusses about proposed modulation scheme. Section III discusses about carrier synchronization. Section IV discusses of Performance Evaluation and eventually Section V concludes the paper.

II. 8PSK DESIGN REVIEW

In wireless communication industry eight phase shift keying (8PSK) is one type of phase modulation scheme. It encodes three bits in one symbol, thereby increasing the data rate in the same bandwidth compared to QPSK. In the same way more number of data is transmitted in less time. Eight phase shift keying or 8PSK uses eight phase-shifts. These occur at $\pi/8$, $3\pi/8$, $5\pi/8$, $7\pi/8$, $9\pi/8$, $11\pi/8$, $13\pi/8$, and $15\pi/8$. The phase difference is $\pi/4$.

For 8PSK modulation the transmitted signal can be represented as

$$s_i(t) = \sqrt{\frac{2E}{T}} \cos\left(2\pi f_c t + (2i-1)\frac{\pi}{M}\right)$$

Where i=1, 2…M

The term $(2i-1)\pi/M$ represents the phase of the signal. Here M=8.Where $s_i(t)$ represents a possible state of sending k bits together. The signal can be represented as

$s_i(t)=s_{i1}\Phi_1(t)+s_{i2}\Phi_2(t)$ for i=1,2…M.

$\Phi_1(t)$ & $\Phi_2(t)$ defined as follows

$$\phi_1(t) = \sqrt{\frac{2}{T}}\cos(2\pi f_c t)$$
$$\phi_2(t) = \sqrt{\frac{2}{T}}\sin(2\pi f_c t)$$

It can be easily seen that

$$s_{i1} = \sqrt{E}\cos\left((2i-1)\frac{\pi}{M}\right)$$
$$s_{i2} = -\sqrt{E}\sin\left((2i-1)\frac{\pi}{M}\right)$$

To get $s_i(t)$ substitute $\Phi_1(t)$,$\Phi_2(t)$, $s_{i1}s_{i2}$ in the signal equation.

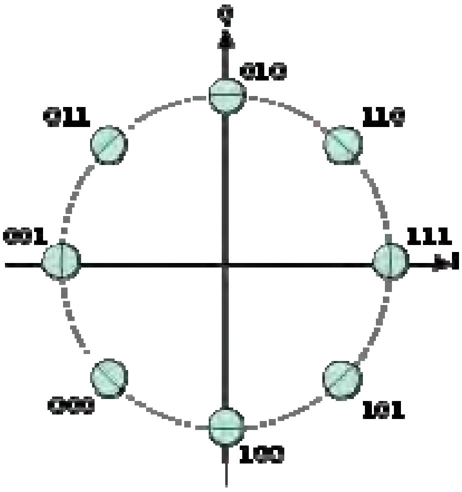

Figure 1 Constellation diagram of 8PSK

III. CARRIER SYNCHRONIZATION

In a digital communication different types of synchronization are established, which are carrier synchronization, symbol synchronization and frame synchronization. In which one of the general problem in wireless communication is carrier synchronization. There are many ways to implement the carrier synchronization in digital communication system which are complicated. Phase Locked Loop (PLL) is the heart for all synchronizers. Local oscillator is required for both transmitter and receiver. The synchronization of the local oscillator at the reception side with the local oscillator at the source is carrier synchronization.

During wireless transmission the digital signal travels from one end (Transmitter) to the other end (receiver) by different paths, called as multipath effect which affects the quality of communication.

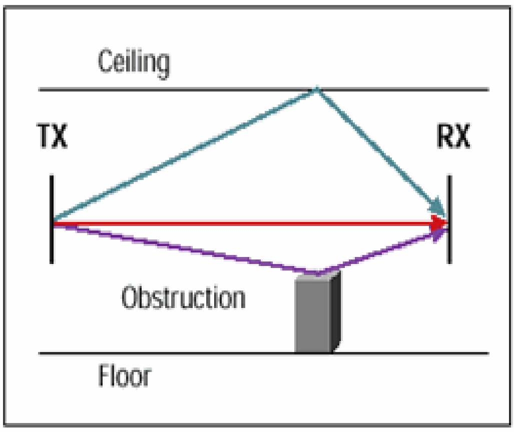

Figure 2 Multipath effect

Multipath propagation is a source for ISI which makes the communication less reliable and also introduces errors in the decision device. These interferences of one symbol with successive symbols can be minimized by using Raised cosine filter which is a type of pulse shaping filter.

Carrier synchronization is achieved by PLL. The PLL is used to remove the phase and frequency offsets in the receiver. Frequency instability in either the transmitter or receiver, and the Doppler Effect when the receiver is in motion relative to the transmitter are the sources of carrier frequency offset. Carrier phase offset is due to phase instability in oscillators and the noise [1, 2].

IV. PERFORMANCE EVALUATION

The 8PSK system includes following blocks: signal generator, interpolation, modulation, channel, demodulation, decimation, carrier recovery.

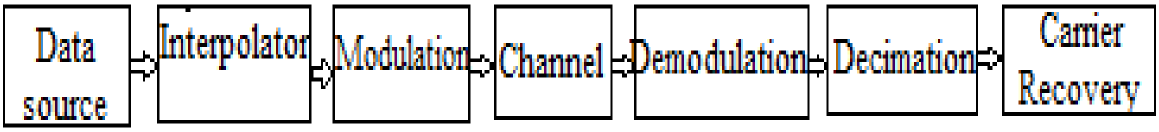

Figure 3 Block Diagram

In signal generator the input signal is generated which is used for 8PSK modulation. Interpolation is used to increase the sampling rate, so that the interpolated signal can be given as input to other systems which is operating at a higher sampling rate. Thus interpolation structure is used for multirate signal processing technique, to get better performance of the system in terms of speed and resource. The raised cosine filter is used to enhance the bandwidth efficiency. After the process of interpolation, modulation begins

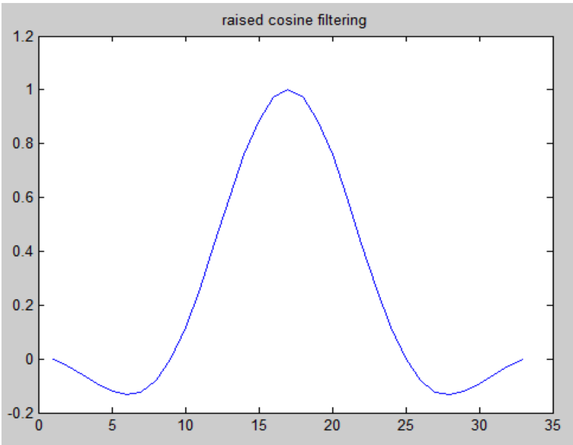

Figure 4 Raised Cosine Filtering

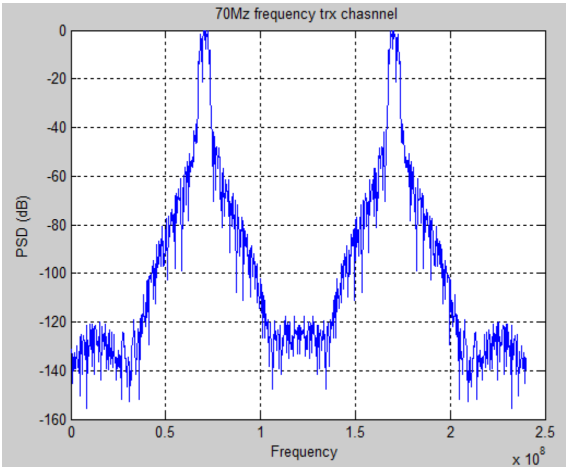

Figure 5 Carrier Signal Frequency in Transmitter Side

Modulation is the process of changing the input signal over some carrier signal and makes it suitable for transmission. In the transmitter side, the carrier signal frequency is 70MHz which is shown in figure 5. For carrier synchronization the transmitter and receiver carrier signal frequencies must be synchronized. The modulated signal is shown in figure 6.

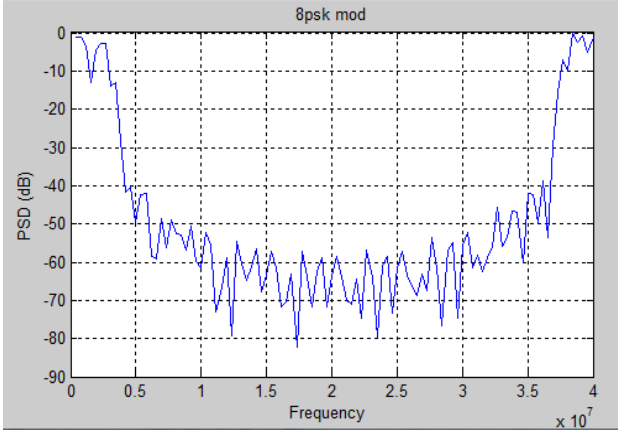

Figure 6 Modulated Signal

Then the modulated signal is passed through the channel. Signal gets affected by noise, depending upon the data length. For example let's consider the data length as 6 and 8. In this case Channel interference is more when the data length is 8 which is shown in the following figures 7 and 8.

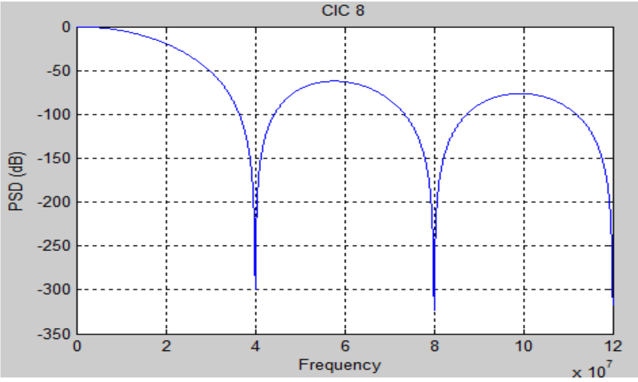

Figure7 Coefficients of 8 – Channel Interference

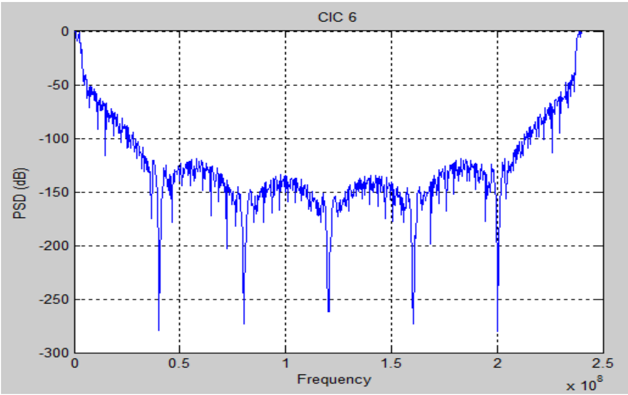

Figure 8 Coefficients of 6 – Channel Interference

Then the received signal is decimated for demodulation. Decimation is the process of reducing the sampling rate followed by demodulation which is the reverse process of modulation. In the receiver side carrier signal frequency is 10MHz.

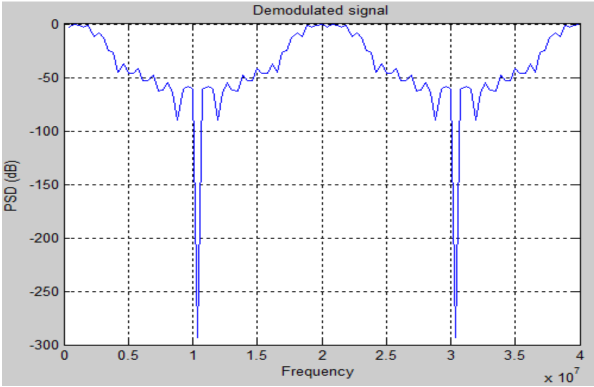

Figure 9 Demodulated Signal

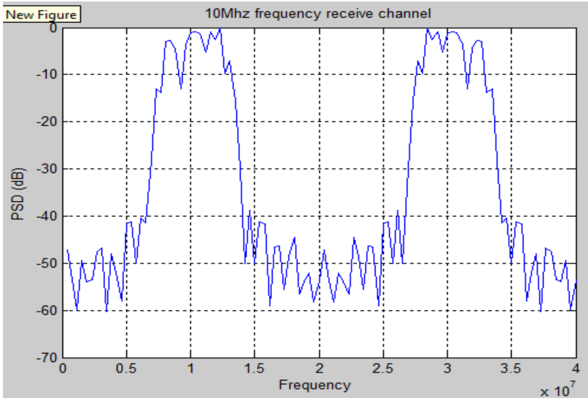

Figure 10 Carrier Signal Frequency In Receiver Side

In wireless communication system carrier synchronization is one of the difficult tasks to achieve. Multipath is due to reflection and refraction of the signal from earthbound objects such as foothills and constructions. The multipath effects produce interference and change the phase of the signal. Fading will occur due to interference. In order to exactly recover the data from the received signal, carrier frequency on transmitter and receiver side must be synchronized. This is achieved by carrier recovery process which is used to synchronize the transmitter and receiver carrier signal frequency and used to minimize the multipath effects [5,6].

The PLL is used to remove the phase and frequency offsets in the receiver. The PLL consists loop filter and voltage controlled oscillator. The output signal from the receiver is given as input to the PLL which is represented as $r_i(t)$. where $r_i(t)=\cos(2\pi f_r t+ \Phi_r)$, r(t) is a externally generated sinusoidal signal in which f_r represents frequency and Φ_r represents phase. Now the PLL creates the locally generated signal which is represented as $s_o(t)$. where $s_o(t)= \cos(2\pi f_s t+ \Phi_s)$. When $f_s = f_r$ and $\Phi_s=\Phi_r$ the output signal will be phase locked to input signal.

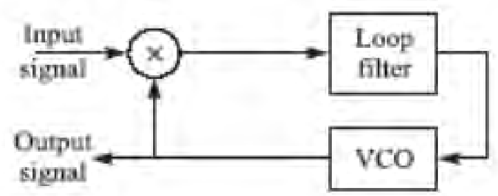

Figure 11 Basic elements of a PLL

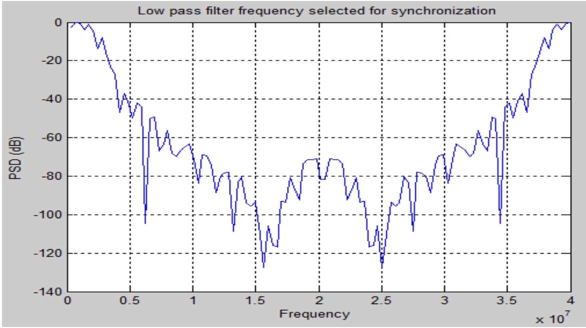

Figure 12 synchronized signal

From the figures 6 and 12 it is observed that the carrier synchronization has been achieved.

V.CONCLUSION

In order to achieve the various modulation standards in the third and upcoming generations in communication industry, the software defined radio offer the flexibility to attain this goal and simultaneously providing high performance. Synchronization of carrier signal is one of the difficult tasks in communication. In this paper 8PSK modulation scheme is used for data transmission. Here the carrier recovery for 8PSK modulation has been performed using PLL.

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