DIRECT SEQUENCE SPREAD SPECTRUM DETECTION USING MODIFIED AMPLITUDE SHIFT KEYING DETECTION: WITH MATLAB & MICROSIM SIMULATION

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Abstract: This paper presents a new method for demodulation of direct sequence spread spectrum using modified amplitude shift keying detection. The proposed technique performs as a peak detector and filter. The bit error rate (BER) performance is calculated which show improvement than the traditional techniques for non coherent ASK receivers and is as good as equal to binary phase keying system. The proposed circuit was simulated using MATLAB & MicroSim software and simulated waveforms are presented. Very less BER obtained at operating frequency of 10 MHz for the proposed circuit.

Keywords: Amplitude Shift Keying (ASK), Bit Error Rate (BER), Additive White Gaussian Noise Channel (AWGN), Binary Amplitude Shift Keying (BASK), ON-OFF Keying (OOK).

Introduction: In ASK, a finite number of amplitudes of the carrier wave are used for modulation & other parameter i.e. phase, frequency of the carrier remains unchanged. The bit 1 of the digital message signal is transmitted by a carrier of particular amplitude and the bit 0 is transmitted by a carrier of other (changed) amplitude. Thus the amplitude of the carrier changes keeping the frequency and phase constant. ON-OFF keying (OOK) is a special case of ASK where the amplitude of one of the carrier is taken as 0. Rapid development of biomedical in the last decodes high performance and speed electronics devices have reported for the capturing the real time signal for the treatment and continuous monitoring the patient in the intensive care unit. Schemes such as binary phase shift keying (BPSK), ASK m-ary etc are proposed. But the most frequent and commonly used technique is ASK, as it is simple and easy to implement. Recently ASK demodulator is proposed using sigma delta demodulator for biomedical implantation [1]. Paper reported by Marcelo Barú [2] for ASK detection using CMOS transistors although consume less power but presents glitches at the output due changing and discharging of output capacitor. The circuit reported by previous author [3] has very complicated circuit with two current edge detector and two comparators and output stage. This circuit has its operating speed of 250 KHz and at the output energy of the signal is not improved. Also the AWGN noise performance is not carried out. In view of above we have proposed a new method with improved bit error rate and inter symbol interference.

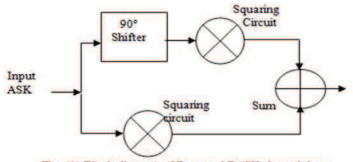


Fig: (1) Block diagram of Proposed BASK demodulator

Fig. 1 shows the concepts of the proposed ASK demodulator circuit. It consists of a 90° phase shifter, two squaring circuits, one summer. The phase of input sinusoidal signal $A\sin(2\pi ft)$ (where A = amplitude and f = frequency) is shifted by 90º by all pass phase shifter [4]. The output signal of 90º phase shifter can be written as $A\cos(2\pi ft)$. The squaring circuit 1 gives its output as $A^2 \cos^2(2\pi ft)$. The output of squaring circuit 2 is given as $A^2 \sin^2(2\pi ft)$. Both these signals are summed in the summer 2 and give the output as A^2 as per the equation:

$$A^2 \sin^2(2\pi ft) + A^2 \cos^2(2\pi ft) = A^2 \qquad (1)$$

The phase of the input sinusoidal signal $A \sin(2\pi ft)$ (where A = amplitude and f = frequency) is shifted by 90º by adjusting the resistance (R) and capacitor (C) of the RC network of the all-pass filter. in which the amplitude of the 90º phase-shifted signal is kept equal to the amplitude of the input sinusoidal signal. The all-pass filter passes the input signal with unity gain and without any reduction in the amplitude. The summed signal, after square rooting, becomes A^2, which provide a peak to peak output.

Simulation & Waveforms: Fig: (2) shows the circuit diagram of proposed circuit in MATLAB & Fig.(3) shows the final waveform.

Proposed BASK Receiver System:

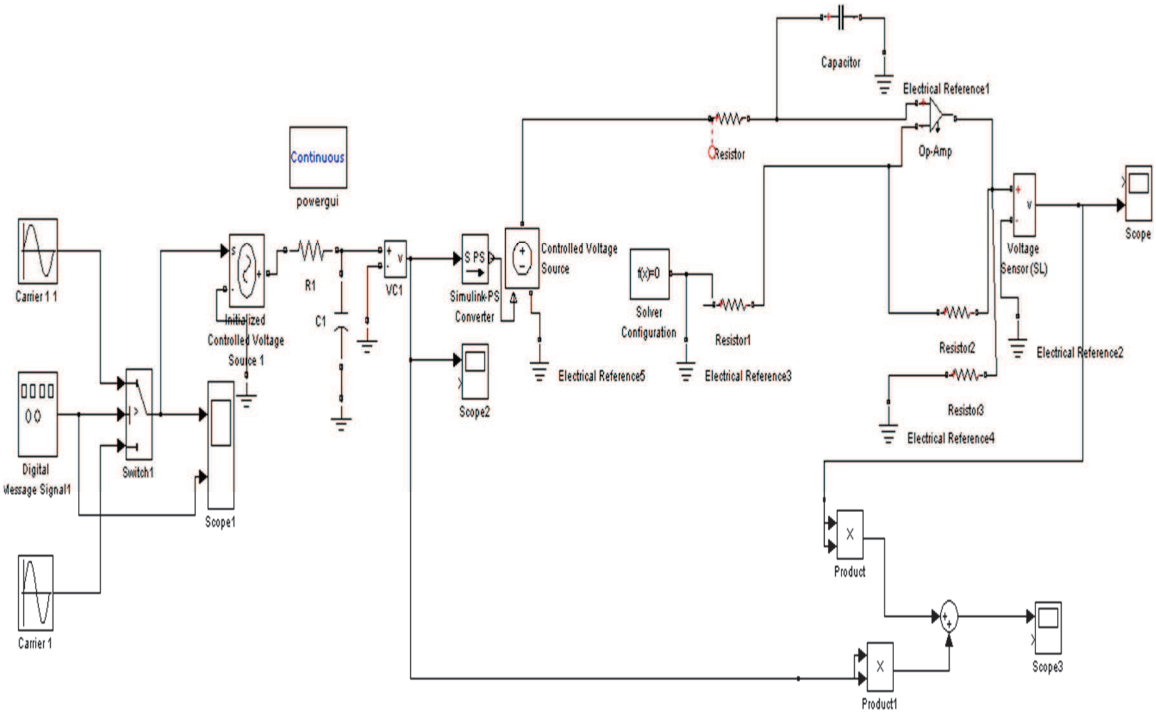


Fig. (2) Circuit diagram in Matlab Simulink.

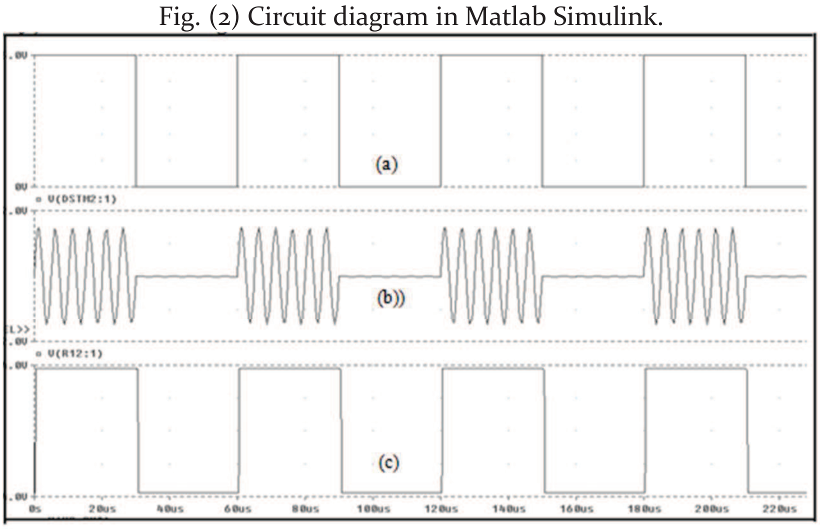


Fig.3 Simulated waveform (a) Input data , (b) Received BASK signal, (c) Demodulated data waveform.

The frequency of the input ASK data is taken as 10MHz. The proposed circuit was implemented by using high-speed operational amplifiers [5], with input signal 1Volt peak of peak.

Bit Error Rate Calculation: At the output of the sum we get the signal as V_m^2 for logic '1' and '0' for logic '0', which is the normalized power of the detected signal. We know that the probability of error of the optimum filter is given as,

$$P_e = \frac{1}{2} erfc\left[\frac{x_{o1}(T) - x_{02}(T)}{2\sqrt{2\sigma}}\right] \quad (2)$$

$$\left[\frac{x_{o1}(T) - x_{02}(T)}{\sigma}\right]^2_{\max} = \int_{-\infty}^{\infty} \frac{|X(f)|^2}{S_{ni}(t)} df \quad (3)$$

Considering the white Gaussian noise, the power spectral density of white Gaussian noise is given as:

$$S_{ni}(f) = \frac{N_o}{2} \quad (4)$$

Substituting this value of $S_{ni}(f)$ in above equation, we get,

$$\left[\frac{x_{o1}(T)-x_{02}(T)}{\sigma}\right]^2_{\max} = \frac{2}{N_o}\int_{-\infty}^{\infty}|X(f)|^2 df \quad (5)$$

Using Parseval's power theorem, above equation becomes as:

$$\left[\frac{x_{o1}(T)-x_{02}(T)}{\sigma}\right]^2_{\max} = \frac{2}{N_o}\int_{-\infty}^{\infty}x^2(t)dt \quad (6)$$

In case of ASK x(t) is present from o to T, hence the limits in above equation (5) can be changed as:

$$\left[\frac{x_{o1}(T)-x_{02}(T)}{\sigma}\right]^2_{\max} = \frac{2}{N_o}\int_{0}^{\infty}x^2(t)dt \quad (7)$$

Further $x(t) = x_1(t) - x_2(t)$. and for ASK, $x_2(t)$ is zero, hence $x(t) = x_1(t)$. so equation (6), can be written as:

$$\left[\frac{x_{o1}(T)-x_{02}(T)}{\sigma}\right]^2_{\max} = \frac{2}{N_o}\int_{0}^{T}x_1^{\,2}(t)dt \quad (8)$$

From the output of sum, the value $\int_0^T x^2(t)dt$ is V_m^2T, therefore equation (8) can be written as:

$$\left[\frac{x_{o1}(T)-x_{02}(T)}{\sigma}\right]_{\max} = \sqrt{\frac{4P_sT}{N_o}} \quad (9)$$

Putting this value in the equation of error probability of ASK is given as:

$$P_e = \frac{1}{2}erfc\left\{\frac{1}{2\sqrt{2}}\sqrt{\frac{4P_sT}{N_o}}\right\} \quad (10)$$

We know that P_S T= E, Energy of one bit
Probability of error in terms of energy of one .bit can be written as:

$$P_e = \frac{1}{2}erfc\left\{\frac{1}{2\sqrt{2}}\sqrt{\frac{4E}{N_o}}\right\} \quad (11)$$

Average energy of per bit $E_b = \frac{E}{2}$, Putting this value in the equation (12)

$$P_e = \frac{1}{2}erfc\left\{\frac{1}{2\sqrt{2}}\sqrt{\frac{4.2Eb}{N_o}}\right\}, \quad (13)$$

In proposed case the final value of bit error probability is:

$$P_e = \frac{1}{2}erfc\left\{\sqrt{\frac{Eb}{N_o}}\right\} \quad (14)$$

Therefore, this technique improves the BER of ASK system equal to the bit error rate of binary phase shift keying technique.

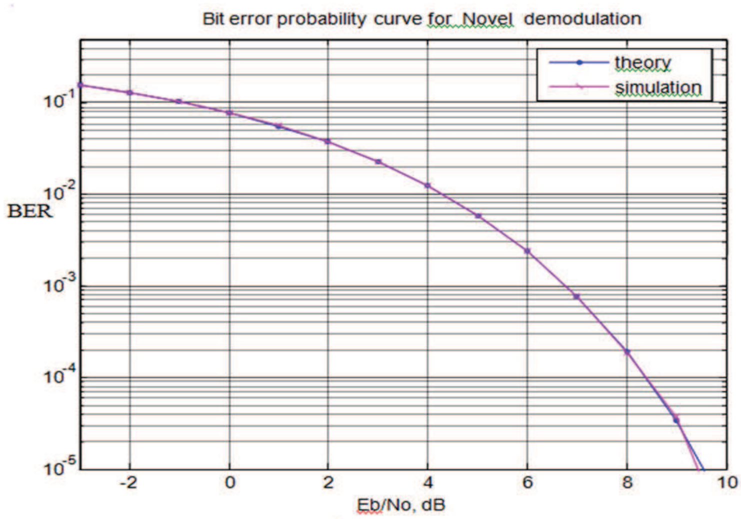


Figure (3)

Direct Sequence Spread Spectrum Signal Detection using Modified ASK Technique: As the wireless personal communication field has grown over the last few years, the method of communication known as spread spectrum has gained a great importance. It involves spreading [9] the desired signal over a bandwidth much larger than the minimum bandwidth necessary to send the signal.

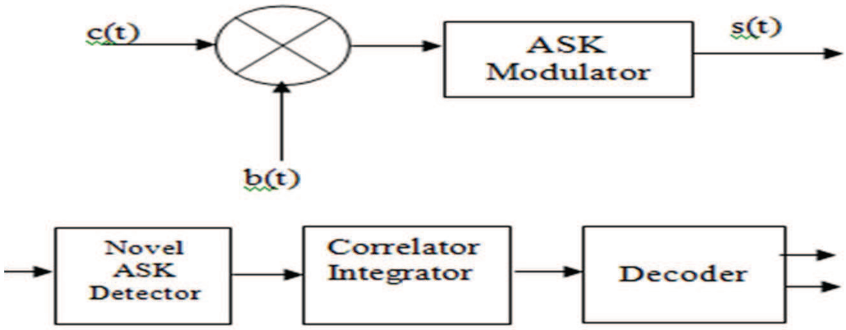
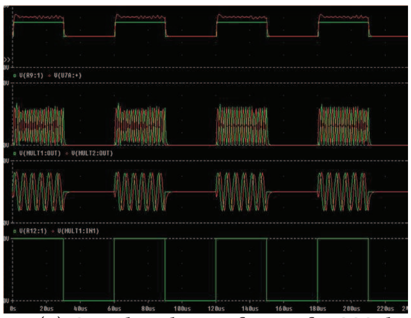


Fig.(4)

Fig.(4) shows the block diagram of DSSS Transmitter & Receiver where c is the PN Sequence code and b is the Data bits to be transmitted and s(t) shows the final DSSS signal. At the receiving end the message signal b(t), is recovered by multiplying the received signal with the locally generated PN sequences in multiplier stage. The multiplied signal is demodulated and passed to decision device. Decision device take the decision on the detector output in favors of 0 or 1. Hence the transmitted data is recovered back as shown below. Here it is assumed that there is perfect synchronization between the transmitter and receiver. The PN sequences used at the receiver are, the same used at the transmitter. Also there is perfect synchronization between the data received and local PN sequences. Fig.5 Shows the waveform of detected Data bits from the Direct Sequence Spread spectrum signal with the help of MicroSim software.



Fig(5) Simulated waveform of DSSS detection

Results: A comparison between the theoretical BER and the simulated transmission BER, which gives very good results, is presented in this section.

(1) The output of Proposed demodulator is V_m^2 for logic "1" and "0"for logic 0 so, we can optimized a batter threshold level which increasing the SNR and thus decreasing the BER.

Comparison of the noise performances of different schemes with purposed method.

(a) Existing error probability for ASK

$$P_e = \frac{1}{2} erfc\left\{\sqrt{\frac{Eb}{2N_o}}\right\}$$

(b) In proposed case the final value of bit error probability is $P_e = \frac{1}{2} erfc\left\{\sqrt{\frac{Eb}{N_o}}\right\}$

(c) Error probability in coherent binary FSK

$$P_e = \frac{1}{2} erfc\left\{\sqrt{\frac{Eb}{2N_o}}\right\}$$

(d) Error probability in coherent binary PSK, Coherent QPSK, coherent MSK

$$P_e = \frac{1}{2} erfc\left\{\sqrt{\frac{Eb}{N_o}}\right\}$$

Conclusion: In this paper we have proposed and simulated an ASK detector using 90 degree phase shifter. It performs better than the conventional ASK and equal to coherent binary PSK, coherent QPSK, coherent MSK, and coherent binary FSK technique in all areas of concern while maintaining Simplicity. Circuit was simulated up to 10MHz frequency using PSPICE software. An example of the simplicity of a proper implemented receiver is the "Novel amplitude shift keying receiver" whose performance was outlined in this paper.

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