

# **2019 IEEE International Workshop on Future Computing (IWOFC 2019)**

**Hangzhou, China  
14 – 15 December 2019**



**IEEE Catalog Number: CFP19WTE-POD  
ISBN: 978-1-7281-2534-3**

**Copyright © 2019 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP19WTE-POD
ISBN (Print-On-Demand):	978-1-7281-2534-3
ISBN (Online):	978-1-7281-2533-6

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

# TABLE OF CONTENTS

<b>OPTIMIZATION STRATEGY FOR ACCELERATING MULTI-BIT RESISTIVE WEIGHT PROGRAMMING ON THE RRAM ARRAY</b> .....	1
<i>Junren Chen ; Huaqiang Wu ; Bin Gao ; Jianshi Tang ; Wenqiang Zhang ; He Qian</i>	
<b>SUB-HARMONIC INJECTION LOCKING MEMRISTOR-BASED OSCILLATOR ARRAYS USED FOR PATTERN RECOGNITION</b> .....	4
<i>Yubing Xu ; Bo Wang</i>	
<b>HARDWARE IMPLEMENTATION OF SOFTMAX FUNCTION BASED ON PIECEWISE LUT</b> .....	7
<i>Xiao Dong ; Xiaolei Zhu ; De Ma</i>	
<b>SPIKING CONTINUOUS ATTRACTOR NEURAL NETWORKS WITH SPIKE FREQUENCY ADAPTATION FOR ANTICIPATIVE TRACKING</b> .....	10
<i>Liutao Yu ; Tianhao Chu ; Zhao Zhao ; Yuanyuan Mi ; Yuchao Yang ; Si Wu</i>	
<b>MAGIC NAND WITHIN NOR GATE</b> .....	13
<i>Hongchang Long ; Xi Zhu ; Zhiwei Li ; Jietao Diao ; Haijun Liu ; Qingjiang Li</i>	
<b>A NOVEL HOMEOSTASIS METHOD TO IMPROVE THE LEARNING EFFICIENCY OF SPIKING NEURAL NETWORKS</b> .....	15
<i>Lianhua Qu ; Lei Wang ; Shuo Tian ; Ziyang Kang ; Shiming Li ; Weixia Xu</i>	
<b>DESIGN OF MODULAR MULTIPLIER BASED ON MEMRISTOR</b> .....	18
<i>Zitao Wei ; Yongjia Wang ; Xianyang Jiang</i>	
<b>THE IMPACT OF NON-LINEAR NVM DEVICES ON IN-MEMORY COMPUTING</b> .....	31
<i>Sai Zhang ; Zongdong Dai ; Rui Xiao ; Haibin Shen ; Kejie Huang</i>	
<b>INSTABILITY CHANGES THE MAGIC NAND GATE TO THE NOR GATE</b> .....	34
<i>Xi Zhu ; Hongchang Long ; Zhiwei Li ; Hui Xu ; Haijun Liu ; Qingjiang Li</i>	
<b>OSCILLATION NEURON BASED ON THRESHOLD SWITCHING CHARACTERISTICS OF NIOBIUM OXIDE FILMS</b> .....	37
<i>Qingxi Duan ; Zhaokun Jing ; Ke Yang ; Ru Huang ; Yuchao Yang</i>	
<b>PULSED OPERATION AND LOW-ENERGY CONSUMPTION CHARACTERISTIC ON HFON RRAM DEVICES AS ELECTRONIC SYNAPSE</b> .....	40
<i>Yuechi Ma ; Ao Yu ; Yaping Zhang ; Zehao Wang ; Xiangxiang Ding ; Yulin Feng ; Lifeng Liu</i>	
<b>A REAL-TIME ONLINE AIRCRAFT NEURAL NETWORK SYSTEM</b> .....	43
<i>Ying Zhang ; Qian Zhao ; Leiyao Tao ; Jian Cao ; Minfeng Wei ; Xing Zhang</i>	
<b>LOW-POWER RESISTIVE SWITCHING CHARACTERISTICS IN TIN/TAON/SIO<sub>2</sub>/PT RRAM DEVICES FOR NEUROMORPHIC APPLICATIONS</b> .....	48
<i>Ao Yu ; Yuechi Ma ; Zehao Wang ; Xiangxiang Ding ; Yulin Feng ; Lifeng Liu</i>	
<b>AN 8-BIT RRAM BASED MULTIPLIER FOR HYBRID MEMORY COMPUTING</b> .....	51
<i>Xuan Zhou ; Xiaolei Zhu ; Bing Chen ; Yi Zhao ; Chengjie Fu</i>	
<b>Author Index</b>	