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NEW COMPOSITE BARKER CODES, GOLD CODES AND KASAMISEQUENCES IN BROADBAND SIGNAL SYNCHRONIZATION SYSTEMS

Volodymyr V. Maksymov, Viktor K. Gatturov, Igor A. Khrapovitsky

Institute of Telecommunication Systems
Igor Sikorsky Kyiv Polytechnic Institute, Kyiv, Ukraine

Background. Currently, noise-like signals (NLS) are widely used, which provide high noise immunity of broadband communication systems (BSS) when transmitting confidential information in an open radio channel, especially in emergency situations. Increasing the efficiency of the NSS is possible with the use of more advanced code structures, in particular, new methods for constructing Barker code sequences used in wireless communication systems with direct sequence spread spectrum technology.

Objective. The aim of the work is to study new composite codes of Barker, Gold and Kasami as synchronization signals of the BSS using simulation.

Methods. Analytical calculation methods are used, as well as simulation modelling in the MatLab software package.

Results. Modelling in the MatLab environment of new composite Barker codes, Gold codes and Kasam isequences as synchronization signals of the BSS showed that the composite sequences of Barker 49 and 77 in the range of SNR change from 0dB to 30dB are more resistant to interference compared to Kasami-63 and Gold-63 by (0,35 – 22,10)%.

Conclusions. Modelling in the MatLab software package showed a greater noise immunity of the new composite Barker codes compared to the Gold and Kasami sequenceswhen used as synchronization signals of the BSS.

Keywords: *Barker codes; composite Barker codes; Gold codes; Kasami sequences; autocorrelation function.*

Introduction

Currently, the demand for noise-like signals (NLS) is determined by the inherent qualities of these signals, which provide high noise immunity of broadband communication systems (BSS) when transmitting confidential information on an open radio channel, especially in emergencies. Although the basics of NLS theory, which are widely used in these networks, are well known, the development of wireless networks requires constant refinement of theoretical provisions in accordance with new data on methods of constructing Barker code sequences used in wireless communication systems with spectrum expansion technology. direct sequence method. NLSs are used in modern multichannel communication systems with code division multiplexing (CDMA, WCDMA), in 802.11 family wireless communication systems with Direct Sequence Spread Spectrum (DSSS) technology, in modern radar systems. Of all the NLSs, Barker sequences, discovered in 1953, have the best correlation characteristics [1]. The main ACF emission in them is equal to the number of bits of the resulting sequence N, and the maximum lateral emission in the positive region has a value of 1. In [2] described 12 sequences with a length of N equal to 14 (14a, 14b), 21 (21a, 21b)), 22 (22a, 22b), 33 (33a, 33b), 49, 77 (77a, 77b), 121, and exceeding the main ACF peak over the positive side ones equal to N. In [3] 4 pairs of new Barker composite sequences were obtained, and in [4] another 28 new pairs that have the same ACF as the sequence from [2]. In [5] the possibility of using new Barker composite sequences as clock signals was investigated and their efficiency in comparison with the sequences from [2] was shown.

The paper investigates new Barker composite codes 49, 77a, 77b (Table 1), Gold codes 63 (Fig. 1) and Kasami sequences 63 (Fig. 2). In table 1 the following notations are introduced: A - canonical Barker sequence; B - inverse sequence; C - mirror sequence; D is the inverse mirror sequence. Given the notation, for example, for the 7th canonical Barker sequence, the following sequences can be written that have the same ACF: A7 - [1 1 1 -1 -1 1 -1]; B7 - [-1 -1 -1 1 1 -1 1]; C7 - [-1 1 -1 -1 1 1 1]; D7 - [1 -1 1 1 -1 -1 -1]. Thus, for variant C7xA7 (D7 x B7) the new Barker composite sequence can be represented as B7A7B7B7A7B7B7B7A7A7A7, which is easily translated into traditional form by replacing the designations of canonical sequences by their code sequences:-1-1-1+1+1-1+1+1+1+1-1-1+1-1-1-1-1+1+1-1+1-1-1-1+1+1-1+1+1+1+1-1-1+1-1+1+1+1-1-1+1-1 +1+1+1-1-1+1-1.

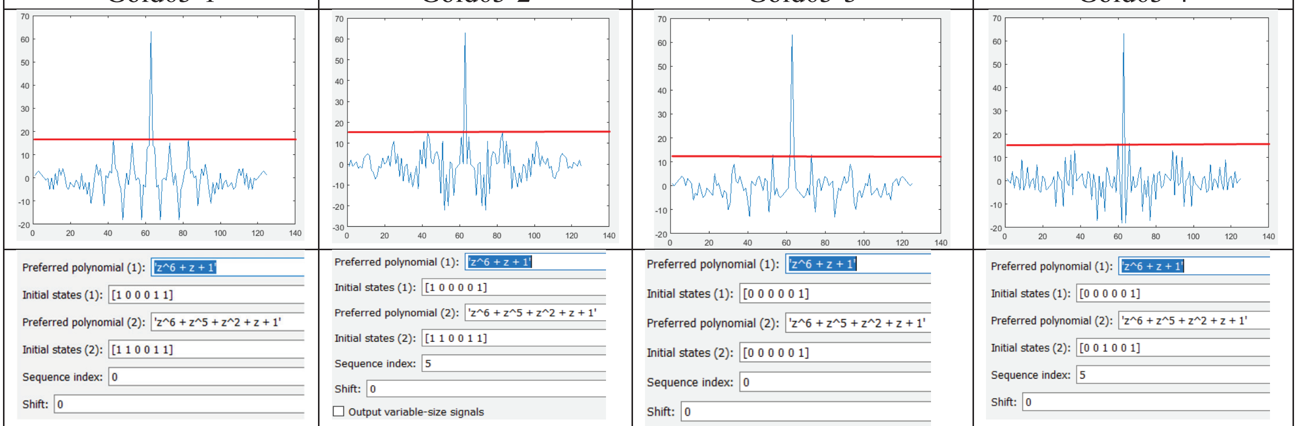
The formation of Gold 63 codes and Kasami 63 sequences and their ACF construction was performed by the MATLAB R2015B program.

For the synthesis of different Gold 63 codes, preferred polynomial (1) 'z^6+z+1' and preferred polynomial (2) 'z^6+z^5+z^2+z+1' were taken. with four variants of randomly selected initial states of registers.

For the synthesis of different sequences, Kasami used a polynomial generator (6 1 0) with four variants of randomly selected initial states of the register.

Table 1. New Barker composite sequences 49, 77a and 77b

№	Variant	NewBarkercompositecodes49
New 1.	C7 x A7 D7 x B7	-1-1-1+1+1-1+1+1+1+1-1-1+1-1-1-1-1+1+1-1+1-1-1-1+1+1-1+1+1+1+1-1-1+1-1+1+1+1-1- 1+1-1+1+1+1-1-1+1-1
New 2.	D7 x A7 C7 x B7	+1+1+1-1-1+1-1-1-1-1+1+1-1+1+1+1+1-1-1+1-1+1+1+1-1-1+1-1-1-1-1+1+1-1+1-1-1-1+1+1- 1+1-1-1-1+1+1-1+1
New 3.	A7 x C7 B7 x D7	-1+1-1-1+1+1+1-1+1-1-1+1+1+1-1+1-1-1+1+1+1+1-1+1+1-1-1-1+1-1+1+1-1-1-1-1+1-1- 1+1+1+1+1-1+1+1-1-1-1
New 4	B7 x C7 A7 x D7	+1-1+1+1-1-1-1+1-1+1+1-1-1-1+1-1+1+1-1-1-1-1+1-1-1+1+1+1-1+1-1-1+1+1+1+1-1+1+1-1-1- 1-1+1-1-1+1+1+1
№	Variant	NewBarkercompositecodes77a
New 1.	C11 x A7 D11 x B7	-1-1-1+1+1-1+1 +1+1+1-1-1+1-1 -1-1-1+1+1-1+1 -1-1-1+1+1-1+1 +1+1+1-1-1+1-1 -1-1- 1+1+1-1+1-1-1-1+1+1-1+1 -1-1-1+1+1-1+1 +1+1+1-1-1+1-1 +1+1+1-1-1+1-1 +1+1+1-1-1+1-1
New 2.	C11 x B7 D11 x A7	+1+1+1-1-1+1-1 -1-1-1+1+1-1+1 +1+1+1-1-1+1-1 +1+1+1-1-1+1-1 -1-1-1+1+1-1+1 +1+1+1-1- 1+1-1 +1+1+1-1-1+1-1 +1+1+1-1-1+1-1 -1-1-1+1+1-1+1 -1-1-1+1+1-1+1 -1-1-1+1+1-1+1
New 3.	A11 x C7 B11 x D7	-1+1-1-1+1+1+1 -1+1-1-1+1+1+1 -1+1-1-1+1+1+1+1-1+1+1-1-1-1 +1-1+1+1-1-1-1 +1-1+1+1- 1-1-1 -1+1-1-1+1+1+1+1-1+1+1-1-1-1 +1-1+1+1-1-1-1 -1+1-1-1+1+1+1+1-1+1+1-1-1-1
New 4	A11 x D7 B11 x C7	+1-1+1+1-1-1-1 +1-1+1+1-1-1-1 +1-1+1+1-1-1-1 -1+1-1-1+1+1+1 -1+1-1-1+1+1+1 -1+1-1- 1+1+1+1 +1-1+1+1-1-1-1 -1+1-1-1+1+1+1 -1+1-1-1+1+1+1+1-1+1+1-1-1-1 -1+1-1-1+1+1+1
№	Variant	NewBarkercompositecodes 77b77b
New 1.	C7 x A11 D7 x B11	-1-1-1+1+1+1-1+1+1-1+1+1+1+1-1-1-1+1-1-1+1-1-1-1-1+1+1+1-1+1+1-1+1-1-1-1+1+1+1- 1+1+1-1+1+1+1+1-1-1-1+1-1-1+1-1+1+1+1-1-1-1+1-1-1+1-1+1+1+1-1-1-1+1-1-1+1-1
New 2.	C7 x B11 D7 x A11	+1+1+1-1-1-1+1-1-1+1-1-1-1-1+1+1+1-1+1+1-1+1+1+1+1-1-1-1+1-1-1+1-1+1+1+1-1-1-1+1-1- 1+1-1-1-1-1+1+1+1-1+1+1-1+1-1-1-1+1+1+1-1+1+1-1+1-1-1-1+1+1+1-1+1+1-1+1
New 3.	A7 x C11 B7 x D11	-1+1-1-1+1-1-1-1+1+1+1-1+1-1-1+1-1-1-1+1+1+1-1+1-1-1+1-1-1-1+1+1+1+1-1+1+1- 1+1+1+1-1-1-1+1-1+1+1-1+1+1+1-1-1-1-1+1-1-1+1-1-1-1+1+1+1 +1-1+1+1-1+1+1+1-1-1-1
New 4	A7 x D11 B7 x C11	+1-1+1+1-1+1+1+1-1-1-1+1-1+1+1-1+1+1+1-1-1-1+1-1+1+1-1+1+1+1-1-1-1-1+1-1-1+1-1-1- 1+1+1+1-1+1-1-1+1-1-1-1+1+1+1+1-1+1+1-1+1+1+1-1-1-1 -1+1-1-1+1-1-1-1+1+1+1



Gold63-1	Gold63-2	Gold63-3	Gold63-4
-1 -1 -1 -1 1 -1 1 1 1 1 1 1 1 1 -1 -1 1 1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1 1 1 -1 1 -1 -1 1 1 -1 1 1 1 -1 -1 -1 -1 1 1 -1 -1 -1 -1 -1 1 -1 1 -1 1 -1 1 -1 -1 -1	-1 1 -1 1 1 1 1 -1 -1 -1 -1 1 - 1 1 -1 1 -1 1 1 1 1 1 -1 1 1 1 -1 1 -1 -1 -1 -1 1 -1 -1 1 -1 1 -1 1 1 -1 1 1 1 -1 -1 1 -1 -1 - 1 -1 -1 -1 -1 1 1 1 1 1 -1 -1 1	-1 -1 -1 -1 -1 -1 -1 1 1 1 -1 1 -1 -1 -1 1 1 1 1 1 -1 1 -1 -1 1 1 1 - 1 -1 -1 -1 1 1 -1 1 1 1 1 1 1 -1 - 1 1 -1 -1 1 1 1 -1 1 1 1 1 -1 -1 1 1 -1 -1 -1 -1 1 -1	1 1 -1 1 -1 1 1 -1 1 1 -1 -1 1 - 1 -1 -1 -1 -1 1 -1 1 1 -1 -1 1 1 -1 1 1 1 -1 1 -1 -1 1 -1 1 -1 1 -1 -1 -1 -1 1 -1 -1 1 1 -1 1 -1 1 1 -1 1 1 -1 1 -1 1 1 -1 1

Fig. 1. Gold63-1, 63-2, 63-3, 63-4 codes

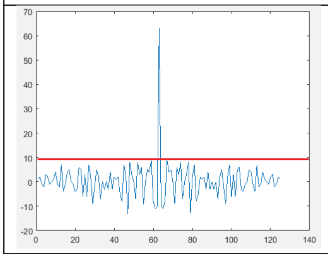
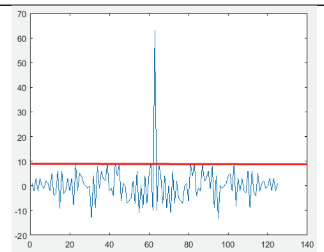
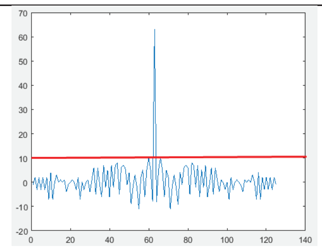
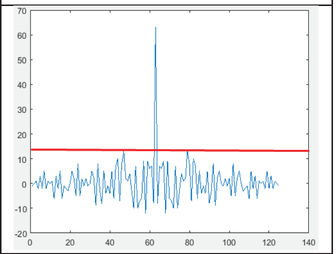
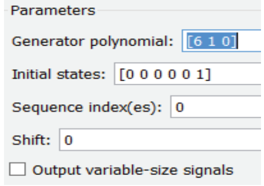
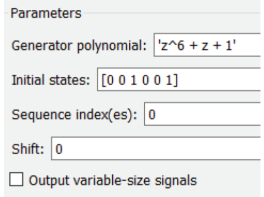
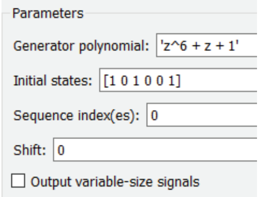
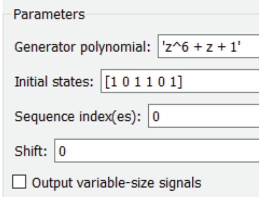
Kasami63-1	Kasami63-2	Kasami63-3	Kasami63-4
			
 	 	 	
-1 -1 1 -1 -1 1 -1 1 -1 1 -1 1 -1 1 1 -1 -1 -1 1 1 1 -1 1 -1 1 -1 -1 1 1 -1 -1 1 1 1 1 -1 -1 1 1 -1 -1 -1 1 1 -1 1 -1 -1 -1 1 -1 -1 1 -1 - 1 1 -1 -1 -1 1 1 -1	-1 1 -1 -1 -1 -1 -1 1 -1 1 1 1 1 - 1 1 -1 1 1 -1 1 -1 1 -1 -1 -1 -1 1 -1 -1 -1 1 -1 -1 -1 1 1 1 1 1 -1 - 1 1 -1 -1 -1 1 -1 1 1 -1 1 -1 -1 1 1 -1 1 -1 -1 1 -1 1 -1	-1 1 -1 -1 -1 1 -1 1 -1 1 -1 -1 1 - 1 1 1 1 -1 -1 1 1 -1 1 1 -1 1 1 -1 -1 1 -1 1 -1 -1 -1 1 1 -1 1 1 1 1 1 1 1 1 1 -1 1 -1 -1 1 -1 -1 1 1 1 1 1 -1 1 -1 1	-1 1 -1 1 1 1 1 -1 1 -1 1 1 -1 1 - 1 1 -1 -1 -1 -1 1 -1 -1 -1 1 -1 -1 -1 1 1 1 1 1 -1 -1 1 -1 -1 -1 1 -1 1 1 -1 1 -1 -1 1 1 -1 1 -1 -1 1 -1 1 -1 -1 1 -1 -1 -1 -1

Fig. 2. Kasami sequences 63-1, 63-2, 63-3, 63-4

The aim of this work is to compare the efficiency of using the new composite Barker codes, Gold codes and Kasami sequences as pulses of NLS synchronization.

Simulation of the ATP reception mode

The MATLAB R2015B program was used for modelling. The scheme of the model (Fig. 3) consists of the following main functional units: SPS packet generator, white Gaussian noise generator (AWGN), matched digital filter and threshold control circuit and error detector. The shaper contains an SPS generator that can be reconfigured to different composite Barker codes (Table 1), the Gold sequence (Fig. 1) and the Kasami sequence (Fig. 2). The generated SPS packets are transmitted to the matched filter, which is reconfigured and allocates the ACS SPS. The threshold level control scheme allows you to automatically determine the level of positive lateral ACF radiation together with the level of interference when they are included in the transmission path.

Testing was performed for each of the four new (New 1 ÷ New 4) Barker composite codes 49 (7x7), 77a (11x7) and 77 b (7x11), each of the four (Gold 63-1 ÷ Gold 63-4) Gold 63 codes (first forming polynomial z^6+z+1 (initial state of registers by default 000001), second forming polynomial $z^6+z^5+z^2+z+1$ (initial state of registers by default 000001), each of four (Kasami 63 -1 ÷ Kasami 63 - 4) Kasami sequences 63 (forming the polynomial z^6+z+1, the initial state of the registers by default 000001).

The generated sequences were fed to the agreed receiving filter with an interval of 1 cycle, the estimation time of 300 cycles.

The comparison was performed on the criterion of the percentage of loss of the peak value of the ACF in the compensation of the noise level of different values of SNR (dB) (Signal-to-Noise Ratio). The efficiency of different types of ACS was evaluated by the criterion of loss of ACF peak sync pulse

$$P(\%) = L_0/A, \quad (1) \quad (1)$$

where L_0 is the threshold level for error-free reception, A is the amplitude of the sync pulse equal to the length of the code.

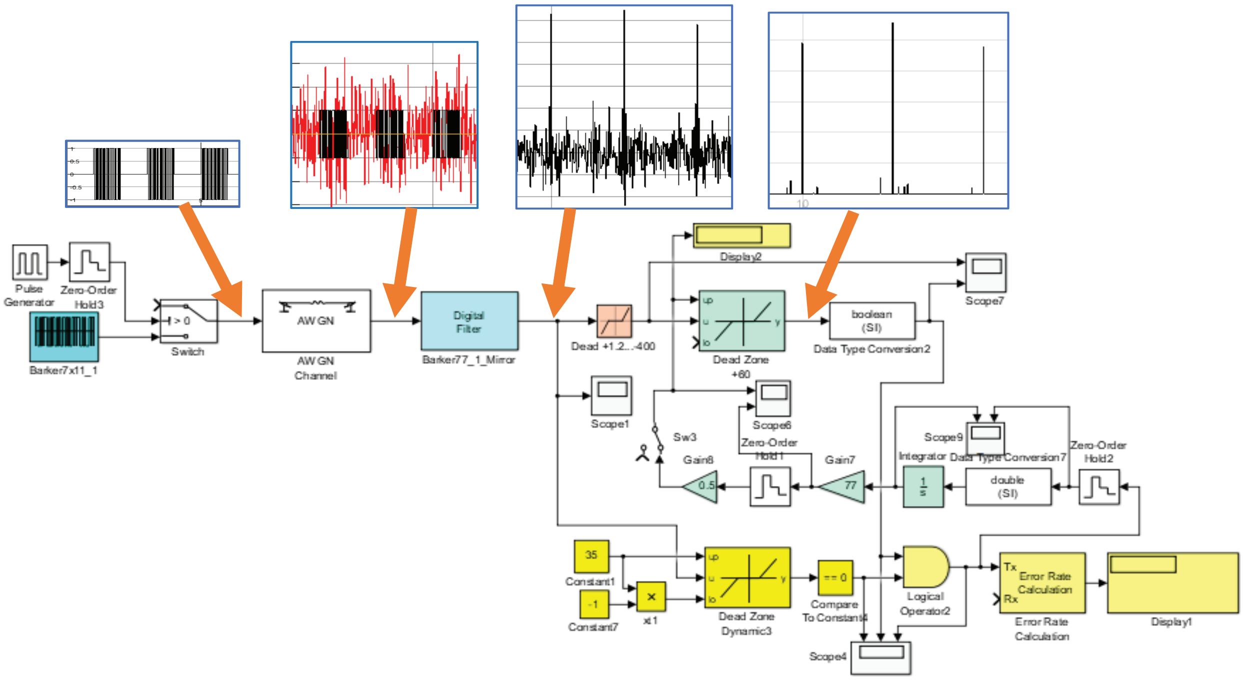


Fig. 3. Scheme of the UPS reception mode model

The efficiency of using the new Barker composite codes in relation to Gold codes and Kasami sequences was evaluated by the parameter

$\Delta P\ (\%) = P_{Bar}\ (\%) - P_{Gold/Kas}\ (\%)$, (2) (2)

where $P_{Bar/Gold/Kas}$ (%) - loss of peak selection when using composite Barker codes/or Gold codes /or Kasami sequences.

Simulation results

The results of the evaluation of the efficiency by the criterion of loss of the ACF peak of the sync pulse are given respectively in table. 2 ÷ 6.

Table 2. The effectiveness of the new Barker composite codes 49 by the criterion of loss of ACF peak sync pulse

SNR dB	Bark49-New1	Bark49-New2	Bark49-New3	Bark49-New4
30	95,90%	95,90%	95,90%	95,90%
20	91,80%	92,90%	91,80%	91,80%
10	80,60%	82,70%	81,60%	80,60%
5	68,40%	69,40%	69,40%	69,40%
4	65,30%	66,30%	66,30%	66,30%
3	62,20%	63,30%	63,30%	63,30%
2	57,10%	59,20%	58,20%	59,20%
1	53,10%	54,10%	55,10%	55,10%
0	51,00%	52,00%	50,00%	51,00%

Table 3. The effectiveness of the new Barker composite codes 77a by the criterion of loss of ACF peak sync pulse

SNR dB	Bark77a - New1	Bark77a -- New2	Bark77a -- New3	Bark77a -- New4
30	97,40%	97,40%	96,80%	97,40%
20	94,20%	94,80%	94,20%	94,20%
10	85,70%	86,40%	85,10%	85,70%
5	76,00%	77,30%	75,30%	76,00%
4	73,40%	74,70%	72,70%	73,40%
3	70,10%	71,40%	70,10%	70,10%
2	66,90%	68,20%	66,90%	66,90%
1	63,60%	64,30%	63,00%	63,60%
0	59,10%	61,00%	59,10%	59,10%

Table 4. The effectiveness of the new Barker composite codes 77b by the criterion of loss of ACF peak sync pulse

SNR dB	Bark77b – New1	Bark77b – New2	Bark77b – New3	Bark77b – New4
30	96,80%	96,80%	97,40%	96,80%

Table 5. The efficiency of Gold 63 codes on the criterion of loss of ACF peak sync pulse

SNR dB	Gold63-1	Gold63-2	Gold63-3	Gold63-4
30	71,40%	74,60%	76,20%	73,00%

20	93,50%	94,20%	93,50%	93,50%
10	84,40%	86,40%	85,10%	84,40%
5	74,70%	76,60%	76,00%	75,30%
4	72,10%	74,00%	73,40%	72,70%
3	68,80%	70,80%	70,10%	70,10%
2	65,60%	68,20%	67,50%	66,90%
1	62,30%	64,30%	64,30%	63,60%
0	59,10%	60,40%	61,00%	59,70%

20	69,80%	72,20%	73,80%	70,60%
10	63,50%	65,90%	67,50%	64,30%
5	55,60%	58,70%	60,30%	57,90%
4	54,00%	56,30%	58,70%	56,30%
3	52,40%	54,00%	56,30%	54,80%
2	51,60%	52,40%	54,00%	54,00%
1	49,20%	50,00%	50,80%	51,60%
0	49,20%	49,20%	49,20%	50,00%

Table 6. The efficiency of Kasami sequences 63 by the criterion of loss of ACF peak sync pulse

SNR dB	Kasami 63-1	Kasami 63-2	Kasami 63-3	Kasami 63-4
30	84,10%	84,10%	82,50%	82,50%
20	81,70%	81,00%	80,20%	80,20%
10	74,60%	73,00%	72,20%	73,80%
5	65,90%	64,30%	64,30%	65,90%
4	64,30%	61,90%	61,90%	63,50%
3	61,90%	57,90%	59,50%	61,10%
2	57,90%	54,80%	57,10%	57,90%
1	54,80%	53,20%	53,20%	54,80%
0	52,40%	51,60%	50,80%	50,80%

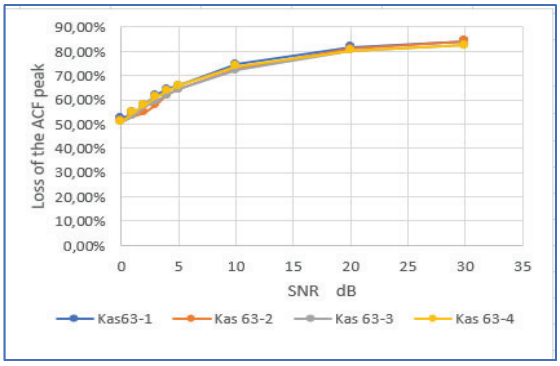


Fig. 4. The efficiency of the new Barker composite codes 49 by the criterion of loss of the ACF peak of the sync pulse

Analysis of simulation results

It is not difficult to see that in each of the tables 2 ÷ 6 the data for the same SNR value are very close. In Fig. 4, as an example, graphs of the efficiency of the four new Barker composite codes 49 by the criterion of loss of the ACF peak of the clock ACF, which show that they almost merge into one line. It should also be noted that the largest values in table 2 take the new composite Barker codes 49 - New 2, in table 3 Barker codes 77a - New 2, in table 4 Barker codes 77b - New 2, in table 5 Gold codes 63 - 3, in table 6 of the Kasami sequence 63 - 1. Given the above, the value of efficiency by the criterion of loss of ACF peak sync pulse in tables 2 ÷ 6 replace the sample mean $P_{cep}(\%)$, calculate the absolute deviation Δ and sample standard deviationS_x of the simulation results formulas:

$$\Delta = P(\%) - P_{cep}(\%), \quad (3)$$

$$S_x = \sqrt{\sum_{i=1}^{N}\left(P(\%) - P_{cep}(\%)\right)^2/(N-1)},\quad (4)$$

and formula (2) will take the form

$$\Delta P\ (\%) = P_{Bar\ cep}\ (\%) - P_{Gold/Kas\ cep}(\%). \quad (5)$$

Table 7 summarizes the calculations of $P_{cep}(\%)$ and $S_x(\%)$ for all four new Barker composite codes 49, 77a, 77b, four Gold codes 63, and four Kasami sequences 63.

Table 7. The results of calculations $P_{cep}(\%)$ i $S_x(\%)$

SNR dB	Bark49		Bark77a		Bark77b		Gold63		Kasami 63	
	$P_{cep}(\%)$	$S_x(\%)$	$P_{cep}(\%)$	$S_x(\%)$	$P_{cep}(\%)$	$S_x(\%)$	$P_{cep}(\%)$	$S_x(\%)$	$P_{cep}(\%)$	$S_x(\%)$
30	95,90%	0,00%	97,25%	0,30%	96,95%	0,30%	73,80%	2,07%	83,30%	0,92%
20	92,08%	0,55%	94,35%	0,30%	93,68%	0,35%	71,60%	1,77%	80,78%	0,72%
10	81,38%	1,00%	85,73%	0,53%	85,08%	0,94%	65,30%	1,77%	73,40%	1,03%
5	69,15%	0,50%	76,15%	0,83%	75,65%	0,83%	58,13%	1,96%	65,10%	0,92%

4	66,05%	0,50%	73,55%	0,83%	73,05%	0,83%	56,33%	1,92%	62,90%	1,20%
3	63,03%	0,55%	70,43%	0,65%	69,95%	0,83%	54,38%	1,63%	60,10%	1,77%
2	58,43%	1,00%	67,23%	0,65%	67,05%	1,10%	53,00%	1,20%	56,93%	1,47%
1	54,35%	0,96%	63,63%	0,53%	63,63%	0,94%	50,40%	1,03%	54,00%	0,92%
0	51,00%	0,82%	59,58%	0,95%	60,05%	0,83%	49,40%	0,40%	51,40%	0,77%

It can be seen that the sample standard deviation of the results from the mean S_x for all codes is in the range (0 ÷ 2.07)%, which allows you to replace the performance graphs of four new Barker composite codes 49, 77a, 77b, four Gold 63 codes and four Kasami sequences 63 by the criterion of loss of the ACF peak of the sync pulse according to their sample mean values of $P_{cepBar49}$(%), $P_{cepBar77a}$(%), $P_{cepBar77b}$(%), $P_{cepGold63}$ (%) and $P_{cepKas63}$(%).

Table 8 summarizes the results of calculations according to formula (5) of the efficiency of the use of new composite Barker codes 49, 77a and 77b in relation to Gold codes 63 and Kasami sequences 63, and in Fig. 5, 6 and 7 show the corresponding graphs.

Table 8. The results of calculations of the effectiveness of the new Barker composite codes 49, 77a and 77b

SNR dB	Bark49		Bark77a		Bark77b	
	$\Delta P_{Bar49-Gold63}$	$\Delta P_{Bar49-Kas63}$	$\Delta P_{Bar77a-Gold63}$	$\Delta P_{Bar77a-Kas63}$	$\Delta P_{Bar77b-Gold63}$	$\Delta P_{Bar77b-Kas63}$
30	22,10%	12,60%	23,45%	13,95%	23,15%	13,65%
20	20,48%	11,30%	22,75%	13,58%	22,08%	12,90%
10	16,08%	7,98%	20,43%	12,33%	19,78%	11,68%
5	11,03%	4,05%	18,03%	11,05%	17,53%	10,55%
4	9,73%	3,15%	17,23%	10,65%	16,73%	10,15%
3	8,65%	2,93%	16,05%	10,33%	15,58%	9,85%
2	5,42%	1,50%	14,23%	10,30%	14,05%	10,13%
1	3,95%	0,35%	13,23%	9,62%	13,23%	9,62%
0	1,60%	-0,40%	10,18%	8,18%	10,65%	8,65%

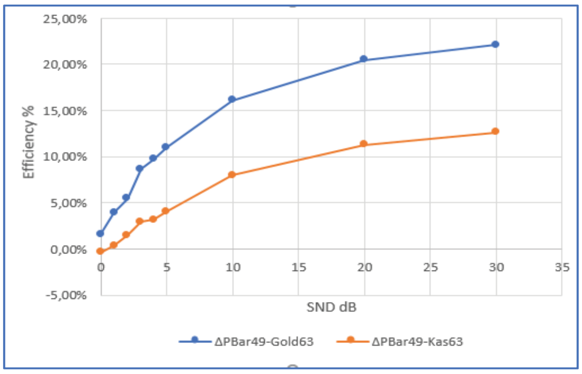


Fig. 5. The effectiveness of the new composite code Barker 49 in relation to Gold 63 and Kasami 63

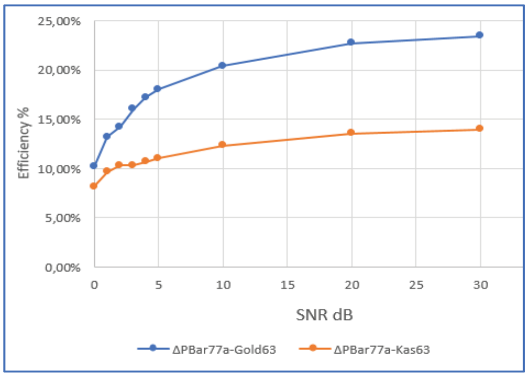


Fig. 6. The effectiveness of the new composite code Barker 77a in relation to Gold 63 and Kasami 63

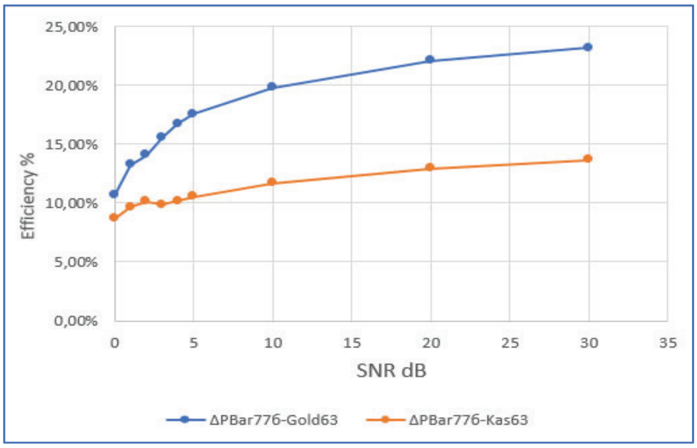


Fig. 7. The effectiveness of the new composite code Barker 77b in relation to Gold 63 and Kasami 63

Conclusions

Analysis of the simulation results shows that in the range of SNR (0 ÷ 30) dB new Barker composite codes 49, 77a and 77b when used as clock signals are more effective than Gold 63 and Kasami 63 codes, namely:

- Barker codes 49 in relation to Gold codes 63 are more effective by (1,60 ÷ 22,10)%. In relation to the Kasami 63 sequences are more effective (0,35 ÷ 12,60)% in the range of SNR (1 ÷ 30) dB, but at SNR 0 dB the Kasami 63 sequence is more effective than the Barker 49 composite code by 0,40%, which can be explained by the measurement error.
- Barker codes 77a in relation to Gold 63 codes are more effective by (10,18 ÷ 23,45)%, in relation to Kasami 63 sequences are more effective by (8,18 ÷ 13,95)%;
- Barker codes 77b in relation to Gold 63 codes are more effective by (10,65 ÷ 23,15)%, in relation to Kasami 63 sequences are more effective by (8,65 ÷ 13,65)%.

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Максимов В.В., Гаттуров В.К., Храповицький І.А.

Нові композитні коди Баркера, Голда та Касамі в системі синхронізації широкосмугових сигналів

Проблематика. В даний час широко використовуються шумоподібні сигнали (ШПС), які забезпечують високу завадозахищеність широкосмугових систем зв'язку (ШСС) при передачі конфіденційної інформації у відкритому радіоканалі, особливо в умовах надзвичайних ситуацій. Підвищення ефективності роботи ШСС можливе при використанні більш досконалих кодових конструкцій, зокрема нових способів побудови кодових послідовностей Баркера, що використовуються в системах бездротового зв'язку з технологією розширення спектра методом прямої послідовності.

Мета. Метою роботи є дослідження нових композитних кодів Баркера, Голда та Касамі в якості сигналів синхронізації ШСС за допомогою моделювання.

Методи. Використовуються аналітичні методи розрахунку, а також імітаційне моделювання у програмному пакеті MatLab.

Результати. Моделювання в середовищі MatLab нових композитних кодів Баркера, Голда і послідовностей Касамі в якості сигналів синхронізації ШСС показало, що композитні послідовності Баркера 49 і 77 в діапазоні зміни SNR від 0дБ до 30дБ більш стійкі до завад у порівнянні з Касамі-63 і Голд-63 на (0,35 - 22,10) %.

Висновки. Моделювання в програмному пакеті MatLab показало велику завадостійкість нових композитних кодів Баркера в порівнянні з кодами Голда та послідовностями Касами при використанні їх як сигнали синхронізації ШСС.

Ключові слова: *коди Баркера; композитні коди Баркера; коди Голда; послідовності Касамі; автокореляційна функція.*