# ALGORITHM OF PULSE POSITION MODULATED SIGNALS RECEPTION IN THE CHANNEL WITH SYNCHRONOUS MULTIPLE ACCESS

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**Abstract**

This article covers the system (wireless chip area network, WCAN) uses a range of UWB (ultra wide band) with PPM (pulse position modulation) modulation for wireless communications between the chips. The article contains materials describing the standard for UWB. Also considered are widely used for signal detection in UWB OR receiver and an analytical calculation of probability of bit error. In addition, we propose a new algorithm for signal reception based on the calculation of the maximum likelihood function, an analytical computation for calculating the probability of bit error. A comparative analysis of probabilities of bit error of the proposed algorithm reception with OR receiver.

## I. INTRODUCTION

At the present stage of development of the technology developed increasingly sophisticated systems that can consist of a large number of boards and chips, placed on them. These factors have created the preconditions for the emergence of new means of communication - a wireless connection between the chips (wireless chip area network, WCAN) [2, 4, 5]. The emergence of this standard is primarily due to a number of limitations inherent in wired communication linyam. The most important of them can be considered expensive and in some cases impossible to strip [2, 3]. Respectively, to the essential requirements imposed on wireless communications systems include low cost of production and operation, and ease of implementation. To date, work is underway to create such systems, but one of the most promising at the moment is a system of communication between the chips that use radio.

For communication between the chips are widely used range that is dedicated to ultra-wideband signals (UWB) [5 – 7].

Standard IEEE 802.15.4a (UWB) UWB (Ultra Wideband) – UWB radio technology, developed by Intel for data transfer speeds up to 500 Mbps at a distance of several meters. To transfer data using very short radio pulses (less than 1 ns) over a wide frequency range 3.1 ... 10.6 GHz [4]. Using UWB technology can create ad hoc networks in which multiple UWB devices will be able to communicate between any two nodes. Short UWB signals are relatively resistant to multipath attenuation arising when wave reflection from walls, ceilings, buildings and vehicles. High-Speed UWB devices are well suited for use with video streams and applications that require fast data transfers [2]. Narrow UWB equipment can be used to track the location of the terrain owners of wireless devices and various objects. Mobile importance is the fact that a wide spectrum requires much less energy than sending a narrow-band signal, for various signal levels: a broad spectrum of possible use of noise-like signals with low signal to noise ratio.

In systems of this type are widely used by different modulation schemes, (BPSK, DPSK, PPM, etc.). Because as has been noted by one of the main requirements for the transceiver is a low cost and simplicity, the PPM [2, 6] modulation scheme is more attractive than, for example, PSK transceiver (PSK modulation involves the correlation receiver and PPM receiver considerably easier ).

## II. DESCRIPTION THE ALGORITHM OF THE OR RECEIVER

Typically in communication systems between chips transmission time is divided into frames [1]. Each frame consists of several time slots:

$$T_f = T_c M ,$$

where $T_f$ – is the duration of the frame, $M$ – the number of slots, $T_c$ – the duration of the slot.

Each transceiver transmits only once per frame in a random slot. Each data bit is encoded by a large number of pulses. If the transferred unit “1” pulse is recorded in the left half slot, if the zero “0” then the right, respectively, in Fig. 1. The duration of the slot must be greater than the pulse duration.

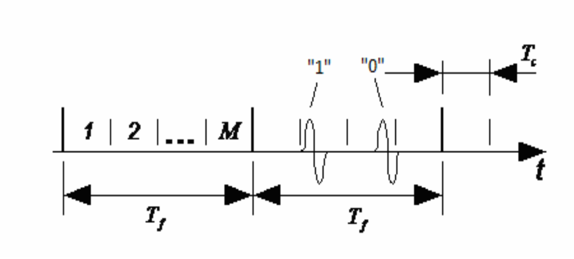


Fig. 1. The communication channel with PPM

We write the signal which is transmitted “k-th” call in “n-th” frame [1].

$$S_n^k(t) = h_{T_c}\left(t - nT_f - \tau_n^{(k)} + v_n^{(k)}\frac{T_c}{2}\right),$$

where – n-th coded symbol of the k-th subscriber, the address component of finding a pulse in the time slots – the address value of the pseudorandom sequence produced by the sensor in communication between two subscribers, $h_{T_c}$ – monocycle used in the system. As such monocycle can be used either Manchester monocycle, which is given in Fig. 2, a Gaussian monocycle which is given in Fig. 3.

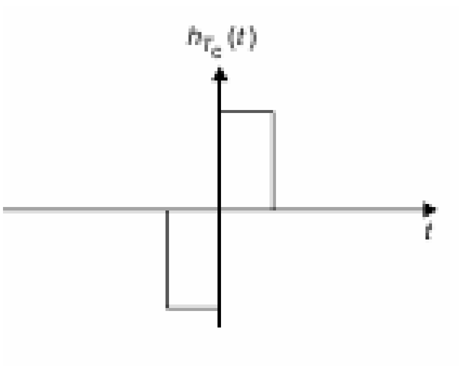


Fig. 2. Manchester monocycle

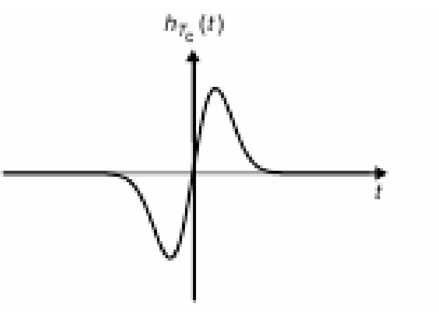


Fig. 3. Gaussian monocycle

Now write the formula for finding the bit error probability. This formula depends on three parameters is [1]:

$$P_b = \frac{1}{2}\left[1 - \left(1 - \frac{1}{M}\right)^{K-1}\right]^N,$$

where M – number of slots in a frame, N – number of pulses that we pass the data bit,. K – number of subscribers.

This receiver has a number of shortcomings. The main drawbacks of these is that the algorithm of such a receiver does not include the number of pulses allocated in subslots from other users in multipath propagation.

On the basis of above stated proposed method of receiving signals is determining the received signal from the maximum a posteriori density.

## III. ALGORITHM TAKING THE MAXIMUM A POSTERIORI DENSITY FUNCTIONS

Suppose we have a system of communication between the chips of any subscriber is connected with another person at random time, and all subscribers have the same sync. With the transfer of information between subscribers may conflict, due to multipath propagation. These is caused by hitting the pulses in time slots used by other subscribers. The decision in this case is much complicated, which increases the bit error probability. Is not the correct signal reception is caused by hitting the pulses in time slots used by other subscribers. The decision in this case is much complicated, which increases the bit error probability.

Propose an algorithm for deciding to the maximum a posteriori density functions.

Suppose we have a communication system in which K – the number of subscribers, M – number of slots per frame, N – number of pulses. In this system, the pulse amplitude for the subscribers of the same and equal to 1. Suppose that due to multipath of subscribers fell into the same time slots.

As well, in this case to decide that the transmitted “1” or “0”?

Let $x_i$ – amplitude when hit in the left subslot (“1”) of pulses from other users, and $y_i$ – respectively, in the right subslot (“0”).

Computablethe probability that the unit was transferred $P(x_i, y_i /"1") = P(x_i - 1, y_i)$ and the likelihood that he was transferred to zero $P(x_i, y_i /"0") = P(x_i, y_i - 1)$.

The calculation showed that for a unit of probability is $P(x_i, y_i /"1") = P(x_i - 1, y_i) = Z \cdot C_{x_i+y_i-1}^{x_i-1}$, for a zero $P(x_i, y_i /"0") = P(x_i, y_i - 1) = Z \cdot C_{x_i+y_i-1}^{y_i-1}$, where Z – a factor which depends on M, N, K.

The decision is reduced to comparison of these probabilities:

$$\frac{P(x_i, y_i/"1")}{P(x_i, y_i/"1")} = \frac{ZC_{x_i+y_i-1}^{x_i-1}}{ZC_{x_i+y_i-1}^{y_i-1}} = \prod_{i=1}^{N} \frac{x_i}{y_i} \geq 1 .$$

Based on these results has been constructed a mathematical model receiver and comparisons of the OR unit and proposed me.

Fig. 4 shows plots of bit error (BER) probability of the number of subscribers with M=2, N=3.

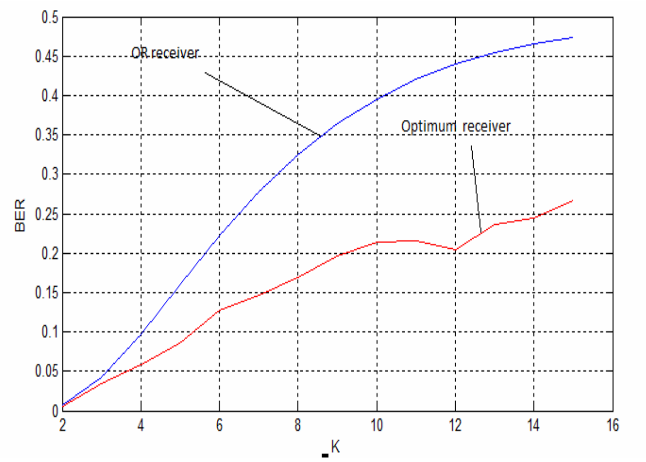


Fig. 4. A plot of bit error probability of the number of subscribers

## IV. CONCLUSION

The proposed algorithm in the article receiving signals is a significant gain in bit error probability as compared to OR receiver. This effect can be seen in Fig. 4.

However, it should be noted that this effect was observed in complete synchronization, for the case of asynchronous operation is necessary to conduct additional studies.

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