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Novelty in QPSK Modulation using Cordic Based Technique

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Abstract: *As is common to all digital communication systems, both the modulator and demodulator must be designed at the same time. How data is encoded and represented in the communications system transmitter-receiver pair have prior knowledge of it so that Digital communication is possible. The modulator and the demodulator are structured like that they will behave opposite to each other in all digital communication systems, both the modulator at the transmitter and the demodulator at the receiver are structured such that they operate opposite to each other. Most communications systems make up one amongst 3 categories: information measure economical, power economical, or cost efficient. In this paper CORDIC rotation based QPSK technique is used for the carrier synchronization.*

Keywords: Modulation, QPSK, CORDIC, Phase-shifting, Carrier synchronization

I. INTRODUCTION

Modern communication system makes use of the digital communication techniques mainly because of the development in the field of VLSI and DSP. It is a lot of price effective and has blessings like noise immunity, electric resistance to the impairments of channels, error detection and correction, encryption, multiplexing of video, sound and data, security, source coding ,equalization. The particular digital modulation techniques should provide low signal to noise ratio, low bit rate, occupy a minimum bandwidth, cost effective and easy to implement. In physical science and telecommunications, modulation is that the technique of varied one or a lot of parameters of a high-frequency periodic wave, called the carrier signal, with information bit stream to be transmitted called a modulating signal.

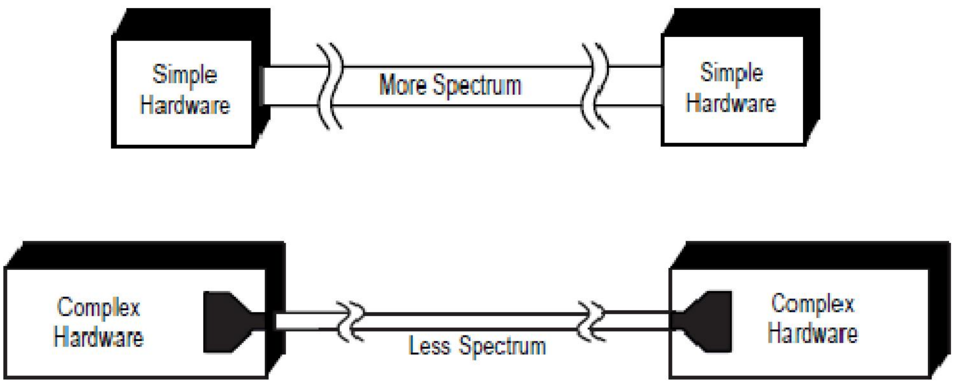

Fig. 1 fundamental trade off

QPSK technology is widely used in digital microwave communication systems, broadband access digital satellite communications systems, and mobile communications and cable television systems. QPSK modulation is that the most suitable option for digital satellite transmission for variety of reasons satellite power transmission potency, anti-interference and comprehensive consideration of the size of the antenna. QPSK reception typically uses coherent reception of the approach, thus there square measure high necessities on the performance of carrier synchronization [1].Carrier synchronization is additionally referred to as carrier recovery, that is, through the receiving device to generate a carrier with the received signal synchronization in phase with the local oscillation, the receiver to do coherent demodulation. Synchronization is additionally a sort of data, consistent with the acquisition and transmission of synchronous data, can be divided into external synchronization and self-synchronization method.By the sender to send a special synchronization data (often stated because the pilot), the receiver to extract the pilot as a synchronization signal technique, referred to as theexternal synchronization technique, the sender does not send a special synchronization information, the receiver managed to extract the synchronization information from the received method, known as the self-synchronization method.The self-synchronization technique could be a lot of fascinating synchronization technique than the external synchronization technique, because all the power and bandwidth can be assigned to the signal transmission [3].

II. QPSK Modulation and Demodulation Algorithm

The proof of how phase modulation, and hence QPSK, is demodulated is shown below. The proof begins by defining Euler's relations, from which all the trigonometric identities can be derived. Euler's relations state the following:

$$sin\omega t = \frac{e^{j\omega t}}{2j} - \frac{e^{-j\omega t}}{2j} \qquad cos\omega t = \frac{e^{j\omega t}}{2} + \frac{e^{-j\omega t}}{2} \tag{1.1}$$

Now considering the multiplication of two sine waves together, thus:

$$\sin^2 \omega t = \frac{e^{j\omega t}}{2j} - \frac{e^{-j\omega t}}{2j} \times \frac{e^{j\omega t}}{2j} - \frac{e^{-j\omega t}}{2j} = \frac{e^{2j\omega t} - 2e^0 + e^{-2j\omega t}}{-4}$$

$$= \frac{1}{2} - \frac{1}{2}\cos 2\omega t \tag{1.2}$$

From equation 2.7, it can be seen that multiplying two sine waves together (one sine being the incoming signal while the other being the local oscillator at the receiver mixer) results in an output frequency $1/2cos2\omega t$ double that of the input (at half the amplitude) superimposed on a dc offset of half the input amplitude.

Similarly, multiplying $sin\omega t$ by $cos\omega t$ gives:

$$sin\omega t.cos\omega t = \frac{e^{2j\omega t} - e^{-2j\omega t}}{4j}$$

$$= \frac{1}{2} sin2\omega t \tag{1.3}$$

Which gives an output frequency $\sin 2\omega t$ double that of the input, with no dc offset. It is now fair to make the assumption that multiplying $sin\omega t$ by any phase-shifted sine wave ($sin\omega t+\varphi$) yields a demodulated waveform with an output frequency double that of the input frequency, whose dc offset varies according to the phase shift, φ.

To prove this,

$$\sin \omega t.sin(\omega t + \varphi) = \frac{e^{j\omega t} - e^{-j\omega t}}{2j} \times \frac{e^{j(\omega t+\varphi)} - e^{-j(\omega t+\varphi)}}{2j}$$

$$= \frac{e^{j(2\omega t+\varphi)} - e^{j(\omega t-\omega t-\varphi)} + e^{j(\omega t+\varphi-\omega t)} + e^{-j(2\omega t+\varphi)}}{-4}$$

$$= \frac{cos(2\omega t+\varphi)}{-2} - \frac{e^{j\varphi} + e^{-j\varphi}}{-4} = \frac{cos(2\omega t+\varphi)}{-2} + \frac{\cos\varphi}{2}$$

$$= \frac{cos\varphi}{2} - \frac{\cos(2\omega t+\varphi)}{2}$$

Thus, the above proves the supposition that the phase shift on a carrier can be demodulated into a varying output voltage by multiplying the carrier with a sine-wave local oscillator and filtering out high-frequency term. Unfortunately, the phase shift is limited to two quadrants; a phase shift of $\pi 2$ cannot be distinguished from a phase shift of $-\pi 2$. Therefore, to accurately decode phase shifts present in all four quadrants, the input signal needs to be multiplied by both sinusoidal and co-sinusoidal waveforms, the high frequency filtered out, and the data reconstructed.

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$$cos\omega t \cdot \sin(\omega t+\varphi) = \frac{e^{j\omega t}+e^{-j\omega t}}{2} \cdot \frac{e^{j(\omega t+\varphi)}-e^{-j(\omega t+\varphi)}}{2j}$$
$$= \frac{e^{j(2\omega t+\varphi)}-e^{j(-\varphi)}+e^{j(\varphi)}-e^{-j(2\omega t+\varphi)}}{4j}$$
$$= \frac{sin(2\omega t+\varphi)}{2}+\frac{e^{j\varphi}-e^{-j\varphi}}{4j} = \frac{sin(2\omega t+\varphi)}{2}+\frac{sin\varphi}{2} \quad (1.4)$$

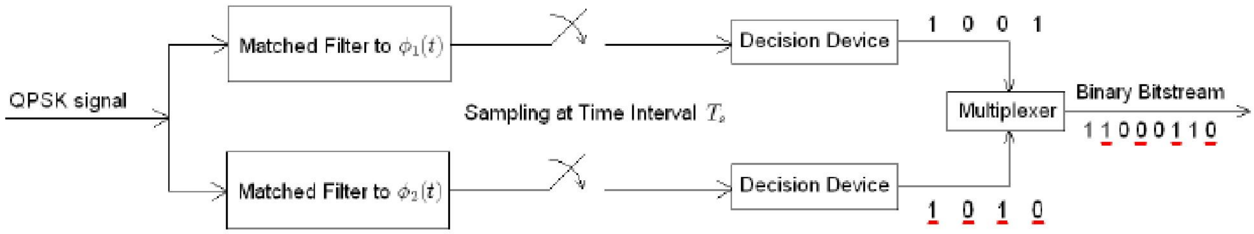

Fig. 2 Block diagram of QPSK demodulator

The matched filters can be replaced with correlations. Each detection device uses a reference threshold price to work out whether or not a one or zero is detected.

III. Result and Simulation

Pi/4 QPSK modulator is used for the modulation of the carrier. FIR filter is used for the filter out the noises and tuning of the frequency and phase the frequency and phase offset are used.The CORDIC-Based PLL subsystem which consists of a Phase Error Detector (PED), P+I Loop Filter, Phase Accumulator, and CORDICROTATE to form the corrected complex signal output values. The simulation model used is shown in fig. 3. The results here show the phase error is with in the .5 degree range and carrier signal output is synchronized with the input signal.

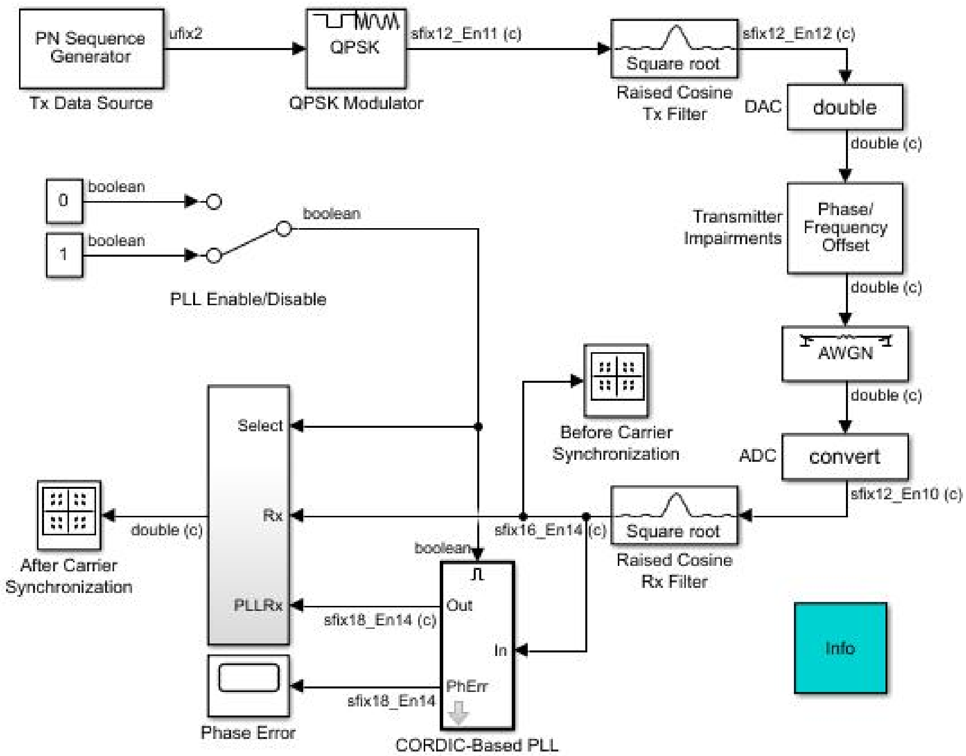

Fig.3 CORDIC-Based QPSK Carrier Synchronization

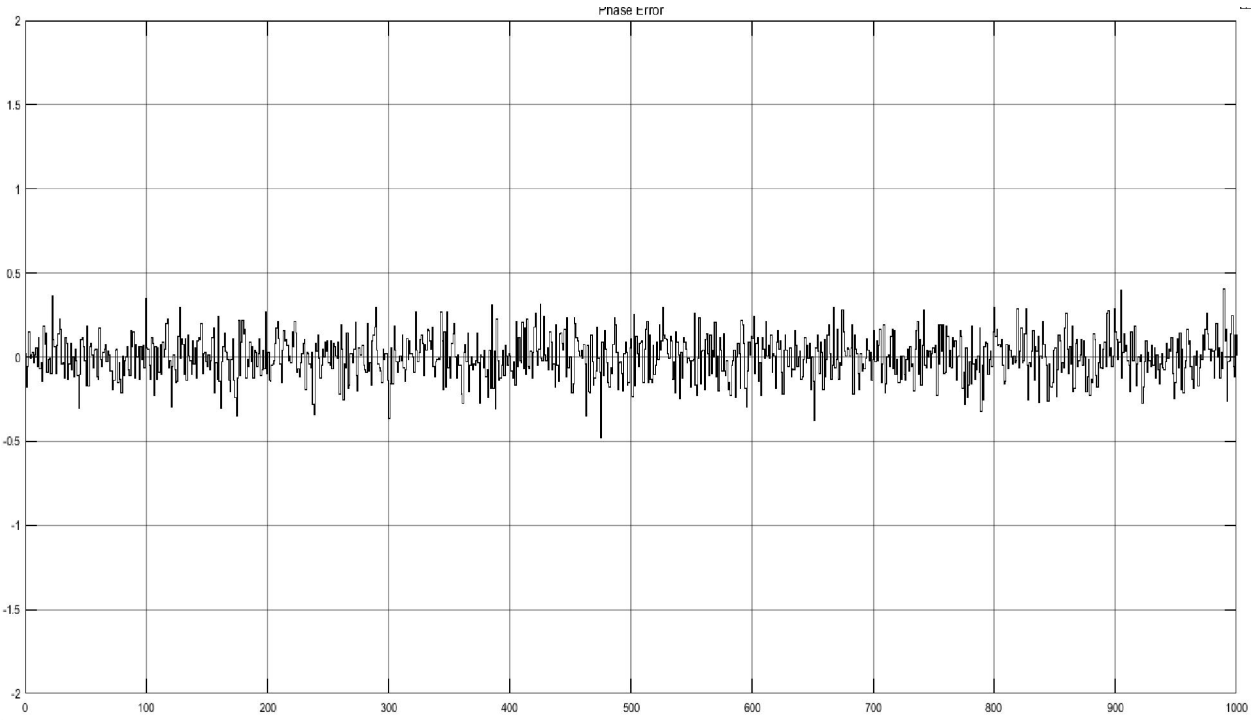

Fig. 4 Phase error in degree

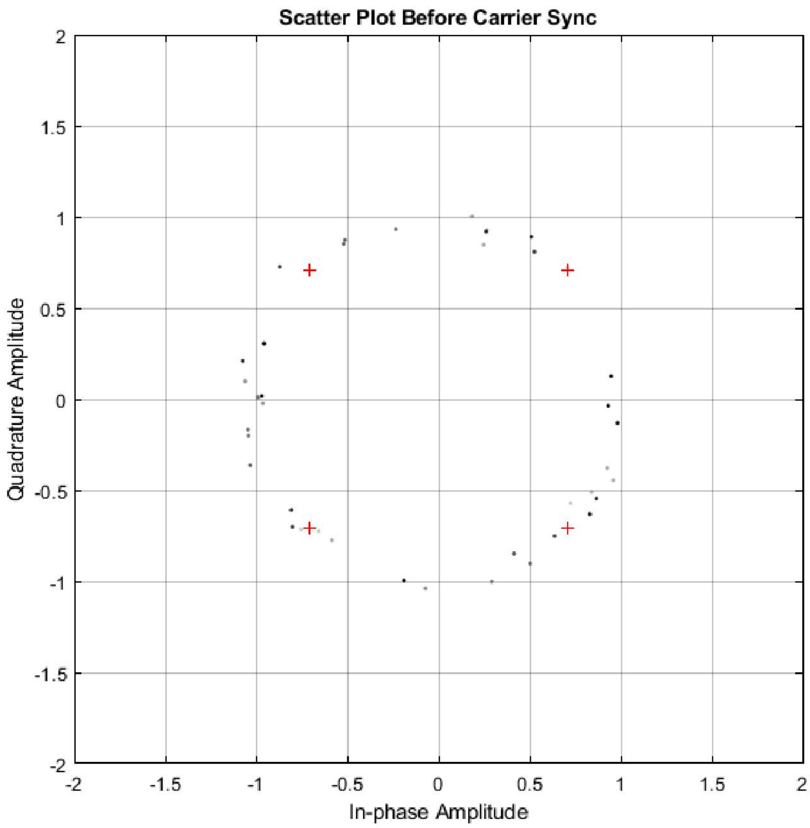

Fig. 5 Scatter plot before carrier synchronization

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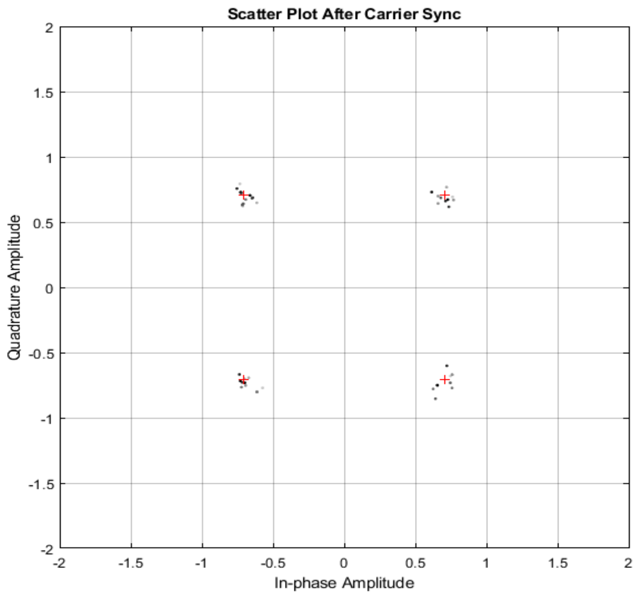

Fig. 6 scatter plot after carrier synchronization

IV. CONCLUSION AND FUTURE SCOPE

This work proposes a CORDIC (Coordinate Rotation Digital Computer) rotation algorithm in a digital PLL (Phase Locked Loop) implementation for QPSK carrier synchronization. Carrier from the modulator as the modulator & demodulator segments will have certain distance from each other. So we produce carrier recovery circuits using PLL (Phase Locked Loop) for the purpose. The phase-locked QPSK receive signal output contains phase ambiguity. For further analysis (e.g., symbol error rate computations), this phase ambiguity may be resolved using one of a number of well-known methods, including known training (preamble) signals, varying demodulator phase offsets, constellation re-ordering, etc. We took the QPSK signal from the modulator to the demodulator with the help of a wire. It is possible to upgrade the system as wireless with the help of an Antenna. For using antenna, we have to use mixer circuit to convert the signal to intermediate signals as well as to radio signal. To implement the hardware model will be leave on the future scholars. In every work there is always scope of improvement.

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