

## Synchronous Quadri Phase Shift Keying

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**Abstract:** The advantage of the digital communication system includes less noise and high reliability. The provision of reliable performance, exemplified by a very low probability of error, is one of the important goal in the effective utilization of channel bandwidth. This study proposes a new keying scheme called as synchronous quadric phase shift keying which is an extension of phase shift keying. In the quadric phase shift keying the modulation scheme is characterized by the fact that the information carried by the transmitted work is contained in the phase of the carrier which can take any one of the four equally spaced values such as  $\pi/4$ ,  $3\pi/4$ ,  $5\pi/4$ ,  $7\pi/4$ . In the synchronous quadric phase shift keying the carrier can take simultaneously any phase value. The advantages of the proposed scheme include high reliability and improved bandwidth.

**Key words:** Synchronous, quadric phase, extension, shift keying, communication, modulation scheme

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### INTRODUCTION

The non-linear power amplification efficiency problem, usually implies the adoption of quasi or constant envelope modulations, like GMSK (Gaussian Minimum Shift Keying), CPM (Continuous Phase Modulation) (Aulin and Sundberg, 1981), FOQPSK (Simon and Yan 1999) or ENCAP-OQPSK, to minimize the inherent distortion. In Simon and Yan (1999) the out of band was reduced replacing the IJF encoder and cross-correlator by a single crosscorrelator, where the cross-correlation mapping rule, based on symbol-by-symbol representation, eliminates the slope discontinuity associated to the IJF-QPSK (Jitter Free-Quadrature Phase Shift Keying) cross correlation operation. Also, Simon and Yan (1999) shown a new improved emission/reception method for FOQPSK, based in a symbol by symbol mapping operation combined with a trellis coding scheme.

According to Gusmao and Esteves (1988, 1990) it was demonstrated that the ENCAP-OQPSK format, allows the description of a great variety of signals with or without constant envelope. The rules of codification inherent to this format, estimates the specification of  $4N$  generating functions not null in the bit interval. As it was emphasized in Gusmao and Esteves (1988, 1997) one ENCAP-OQPSK format advantage is the ability to describe analytically the signals after the transmission through a band-pass non-linearity without memory. So this format can be applied to describe analytically the output of the non-linearity. In the ENCAP  $4N$  format context, is carried

a new analytical description for signals directly generated from this format. The analytical characterization of encoded signals is made shown that the complex envelope can be described as function of  $4N+2$  pulses, not null in the time interval  $[-T, T]$  and defined from a set of  $4N$  generating functions. Consequently, emission structures adjusted to this type of signals are presented, based in a serial association of two encoders with a mapper that establishes one correspondence between the codified sequences and the symbol associated to each complex envelope component. It is also demonstrated that, by using a proper generating functions set with this coding rule, it is possible to include as an particular case of ENCAPOQPSK format the signal interpretation made in Simon and Yan (1999). The equivalence between the ENCAP format and the generalized ENCAP-OQPSK format is directly related with the decomposition of ENCAP-OQPSK signals in linear OQPSK type components. This equivalence (Gusmao *et al.*, 1998; Forney, 1973) leads to OQPSK schemes with lower pulses number and simpler emission/reception structures, since it only needs the specification of  $4N$  different pulses shapes.

### SYNCHRONOUS QUADRI PHASE SHIFT KEYING

The modulation scheme is characterized by the fact that, the information carried by the transmitted wave is contained in the phase.

$$S_i(t) = \begin{cases} \sqrt{2E/T} \cos [2\pi f_c t + (2i-1)\pi/j] & 0 \leq t \leq T \\ 0 & \text{elsewhere} \end{cases}$$

$f_c$  cut off frequency, E Energy of the signal,  $i = 1, 2, 3, 4$  and  $j$  can take either even order or odd order integrals Where T is the symbol duration. Each possible value of the phase corresponds to an unique pair of bits called a debit. Thus for example we may choose the foregoing set of phase values to represent the gray encoded set of debits 10, 00, 01 and 11.

In general

$$S_i(t) = \begin{cases} \sqrt{2E/T} \cos [(2i-1)\pi/j] \cos 2\pi f_c t \\ -\sqrt{2E/T} \sin [(2i-1)\pi/j] \sin 2\pi f_c t & 0 \leq t \leq T \\ 0 & \text{elsewhere} \end{cases}$$

There are only two ortho normal basis functions (Fig. 1).

Simultaneously four message signals can be transmitted.

$b_1(t), b_2(t), b_3(t), b_4(t)$

$b_1 = 1 \quad b_2 = 1 \quad b_3 = 1 \quad b_4 = 1$   
 01 01 01      01 01 01      01 01 01      01 10 10

$$\Phi_1(t) = \sqrt{2/T} \cos 2\pi f_c t \quad 0 \leq t \leq T$$

$$\Phi_2(t) = \sqrt{2/T} \sin 2\pi f_c t \quad 0 \leq t \leq T$$

There are 4 message points and the associated signal vectors are desired by

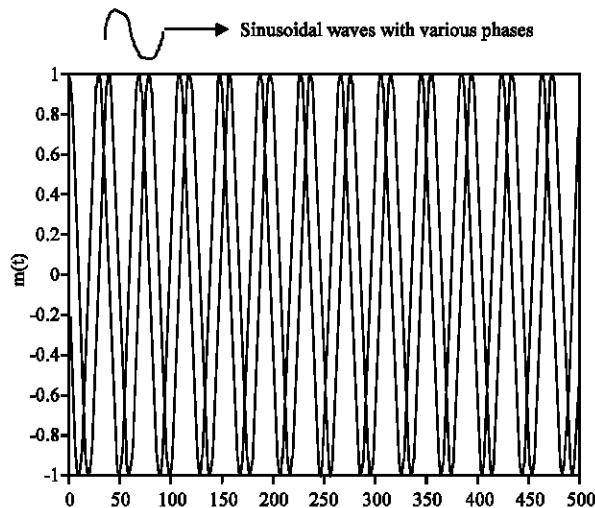


Fig. 1: Two ortho normal basis functions

$$S_i = \begin{cases} \sqrt{E} \cos (2i-1)\pi/j \\ -\sqrt{E} \sin (2i-1)\pi/j & i = 1, 2, 3, 4 \end{cases} \quad \begin{matrix} i = 1, 2, 3, 4 \\ x_j = \text{integral multiples} \\ \text{of even No. or integral} \\ \text{multiples of odd No.} \end{matrix}$$

Thus a synchronous QPSK signal is characterized by having a two dimensional signal constellation (i.e.,  $N = 2$ ) and four message points (i.e.,  $M = 4$ ) as illustrated in the Fig. 2.

These regions are marked as  $Z_1, Z_2, Z_3, Z_4$ . The received signal  $x(t)$  is defined as:

$$x(t) = s_i(t) + w(t): 0 \leq t \leq T$$

$$i = 1, 2, 3, M$$

Where,  $w(t)$  is the sample function of a white Gaussian noise process of Zero mean and power spectral density  $N_0/2$ .

$$x_1 = x(t) \Phi_1(t) dt = \sqrt{E} \cos [(2i-1)\pi/j] + w_1$$

and

$$x_2 = (t)\Phi_2(t) dt = \sqrt{E} \sin [(2i-1)\pi/j] + w_2$$

Where,  $i = 1, 2, 3, 4$ .

The transmitter and receiver diagram is depicted in Fig. 3 and 4.

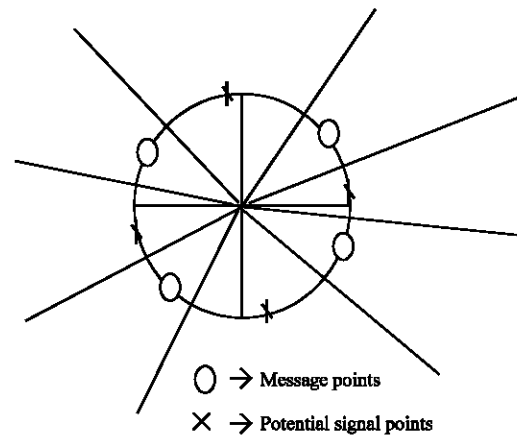


Fig. 2: Signal space diagram

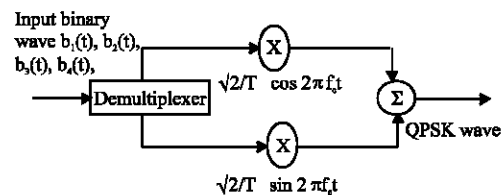


Fig. 3: Synchronous QPSK transmitter

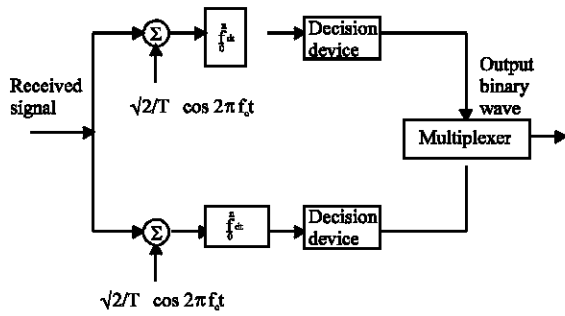


Fig. 4: Synchronous QPSK receiver

Thus  $x_1$  and  $x_2$  are sample values of independent Gaussian random variables with mean values equal to  $E \cos. [(2i - 1)\pi/j]$  and  $-E \sin [(2i-1)\pi/j]$ , respectively with a common variance equal to  $N_0/2$ .

### CONCLUSION

This study has presented an overview of Synchronous QPSK behavior in a simple experimental scenario. It is developed under two popular keying schemes such as Frequency shift keying and amplitude shift keying. The subsequent study of keying schemes has revealed that Synchronous QPSK performance is slightly better than QPSK and efficiently power saving than FSK schemes. The power and Bandwidth consumption is better in synchronous QOSK Schemes. The advantage of the digital communication system includes less noise and high reliability. The provision of reliable performance, exemplified by a very low probability

of error, is one of the important goal in the effective utilization of channel bandwidth. Thus this study proposes a new keying scheme called as synchronous quadric phase shift keying which is an extension of phase shift keying.

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