

**MINISTRY EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL AVIATION UNIVERSITY**

**ELECTRONICS AND CONTROL  
SYSTEMS**

**N 2 (44) 2015**

**KYIV**

## Electronics and control systems, N 2 (44), 2015

<http://ecs.in.ua>

**Journal Scope:** The Scientific Journal is intended for publishing original papers concerning the following fields of research: theory and methods of signal processing, automatic control systems, computer-aided design systems, transport systems, mathematical modeling of processes and systems.

**History:** The Scientific Journal “Electronics and control systems” was founded in 2003. The first volume of the Scientific Journal was published under the title “Electronics and control systems” in 2003. Scientific journal “Electronics and control systems” is referred to Ukrainian professional and scientific publications in the field of Engineering, Chemical (Ecological Safety) and Pedagogical Sciences.

**Abstracts & Indexing:** Google Scholar; Russian science citation index (RSCI); the Vernadsky National Library of Ukraine; Scientific and Technical Library of the National Aviation University; EBSCO information services; Research Bible; Simple Search Metadata; Scientific Electronic Library; Ulrich’s Periodicals Directory.

**Disclaimer:** The Editorial Board of the Scientific Journal “Electronics and control systems” makes every effort to ensure the accuracy of all the information (the 'Content') contained in its publications. However, the Editorial Board is not responsible for authenticity of facts, names, photos and other Content of the article and disclaims all representations and warranties whether express or implied to the maximum extent permitted by effective legislation of Ukraine. Any views expressed in this publication are the views of the authors and are not necessarily the views of the Editorial Board of the Scientific Journal “Electronics and control systems”.

**Copyright © 2015 National Aviation University.** All rights reserved. No part of this publication may be reproduced, stored, transmitted, or disseminated, in any form, or by any means, without prior written permission from National Aviation University, to whom all requests to reproduce copyright material should be directed, in writing.

Certificate of State Registration KV N 16720-5292 PR of 21 May 2010.

Approved for publication by the Academic Council of the National Aviation University (Minutes 7 of 27 May 2015).

**Submissions:** All submissions should be made online at the Journal “Electronics and control systems” (<http://ecs.in.ua>). Complete guidelines for preparing and submitting a manuscript to this Scientific Journal are provided at the Scientific Journal website.

Enquiries to Scientific Journal Proceedings of the National Aviation University should be addressed to the Editorial Board:

Kosmonavta Komarova avenue, 1  
Kyiv, Ukraine, 03680  
Phone: (38 044) 406 75 27  
Fax: (38 044) 406 74 12  
<http://ecs.in.ua>

UDC [621.38 + 681.51] (082)''540.3''

## EDITOR-IN-CHIEF

**V. M. Sineglazov**, IEEE Senior Member, Dr. Sci. (Eng.), Prof., Head of Aviation Computer Integrated Complexes Department, National Aviation University, Ukraine

## DEPUTIES OF EDITOR-IN-CHIEF

**A. A. Tunik**, IEEE Senior Member, Dr. Sci. (Eng.), Prof., National Aviation University, Ukraine

**F. J. Yanovsky**, IEEE Fellow, Dr. Sci. (Eng.), Prof., Head of Electronics Department, National Aviation University, Ukraine

## EXECUTIVE SECRETARY

**O. A. Sushchenko**, Ph.D., Associate Prof., National Aviation University, Ukraine

## EDITORIAL BOARD

**A. Ya. Biletskiy**, Dr. Sci. (Eng.), Prof., National Aviation University, Ukraine

**L. N. Blokhin**, Dr. Sci. (Eng.), Prof., National Aviation University, Ukraine

**V. V. Vasylyev**, Dr. Sci. (Eng.), Prof., Corresponding Member of the National Academy of Sciences of Ukraine, National Aviation University, Ukraine

**L. Ya. Ilnitskiy**, Dr. Sci. (Eng.), Prof., National Aviation University, Ukraine

**I. A. Kalyaev**, Dr. Sci. (Eng.), Prof., Corresponding Member of the National Academy of Sciences of Russia, Institute of Multiprocessor Computing Systems, Research Institute of MCS, Russia

**Kzhishtof Kulpa**, Dr. Sci. (Eng.), Prof., Warsaw University of Technology

**Lyubka Doukovska**, Dr. Sci., Institute of Information and Communication Technologies of Bulgarian Academy of Sciences, Bulgaria

**V. V. Nechaev**, Dr. Sci. (Phys.-Mat.), Prof., Moscow Institute of Radio Engineering, Electronics, Automation (MIREEA), Russia

**I. G. Prokopenko**, Dr. Sci. (Eng.), Prof., National Aviation University, Ukraine

**François Le Chevalier**, Dr. Sci. (Eng.), Prof., Delft University of Technology, Netherlands

**L. V. Sibrak**, Dr. Sci. (Eng.), Prof., Head of Radio Electronic Devices and Systems Department, National Aviation University, Ukraine

**George T. Schmidt**, IEEE Fellow, Dr. Sci. (Eng.), Prof., Massachusetts Institute of Technology (Cambridge), USA

The journal is included in the list of scientific publications of Higher Attestation Commission of Ukraine, to be published the main results of theses in Engineering.

*Approved for publication by the Academic Council of National Aviation University (Minutes 7 of 27 May 2015).*

Registered with Ministry of Justice of Ukraine.

Certificate of State registration of the print media.

Series KV №16720-5292 PR on May 21, 2010.

Editorial board address: 1 Kosmonavta Komarova Ave., Kyiv-58, 03680

Tel. (38 044) 406 72 47

<http://ecs.in.ua>

© National Aviation University, 2015