IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS

The IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS is published as a monthly journal under the co-sponsorship of the IEEE Circuits and Systems Society, the IEEE Computer Society, and the IEEE Solid-State Circuits Society. All members of the IEEE are eligible for membership in all three societies upon payment of membership fee. Current society membership fees are: Circuits and Systems Society-$22, Computer Society - $60, and Solid-State Circuits Society-$22. For information on joining, visit the IEEE website at https://www.ieee.org/membership/join or write to the IEEE Computer Society, 1730 Massachusetts Avenue, NW, Washington, DC 20036-1903. The website lists the most current prices. The annual subscription fee for members of a co-sponsoring society is $40.00. Members can access issues at no extra charge.

Associate Editors

MAGDY ABADIR
Helic Inc.
Yokohama, Kanagawa 226-8503, Japan
Magdy.abadir@gmail.com

MASSIMO ALIOTO
National Taiwan Univ.
117583, Singapore
massimo.alioto@gmail.com

THORGBRIT ALSKAN
Integ. Electron. Syst.
Scottish Microelectron. Centre
Kings Buildings
Edinburgh EH9 3JF, U.K.
T.alskan@ed.ac.uk

CHYE CHIRIN BOON
Nanyang Technol. Univ. Singapore
ECCBoon@ntu.edu.sg

ANDREA BUSSO
Telecom. Circuits Lab (TCL)
Politecnico di Torino
Corso Duca degli Abruzzi 24
10129 Turin, Italy
a.buss@polito.it

TECHNUK ARSLAN
Nanyang Technol. Univ.
639798, Singapore
ECHChang@ntu.edu.sg

SUSAN D. CHENG
Meng-Fan (Marvin) Chang
National Taiwan Univ.
Taipei 10617, Taiwan
sdceng@ntu.edu.tw

YAO-WEN CHENG
National Taiwan Univ.
Taipei 10617, Taiwan
pokicheng@ntu.edu.tw

PAOLO C. CROVETTI
F. S. Sebastiano@tudelft.nl
Delft Univ. Technol.
Delft 2628, The Netherlands

POKICHI CHEN
Tokyo Inst. Technol.
Yokohama Kanagawa 226-8503, Japan
dodo.s.s.a@m.titech.ac.jp

ROBERT G. COOPER
Mathematik und Informatik
Universität Bremen
Bremen 28359, Germany
drechsel@uni-bremen.de

IBRAHIM (ANG) EFELED
Khalil Univ.
Masdar City Campus
Abu Dhabi, UAE
ibrahim.elade@ku.ac.ae

RUOAN HAN
University of California, Berkeley
CA 94720-1776, USA
ruohan.han@berkeley.edu

MASANORI HASHIMOTO
Osaka Univ.
Suita, Osaka 565-0871, Japan
hasimoto@ist.osaka-u.ac.jp

CHUN-HUAT HENG
National Taiwan Univ.
117583, Singapore
elechtc@ntu.edu.sg

DEUKHYUN HEO
Washington State Univ.
Pullman, WA 99164-2752 USA
dheo@wsu.edu

TUONG VI HO
National Chung Cheng Univ.
Hsinchu 30010, Taiwan
tybahn@nccu.edu.tw

HOUMAN HOMAYOUN
George Washington Univ.
FAIRFAX, VA 22030 USA
shomayoun@ gwu.edu

YUH-SHIAN HWANG
National Taiwan Univ.
Taipei 10617, Taiwan
yshwang@mail.nmtu.edu.tw

ALI JOSHI
National Taiwan Univ.
Taipei 10617, Taiwan
najoshi@ntu.edu.tw

BO-HAI KANG
National Taiwan Univ.
Taipei 10617, Taiwan
bhkang@ntu.edu.tw

THOMAS SIEGERT
Associate Director, Information Technology
The Institute of Electrical and Electronics Engineers
Univ. Florida
Gainesville, FL 32611-6200 USA
thomas.siegert@ieee.org

JOSÉ M. F. MOURA
President
TOSHIKATSU MURAKAMI
President-Elect
KATHLEEN Kramer, Secretary
JAMIE J. FERRIES, Past President

IEEE Officers

RAVI K. JOSHI
IEEE Res. Dev.
Yale University, New Haven, CT 06520, USA
ravijoshi@yale.edu

TANNAI KARAKI
Intel Corp.
Hillsboro, OR 97124 USA
tannaik@intel.com

CHIHWOO KIM
Korea Univ.
Seoul 02812, Korea
ckim@korea.ac.kr

TONY KIM
Yonsei Univ.
Auston, TX 78701 USA
jaydeep@u.texas.edu

YUKSAN KURUS
Hong Kong Univ. Sci. Technol.
Clear Water Bay, Kowloon
Hong Kong
yskurus@hkbu.edu

YOMOYUNG LEE
Yonsei Univ.
Gwangju 61419, South Korea
yomoyung@skku.edu

HAI L
Duke Univ.
Durham, NC 27708 USA
hai66@pitt.edu

HUANG LI
Chinese Acad. Sci.
Beijing 100190, China
lihuang@ict.ac.cn

PRAJASTA MISHRA
Univ. Florida
Gainesville, FL 32611 USA
prabhat@ufl.edu

BUI-Anh TRAN
Indore, MP 452 016, India
buianh@iiit.ac.in

WITTOL M. KINSNER
President, IEEE-USA
MARK TEHRANIPOOR
President, Standards Association

ALAEHRO "ALEX" ACERO,
Director, Division IX—Signals and Application

CHERIF AMIRAT,
Information Technology
WILLIAM HAWKINS, Marketing

CECELIA JANKOWSKI,
Member and Geographic Activities

MICHAEL FORSTER,
Publications

MARK ZWOLINSKI
Senior Managing Editor

IEEE Executive Staff

STEPHEN P. WELBY, Executive Director & Chief Operating Officer

IEEE Publishing Operations

KELLY MCKINNEY
Director, Production Services

Associate Director, Information Technology

NEELAM KHURANA
Senior Managing Editor

Joanne Gillick

IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS is published by The Institute of Electrical and Electronics Engineers, Inc. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society/Council, or its members. IEEE ELECTROCOMMUNICATIONS OFFICE: 3 Park Avenue, 17th Floor, New York, NY 10016-5997. IEEE Periodicals Department. (First Class Postage Paid at New York, NY and at additional mailing offices. Copyright © 2019 by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved. Periodicals Postage Paid at New York, NY and at additional mailing offices. Postmaster: Send address changes to IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS, 445 Hoes Lane, Piscataway, NJ 08854-4141. NJ Telephone 609-445-7311. IEEE Periodicals: Printed in the USA. IEEE prohibits discrimination, harassment, and bullying. For more information visit http://www.ieee.org/nondiscrimination. Printed in U.S.A. 1Digital Object Identifier 10.1109/TVLSI.2019.2909678