ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
әл-Фараби атындағы Қазақ ұлттық университетінің

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный университет
имени аль-Фараби

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
al-Farabi Kazakh National University

SERIES
PHYSICO-MATHEMATICAL

5 (339)

SEPTEMBER – OKTOBER 2021

PUBLISHED SINCE JANUARY 1963

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series physico-mathematical journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of chemistry and technologies in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of chemical sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Физикалық-математикалық сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын усынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия физико-математическая» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары.
Физика-математикалық сериясы».
ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.). Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 14.02.2018 ж. берілген **No 16906-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.
Тақырыптық бағыты: *математика, информатика, механика, физика, ғарыштық зерттеулер, астрономия, ионосфера.*
Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.
Редакцияның мекен-жайы: *050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19*
http://www.physico-mathematical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

«Известия НАН РК.
Серия физика-математическая».
ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).
Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **No 16906-Ж** выданное 14.02.2018 г.
Тематическая направленность: *математика, информатика, механика, физика, космические исследования, астрономия, ионосфера.*
Периодичность: 6 раз в год.
Тираж: 300 экземпляров.
Адрес редакции: *050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19*
http://www.physico-mathematical.kz/index.php/en/

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Physical-mathematical series.
ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty). The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. 16906-Ж,** issued 14.02.2018
Thematic scope: *mathematics, computer science, mechanics, physics, space research, astronomy, ionosphere.*
Periodicity: 6 times a year.
Circulation: 300 copies.
Editorial address: *28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19*
http://www.physico-mathematical.kz/index.php/en/

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
PHYSICO-MATHEMATICAL SERIES
ISSN 1991-346X
Volume 5, Number 339 (2021), 83–90 ***https://doi.org/10.32014/2021.2518-1726.88***

UDC 621.391

Seilova N.A.[1], Dzhuruntaev D.Z.[1], Mamyrbayev O.Zh. [2], Batyrgaliev A.B.[1], Turdalyuly M.[1]

[1]Satbayev University, Almaty, Kazakhstan;
[2]Institute of Information and Computational Technologies, Almaty, Kazakhstan.
E-mail: *n.seilova@satbayev.university*

DIGITAL GENERATORS OF A PSEUDORANDOM PULSES SEQUENCE AND THEIR MODELING WITH USE OF FPGA INTHE ENVIRONMENT CAD QUARTUS II

Abstract. The paper considers the functional modeling of digital generators of a pseudo and ompulses sequence based on FPGAs in the environment of the computer-aided design system (CAD) QUARTUS II by Altera, which supports all stages of designing digital devices based on programmable and reconfigurable logics. Digital generators of a pseudo and ompulses sequence of the Fibonacci or Galois configuration are built on linear feedback shift registers with XOR logic gates. Using the QUATUS II CAD system, the project was compiled, the RTL circuits of digital generators of a pseudo and ompulses sequence were synthesized and obtained, their functional modeling was performed, and the timing diagrams of the circuits operation were constructed. Thus, the problem of developing a circuit for a digital generator of a pseudo and ompulses sequence based on the linear feedback shift registers using FPGAs in the Quartus II CAD environment is relevant and is of practical interest in using it to protect confidential speech information at creating cryptographic keys for encrypted data transmission.

In order to provide improved cryptographic strength of generated sequences with a relatively long period and good statistical properties by improving the scheme of the LFSR shift algorithm generator with a complicated timing scheme.

Key words: Programmable logic integrated circuit, digital pseudorandom pulses generators, primitive polynomial, functional modeling, project compilation.

Introduction. Currently, the problem of protecting acoustic (voice) information is characterized by a constant expanding the arsenal of means for secretly removing and intercepting voice signals, the technical characteristics and application methods of which are being steadily improved. A speech signal is a complex acoustic signal originating from human speech [1-4]. The speech signal spectrum is continuous, however, frequency components in the ranges of more than 3 kHz and less than 300 Hz make a significantly smaller contribution to the signal, therefore, as a rule, the speech signal spectrum is considered in the range from 0.3 to 3 kHz. A fairly wide range of applications in modern computing systems find digital generators of a pseudorandom pulses sequence. Using them, you can change the characteristics of speech and make it inaudible for the eavesdropper who intercepts the processed speech message [5-7].

Materials and methods. For efficient use of the digital generator of pseudorandom pulses sequence, it is necessary to know and understand various approaches and aspects of synthesis and modeling of its circuits, which is practically impossible without the use of the Quartus II computer-aided design (CAD) system from Altera. The process of designing digital devices in the Quartus II CAD environment includes the following stages: creation of modules of the initial description of the designed device, synthesis and implementation of the project based on Altera PLD and simulation of digital devices [8-11].

Thus, the task of developing a digital generator circuit for a pseudorandom pulses sequence based on the LFSR shift register in the Quartus II CAD environment is relevant and of practical interest to use it to protect confidential voice (acoustic) information.

The purpose of this article is to create circuits of the digital generator of pseudorandom pulses sequence and their functional simulation of PLD in the Quartus II CAD environment.

Results. Currently, the circuits of the digital generators of the pseudorandom pulses sequence are implemented programmatically using one of the high-level languages, for example, Verilog [9, 11-14] or in a hardware (circuit) method using a graphic editor. Graphic description of digital generator circuit of pseudorandom pulses sequence is selected. This is justified when the use of high-level languages such as VHDL or Verilog, that is, a text description of a digital generator of a pseudorandom pulses sequence based on a feedback shift register will be less clear than the circuit. The advantage of a graphical method of entering a description of a circuit is its tradition and clarity.

If you create files, that is, the logic of the project to draw as diagrams, the CAD Quartus II Block Diagram/ Schematic File is launched, the Quartus Prime Lite Edition dialog box opens. At the top of this window are the main controls, the menu bar and toolbars.

Then, after pressing the button in the toolbar of the graphics editor Quartus II, the Symbol window (figure 1) opens and in this window using the primitives: logic – XOR logic element (modulo-two adder) and storage – D-type synchronous trigger (dff), the diagrams of the digital generator of the pseudorandom pulses sequence will be drawn.

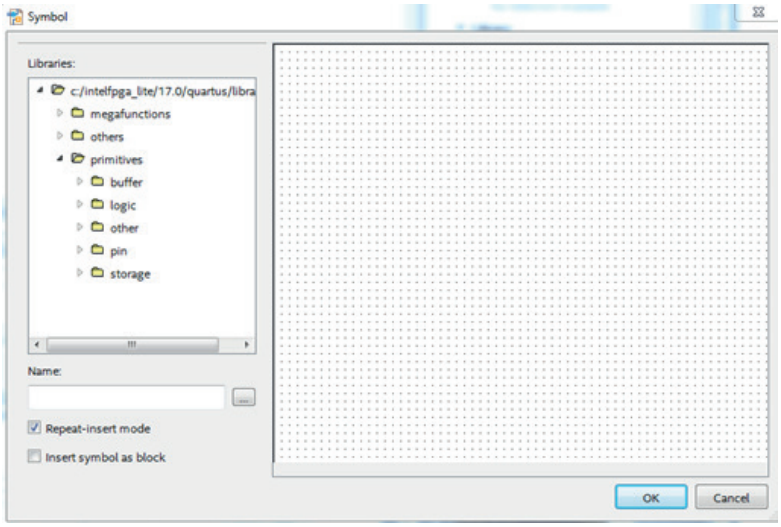

Figure 1. Symbol Window.

Diagrams of digital generators of pseudorandom pulses sequence. Circuits of digital pseudorandom pulses sequence generators are typically implemented based on a linear feedback shift register (LFSR). Feedback to the shift register is entered with use of XOR logic elements – modulo-two adders. The shift register consists of memory elements – triggers, in each of which the current one state (value) of one bit: 0 or 1, is stored. The pseudorandom pulses sequence generator is given by some polynomial (primitive polynomial) and may structurally have a Fibonacci or Galois configuration [12-15].

The electric circuits of digital generators of the pseudorandom M-sequence of impulses of a configuration of Fibonacci and Galois constructed on the basis of a primitive polynomial φ (x) =$x^5 + x^3 + 1$ are provided on figures 2 and 3. The maximum repetition period of the pseudo and ompulsesse quence of these circuits is $2^5 - 1 = 31$ [11].

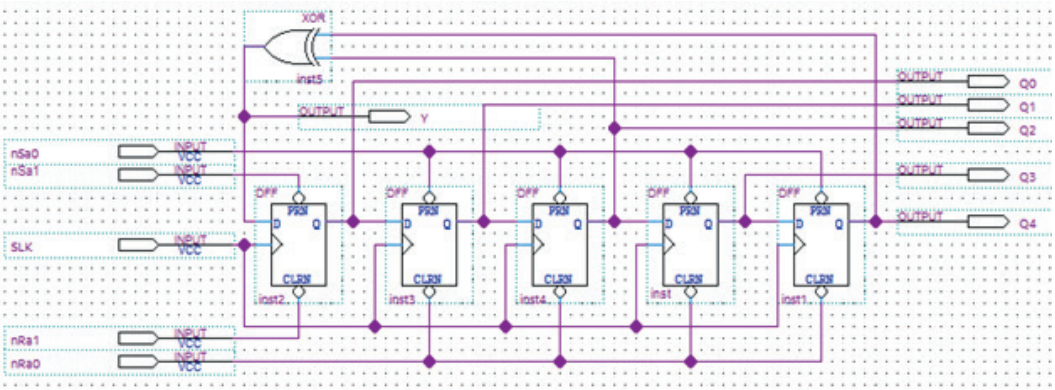

Figure 2. Diagram of digital generator of pseudorandom pulses sequence of Fibonacci configuration.

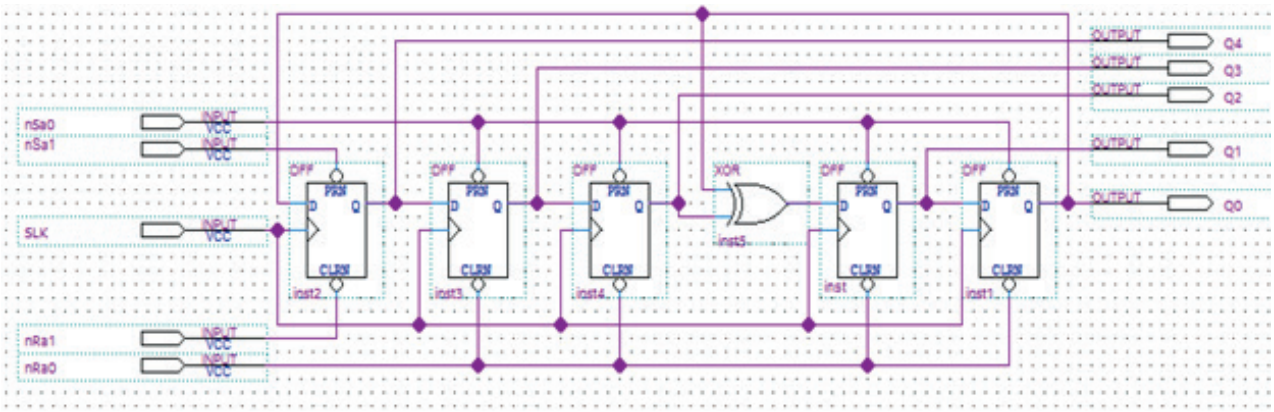

Figure 3. Diagram of digital generator of pseudorandompulses sequence of Galois configuration.

Figures 2 and 3 accept the following designations: nSa0 and nRa0 – asynchronous inputs of resetting the corresponding triggers to the state of logical zero; nSa1 and nRa1 – asynchronous inputs of trigger setting to logical unit state; CLK is a clock synchronization signal that determines the duration and interval between pulses; Q0, Q1,..., Q4 – outputs of bit triggers; Y is the output of the Fibonacci configuration pulsespseudorandom sequence generator. The letter *n* denotes the inverse values of these signals.

The digital pseudorandom pulses sequence generator circuit of the Fibonacci configuration (figure 2) uses an XOR logic element with a modulo-two adder, and the digital generator circuit of the Galois configuration (figure 2) uses an XOR logic element with an integrated modulo-two adder. Then supplying pulses of pseudorandom sequence from outputs of these generators to input of active RC of Sallen–Key low-pass filter of the second order, acoustic noises of chaotic character can be obtained at its output [12,14].

Logic implementation of digital generator circuits at RTL-level. Using the Quartus II compiler, syntax errors in the diagrams of digital generators are analyzed, synthesized and detected. Thus, the logic completeness of the circuits is checked, that is, the possibility of combining the schema description files into a single whole, and the possibility of implementing the circuits on the selected Altera PLD chip. After successful compilation (*Processing* > *Start Compilation*), digital generator circuits of pseudorandom pulses sequence at the register-transfer level (RTL) are obtained, which are shown in figures 4 and 5.

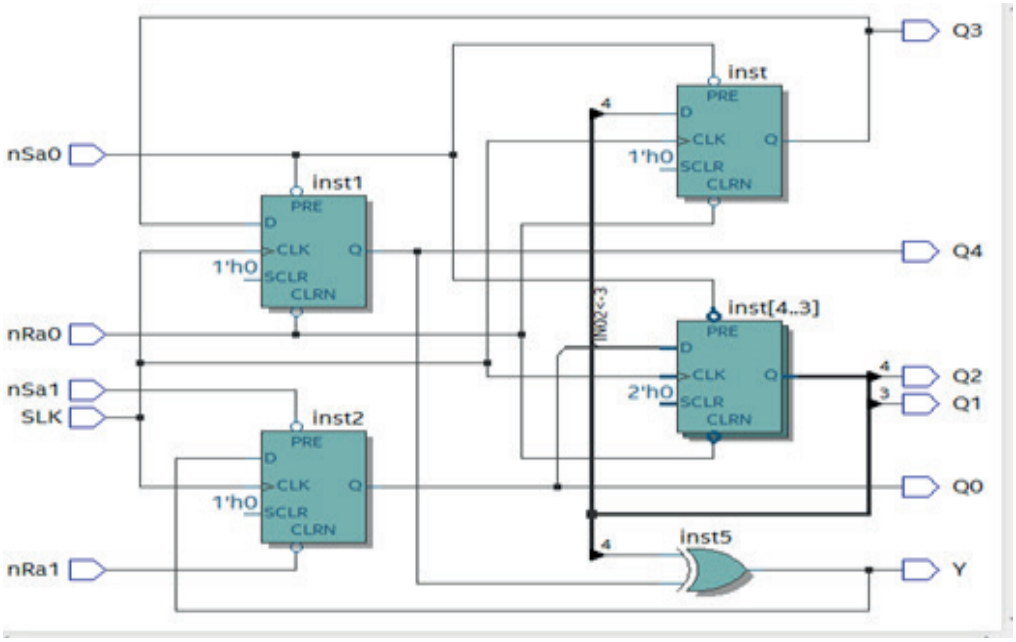

Figure 4. Diagram of the pseudorandom pulses sequence generator of the Fibonacci configuration at the RTL-level.

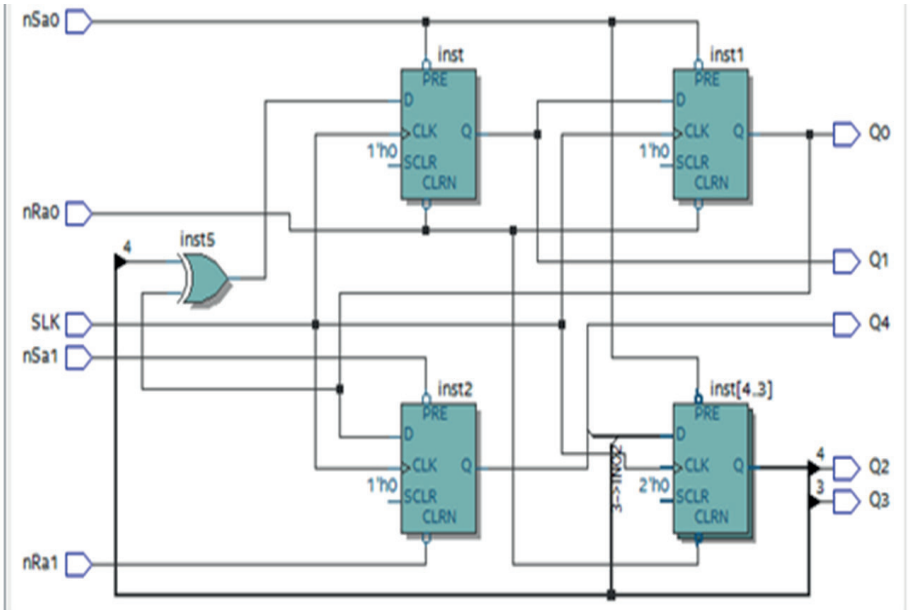

Figure 5. Diagram of generator of pseudorandom pulses sequence of Galois configuration on RTL-level.

Figures 6 and 7 show the conditional graphical designations (symbols) of the Fibonacci and Galois configuration for pseudorandom pulses sequence digital generators, which are obtained after executing the command *File->Create/Update- >Create Symbol Files For Current File*.

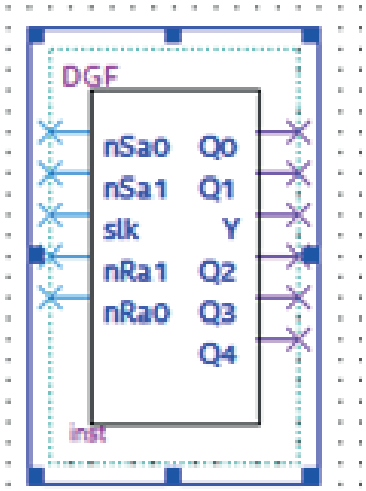

Figure 6. Conditionally-graphic designation of DGF module

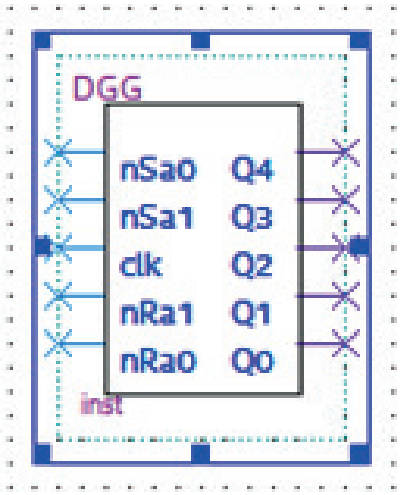

Figure 7. Conditionally-graphic designation of DGG module.

Functional modeling and time charts. Then, using the functional modeling method, the correct functioning of digital generator circuits is checked before programming or configuring Altera PLD [14,15].

Time diagrams obtained during functional modeling of circuits of digital generators of pseudorandom pulses sequence are shown in figures 8 and 9, where the letter T denotes the repetition period of circuits of generators.

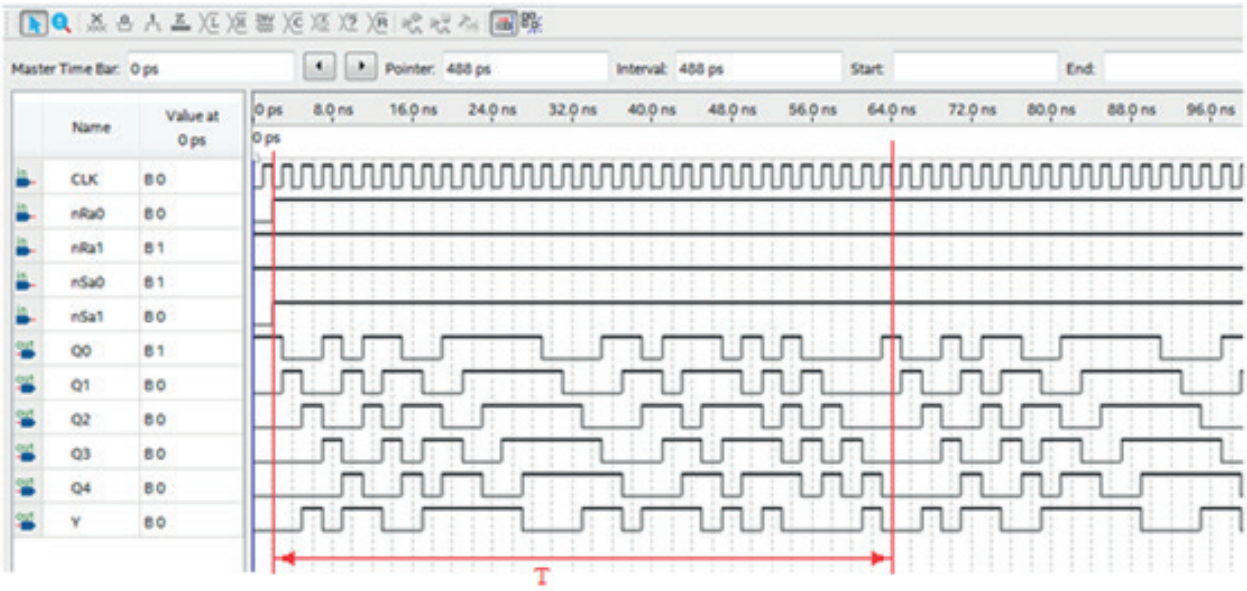

Figure 8. Time diagrams for operation of pseudorandom pulses sequence generator of Fibonacci configuration.

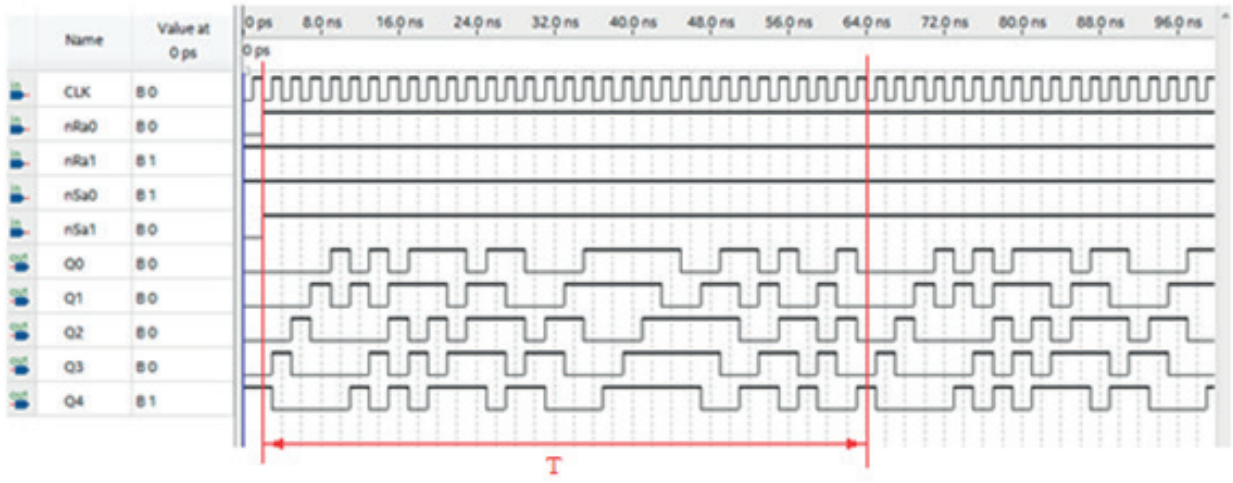

Figure 9. Time diagrams for operation ofpseudorandom pulsessequencegenerator of Galois configuration.

Discussion. This work allows schematically and logically to be implemented at the register-transfer level, to obtain conditionally graphic designations, as well as, to verify the correctness of circuits construction and their operation, to construct time diagrams for operation of digital pseudorandom pulses sequence generators of Fibonacci and Galois configuration based on FPGA ALTERA using QUARTUS II CAD.

It is further contemplated to improve the cryptographic stability of the generated sequences with relatively long periods and good statistical properties by improving the digital pseudorandom pulses sequence generator circuit based on the use of LFSRs with a complicated timing scheme.

Conclusion. This work relates to the field of information security for creating cryptographic keys for encrypted data transmission, and can also be used in systems for protecting confidential voice information using acoustic noise at frequencies of sound signals.

Source of financing. The work was carried out within the framework of the grant financing project «Quality assessment of spatial electromagnetic noise in active information protection systems», IRN AP08856630.

Сейлова Н.А.[1], Журынтаев Ж.З.[1], Мамырбаев О.Ж.[2], Батыргалиев А.Б.[1], Тұрдалыұлы М.[1]

[1] Сәтбаев Университеті, Алматы, Қазақстан;
[2]ҚР БҒМ ҒК Ақпараттық және есептеуіш технологиялар институт, Алматы, Қазақстан.
E-mail: *n.seilova@satbayev.university*

ПСЕВДО КЕЗДЕЙСОҚ ИМПУЛЬСТАР ТІЗБЕГІНІҢ САНДЫҚ ГЕНЕРАТОРЛАРЫ ЖӘНЕ ОЛАРДЫ CAD QUARTUS II ОРТАСЫНДА FPGA КӨМЕГІМЕН МОДЕЛЬДЕУ

Аннотация. Мақалада Altera компаниясының QUARTUS II автоматтандырылған жобалау жүйесінің (CAD) ортасында FPGA негізіндегі импульстердің жалған (псевдо) кездейсоқ тізбегінің цифрлық генераторлары сұлбаларының функционалды модельдеуі қарастырылған, ол бағдарламаланатын және қайта конфигурацияланатын логика негізінде цифрлық құрылғыларды жобалаудың барлық сатыларын қамтиды. Фибоначчи немесе Галуа конфигурациялы импульстерінің жалған кездейсоқ тізбегінің цифрлық генераторлары XOR логикалық элементтері бар сызықтық кері байланысты ығыстыру регистрлерінде құрастырылған. QUATUS II CAD жүйесін қолдана отырып, жоба құрастырылды, импульстердің жалған кездейсоқ тізбегінің цифрлық генераторларының RTL-сулбасы синтезделді және алынды, олардың сұлбаларына функционалды модельдеу жүргізілді және жұмыс істеу уақыт диаграммалары құрылды. Сонымен, CAD QUATUS II ортасында FPGA-ны қолдана отырып, LFSR ығыстыру регистрі негізінде импульстердің жалған кездейсоқ тізбегінің цифрлық генераторының схемасын құру өзекті болып табылады және оны шифрланған деректерді беру үшін криптографиялық кілттерді құру кезінде құпия сөйлеу ақпаратын қорғау үшін пайдалану практикалық қызығушылық тудырады.

Болашақта салыстырмалы түрде ұзақ кезеңдермен және жақсы статистикалық қасиеттермен құрылған тізбектердің криптографиялық беріктігін күрделі тактикалық тізбегі бар LFSR ауысым регистрлерін қолдану негізінде цифрлық псевдо-кездейсоқ импульстік реттілік генераторының тізбегін жетілдіру арқылы жақсарту күтілуде.

Түйінді сөздер: Бағдарламаланатын логикалық интегралды схема, импульстердің жалған кездейсоқ тізбегінің сандық генераторлары, қарапайым көпмүшелік, функционалды модельдеу, жобаның компиляциясы.

Сейлова Н.А.[1], Джурунтаев Д.З.[1], Мамырбаев О.Ж.[2], Батыргалиев А.Б.[1], Тұрдалыұлы М.[1]

[1]Университет Сатпаева,Алматы, Казахстан;
[2] Институт информационных и вычислительных технологий КН МОН РК, Алматы, Казахстан.
E-mail: *n.seilova@satbayev.university*

ЦИФРОВЫЕ ГЕНЕРАТОРЫ ПСЕВДОСЛУЧАЙНОЙ ПОСЛЕДОВАТЕЛЬНОСТИ ИМПУЛЬСОВ И ИХ МОДЕЛИРОВАНИЕ С ИСПОЛЬЗОВАНИЕМ ПЛИС В СРЕДЕ САПР QUARTUSII

Аннотация. В работе рассматривается функциональное моделирование цифровых генераторов псевдо случайной последовательности импульсов на основе ПЛИС в среде системы автоматизированного проектирования (САПР) QUARTUSIIфирма Altera, которая поддерживает все этапы проектирования цифровых устройств на основе программируемой и реконфигурируемой логики. Цифровые генераторы псевдо случайной последовательности импульсов конфигурации Фибоначчи или Галуа построены на регистрах сдвига с линейной обратной связью с логическими элементами XOR с использованием аппаратного (схемного) способа с помощью графического редактора. Достоинством графического способа ввода описания схемы является его традиционность и наглядность. С помощью САПР *QUATUS II* выполнена компиляция проекта, синтезирована и получена *RTL*-схемы цифровых генераторов псевдослучайной последовательности импульсов, выполнены их функциональное моделирование и построены временные диаграммы работы схем. Таким образом,

задача разработки схемы цифрового генератора псевдо случайной последовательности импульсов на основе регистра сдвига *LFSR* с использованием ПЛИС в среде САПР *Quartus II* является актуальной и представляет практический интерес использования её для защиты конфиденциальной речевой информации при создании *криптографических ключей* для зашифрованной передачи данных.

В дальнейшем предполагается улучшить крипто стойкость генерируемых последовательностей с относительно большими периодами и хорошими статистическими свойствами путем усовершенствования схемы цифрового генератора псевдослучайной последовательности импульсов на основе использования регистров сдвига LFSR с усложненной схемой тактирования.

Ключевые слова: программируемая логическая интегральная схема, цифровые генераторы псевдослучайной последовательности импульсов, примитивный многочлен, функциональное моделирование, компиляция проекта.

Information about the authors:

Seilova Nurgul Abadullaevna – Assistant professor, Ph.D., Head of the Department "KBOiKHI", Director of the Institute of "Cybernetics and Information Technologies" of the Satbayev University, Almaty, Kazakhstan; n.seilova@satbayev.university; https://orcid.org/0000-0003-3827-179X;

Dzhuruntaev Dzholdas Zaurbekovich – Doctor of Technical Sciences, Associate Professor of the Department of Cybersecurity, Processing and Storage of Information, Institute of Cybernetics and Information Technologies, Satbayev University, Almaty, Kazakhstan; joldas.zaurbek@gmail.com; **https://orcid.org/0000-0003-4751-2014;**

Mamyrbayev Orken Zhumazhanovich – Ph.D, Associate Professor, Deputy General Director in Science, Institute of Information and Computational Technologies, Almaty, Kazakhstan, **morkenj@mail.ru**, **https://orcid.org/0000-0001-8318-3794;**

Batyrgaliyev Askhat Bolatkanovich – PhD student, specialty "Radio engineering, electronics and telecommunications", senior-lecturer, Satbayev University, Almaty, Kazakhstan;*askhat.b.b@gmail.com*, *https://orcid.org/0000-0002-1103-8659;*

Turdalyuly Mussa – PhD, Head of Software Engineering Department, Satbayev University, Almaty, Kazakhstan, *m.turdalyuly@gmail.com*, https://orcid.org/0000-0002-1470-3706.

REFERENCES

[1] Harris D., Harris S. Digital circuitry and computer architecture. – Second edition. – Publishing house Morgan Kaufman, English Edition 2013. – 1619 p.

[2] Gerasimenko V.G., Lavrukhin Yu.N., Tupota V.I. Methods for protecting acoustic speech information from leakage through technical channels. – M.: RCIB "Fakel", 2008. – 258 p.

[3] Gorbatov V.S. Control of the security of speech information in the premises. – M.: NRNU MEPhI, 2014. – 248 p.

[4] Khorev A.A., Shcherbakov V.A., Chernigin O.S. Noise generator control device // Patent for invention 2725907 C1, Application 07.07. No. 2019138619 dated 11/29/2019.

[5] Karpov A.P. Development of a masker for analog speech signals // Bulletin of the Penza State University. – Penza: 2016. – No. 1 (13). – P.62-64.

[6] Mishukov A.A. Figurative analysis and masking of speech information // A.A. Mishukov, R.A. Ustinov, N.S. Dvoryankin // Information technologies, communication and information protection of the Ministry of Internal Affairs of Russia. – 2012. – Issue. 2.

[7] Khorev A.A., Tsarev N.V. Method and algorithm for the formation of speech-like interference // Bulletin of the Voronezh State. un-that. Series: System Analysis and Information Technology. – Voronezh: 2017. – No. 1. – P. 57-67.

[8] Bykov A.I. Digital noise generators of vibroacoustic protection systems – M.: Publishing house of the Russian Scientific and Technical Society of Radio Engineering, Electronics and Communication named after A.S. Popova.– 2015. – Volume 5. – No. 4. – P. 407-411.

[9] Kuznetsov V.M. Generators of random and pseudorandom sequences on digital delay elements. Abstract of the dissertation for the degree of Doctor of Technical Sciences. – Kazan: KAI, 2011.

[10] Pesoshin V.A. Generators of pseudorandom and random numbers on shift registers.: monograph. / Pesoshin V.A., Kuznetsov V.M. – Kazan: Kazan Publishing House. state tech. University, 2007. – 296 p.

[11] Breskina O.M., Koreshkova A.A., Ivanov A.P. Implementation of a pseudorandom sequence generator on FPGAs from Altera. – Penza: Publishing house of the Penza state. University, 2015. – No. 5. –P. 17-20.

[12] Tarasov I.E., Pevtsov E.F. Basics of designing digital devices using the Verilog language. Tutorial. – M.: MSTU MIREA, 2011. – 179 p.

[13] Efremov N.V. Introduction to the computer-aided design system Quartus II: a tutorial. – M.: GOU VPO MGUL, 2011. – 147 p.

[14] Zaurbek A., Seilova N.A., Dzhuruntaev D.Z. Synthesis and simulation of digital pseudorandom impulse sequence generator based on PLIC FPGA Xilinx using CAD Vivado 2016.2 and development of acoustic noise generator scheme for the protection of information. //computer modelling & new technologies 2017 21(1), Scientific and research journal, Mathematical and Computer Modelling, ISSN 1407-5806, ISSN: 1407-5814.– Latvia, Riga, 2017. – P. 39-46.

[15] Zaurbek A., Zhaibergenova A.ZH., Dzhuruntaev D.Z. Developing of the project of a random access memory on FPGA with use of a CAD of QUARTUS II and the Verilog language. //Information technologies, management and society the 16th international scientific conference 2018. April 26-27, ISMA University – Riga, 2018.

МАЗМҰНЫ

ФИЗИКА

ИНФОРМАТИКА

МАТЕМАТИКА

СОДЕРЖАНИЕ

ФИЗИКА

ИНФОРМАТИКА

МАТЕМАТИКА

CONTENTS

PHYSICS

COMPUTER SCIENCE

MATHEMATICS

Publication Ethics and Publication Malpracticein
the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethicalguidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any otherlanguage, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

www:nauka-nanrk.kz

http://physics-mathematics.kz/index.php/en/archive

ISSN2518-1726 (Online),
ISSN 1991-346X (Print)

Редакторы: *М.С. Ахметова, А. Ботанқызы, Д.С. Аленов, Р.Ж. Мрзабаева*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 15.10.2021.
Формат 60x881/8. Бумага офсетная. Печать –ризограф.
4,6 п.л. Тираж 300. Заказ 5.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19