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В. В. Корчинський, К. О. Осадчук, В. Й. Кільдішев
ОНАЗ ім. Попова О. С., м. Одеса, вул. Кузнечна 1

МЕТОД МУЛЬТИПЛЕКСУВАННЯ ТАЙМЕРНИХ СИГНАЛЬНИХ КОНСТРУКЦІЙ НА ОСНОВІ ТЕХНОЛОГІЇ OFDM

Розглянуто метод мультиплексування непозиційних таймерних сигнальних конструкцій на основі технології OFDM. В роботі подальший розвиток технології OFDM спрямовано на підвищення захищеності передаваних даних на основі непозиційних таймерних сигнальних конструкцій. Як джерела широкосмугових сигналів запропоновано використовувати таймерні сигнальні конструкції, що дає змогу підвищити структурну й інформаційну прихованість передавання порівняно з РЦК.

Ключові слова: захищеність, OFDM, таймерна сигнальна конструкція.

V. V. Korchynski, E. A. Osadchuk, V. I. Kildishev
ONAT named after A. S. Popova, 1 Kovalska str., Odesa

METHOD OF MULTIPLEXING OF TIMER SIGNAL STRUCTURES BASED ON OFDM TECHNOLOGY

The method of multiplexing of timer signal structures. based on OFDM technology was considered. This technology is used in many data transmission standards, both in wired channels - asymmetric digital subscriber line (ADSL), and in wireless networks – the standards of IEEE 802.11a and HiperLAN/2. OFDM is characterized by high spectral efficiency, resistance to radio frequency interference, low level of multi-path distortion. The OFDM is implemented by multiplexing some number of broadband signals with orthogonal multiplexing and simultaneously transmitting them at different subcarrier frequencies. This technology is developed for discharge-digital codes (DDC), therefore it cannot be fully compatible with non-position signal structures, such as timed signal structures (TSS). In researching, the further development of OFDM technology is aimed at increasing the security of transmitted data based on TSS. As sources of broadband non-position signals, it was proposed to use TSS, which allows to increase the structural and information privacy of the transmission in comparison with the DDC. For this reason, it is important to introduce TSC into advanced data transmission technologies to increase the stealth indicators. The aim of the work is the development of the algorithm for multiplexing timer signals based on the principles of OFDM technology.

Key words: security, OFDM, timer signal structures.

Introduction

OFDM (Orthogonal Frequency Division Multiplex) technology is used in many data transmission standards, both in wired channels – asymmetric digital subscriber line (ADSL) and in wireless networks – IEEE 802.11a and HiperLAN/2 standards. The prevalence of this technology is explained by the following advantages: high spectral efficiency, resistance to radio frequency interference, low level of multipath distortions [1, 2].

The principle of the formation of signal structures in OFDM consists in multiplexing a certain number of broadband signals with orthogonal multiplexing and simultaneously transmitting them at different subcarrier frequencies using a certain type of modulation, for example, QAM. Partial overlapping of subchannels due to orthogonal subcarriers of frequencies with sufficient separation allows to provide the spectral efficiency of the method and to minimize intersymbol interference. This technology is developed for discharge-digital codes (DDC), therefore it cannot be used to the full extent for non-position signal structures, such as timed signal structures (TSS) [1, 2]. In this work, the further development of OFDM technology is aimed at increasing the security of transmitted data based on TSC.

The theory of timer coding [3] was proposed in the 80s of the last century. The usage of timer signals in communication systems allows to increase the amount of transmitted information in the binary channel over limited range of nayqvist elements. Algorithms of controlling the fidelity of received signal structures have also been developed, in which additional test elements are not required. It was shown in [4, 5] that due to TSC, the structural and information stealth of the transmission is increased in comparison with DDC. This is explained by the large variational possibilities for the synthesis of various ensembles of TSC with a slight change in the parameters of their building. For this reason, it is important to introduce TSC into advanced data transmission technologies for the task of increasing the main stealth indicators. The aim of the work is the development of the algorithm for multiplexing timer signals based on the principles of OFDM technology.

Construction of Timer Signal Structures

Let's consider features of construction of various ensembles of TSS and estimate the possibilities of timer coding for data protection against accidental jamming and unauthorized access. As a rule, for the construction the signal structures is selected the time interval $T_c = nt_0$, consists of n nayqvist elements with durance t_0. In the TSS, the moments of modulation, in consists to the positional codes, are multiples not t_0, but the base time interval Δ (where $\Delta = t_0/s$; $s = 1, 2, 3, ..., l$). Thus, the TSS contains pulses with durations $t_c = t_0 + k\Delta$ (где $k = 0, 1, 2, ..., s \cdot (n-2)$). The energy distance between signal structures is determined by the amount $\Delta < t_0$, that's why the number of their realization N_p on the interval T_c significantly more than in the DDC

$$N_p = \sum_{i=1}^{n} \frac{[(n \cdot s) - [(s-1) \cdot i]]!}{i! \cdot [[(n \cdot s) - [(s-1) \cdot i]] - i]!}, \tag{1}$$

where i – number of information modulation moments. In fig. 1 shows an example of the construction of three TSSs on the interval $T_c = 4t_0$, $t_c = 4\Delta$

For the task of detecting and / or correcting errors set N_p is divided into a subset of allowed and unresolved signal structures. In [3], for this problem the quality equation is proposed to use:

$$\sum_{k=1}^{i} A_k x_k \equiv 0 \bmod A_0 \,. \tag{2}$$

In equation (2), it is necessary to find the dependence of the weighting coefficients $A_k (k = 1, i)$ and modul A_0. Also, based on equation (2), a decoding device is implemented. Change at least one value from a set of parameters n, s and i allows to form a new ensemble of signal structures. In fig. 2 shows the change in the ensemble of realizations TSS $N_{p\ \text{тск}}$ depend on n, s and i. change during the communication session ensemble of signal structures allows to create effective algorithms to improve the structural and information stealth transmission [4].

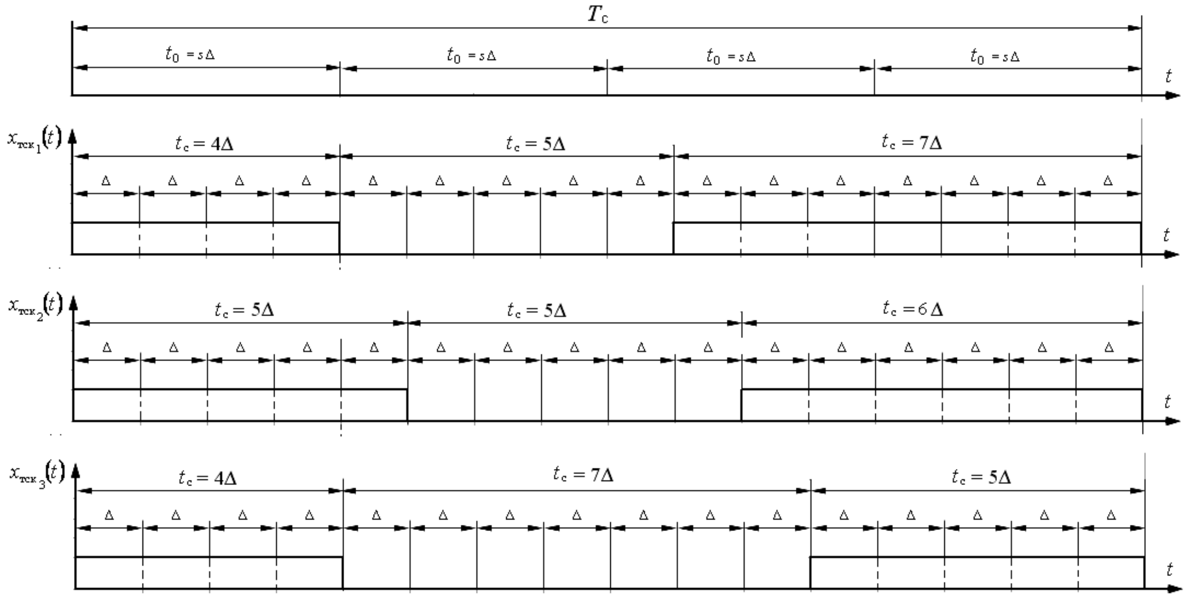

Fig. 1. Construction of three signal realizations of TSS $x_{\text{TSS}i}$ on the time interval $T_{\text{c}} = 4t_0$

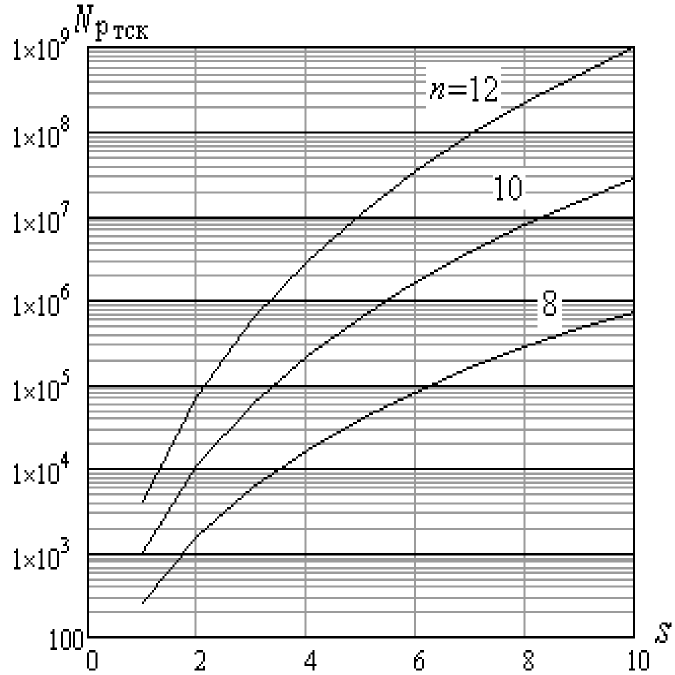

Fig. 2. Dependence of the number of timed signal structures on s at meanings n =8, 10, 12

Algorithm for multiplexing non-position signals

In OFDM, a high-speed stream of positional elements t_0 is transformed in N parallel bit streams with decreasing speed in the same number of times. Each of the streams is transmitted by its own subcarrier with an orthogonal frequency followed by modulation, for example, QAM. Thus, the overall data transfer rate remains unchanged.

In the proposed algorithm, the multiplexing of the timer signals is carried out taking into account the features of their construction and parameters n, s и i. In fig. 3 (a) presents two signal structures tss-1 and tss-2 with parameters: $n = 4$; $s = 4$; $i = 2$. The conversion process is reduced in multiplexing the pulses of the timer signals in the interval $T_{\text{м}} = zT_{\text{с}}$ (where $z = 2$ – the number of multiplexed TSSs with increasing their duration in $L = 2z$).

In fig. 3 (b) and (c) shows the process of extending the pulses of the timer signals $t_{\text{c}1}$, $t_{\text{c}2}$, $t_{\text{c}3}$ in $L = 4$ when multiplexing them on the time interval $T_{\text{м}} = 2T_{\text{c}}$. In view of the non-equidistant pulses $t_{\text{c}1}{}^{*}$, $t_{\text{c}2}{}^{*}$, $t_{\text{c}3}{}^{*}$ The resulting guard intervals will have a different duration. for pulses TSS-1: $T_{ЗИ1} = 16\Delta$, $T_{ЗИ2} = 12\Delta$, $T_{ЗИ3} = 4\Delta$. Obviously, increasing the number of multiplexed channels improves the noise immunity of transmission. For $z = 2$ and $s = 4$ joint use of TSC with OFDM allowed to reduce the number of orthogonal subcarriers of frequencies in comparison with the RCC. Taking into account the time interval, the orthogonal frequencies are selected:

$$f_{\text{н}_i} \leq \frac{1}{\Delta}. \tag{3}$$

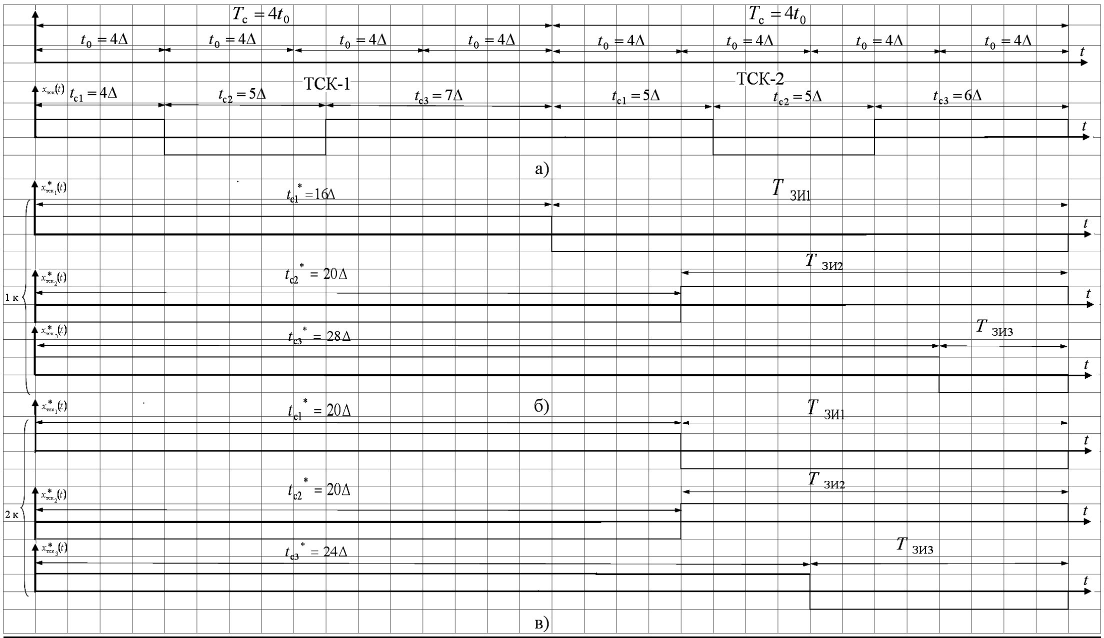

Fig. 3. Multiplexing of pulses of two TSSs

The complex structure of the timing signals and the features of their multiplexing increase the structural stealth of signal structures, which complicates unauthorized access to confidential information.

Conclusion

The proposed method of multiplexing of non-position timer signals with their furher orthogonalization allows: to increase the structural stealth of signal structures; to enlarge the volume of transmitted data in comparison with the ddc; reduce the quality of subcarriers frequency.

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