



*Front. Inform.  
Technol. Elec-  
tron. Eng.*

**Administrated by**  
Chinese Academy of Engineering

**Sponsored by**  
Chinese Academy of Engineering  
& Zhejiang University

**Published by**  
Springer & Zhejiang University  
Press

**Edited by**  
Editorial Office of *Journal of  
Zhejiang University-SCIENCE  
& FITEE*

**Printed by**  
Hangzhou Shengyuan Printing  
Services Co., Ltd.

**Publication Date**  
1<sup>st</sup> Week per Month

**Price (Domestic)**  
160 CNY/Issue

**ISSN 2095-9184**  
**CN 33-1389/TP**

# CONTENTS

## Special Issue on Evolution and Innovation of Antenna Systems for Beyond 5G and 6G

### Editorial

- 1 Evolution and innovation of antenna systems for beyond 5G and 6G  
Bao-yan DUAN

### Review Articles

- 4 Microwave metamaterials: from exotic physics to novel information systems  
Rui-yuan WU, Tie-jun CUI
- 27 Dispersion-engineered wideband low-profile metasurface antennas  
Wei E. I. LIU, Zhi Ning CHEN, Xianming QING
- 39 Channel measurements and models for 6G: current status and future outlook  
Jian-hua ZHANG, Pan TANG, Li YU, Tao JIANG, Lei TIAN
- 62 Decoupling methods of MIMO antenna arrays for 5G applications: a review  
Xiao-xi ZHANG, Ai-di REN, Ying LIU
- 72 Energy-efficient power amplifiers and linearization techniques for massive MIMO transmitters: a review  
Xin LIU, Guan-sheng LV, De-han WANG, Wen-hua CHEN,  
Fadhel M. GHANNOUCHI

---

### Guest Editors

Bao-yan DUAN, Editor-in-Chief, Xidian Univ, China  
Jian-hua ZHANG, Editor-in-Chief Assistant, Beijing Univ Posts Telecommun, China  
Ying LIU, Editor-in-Chief Assistant, Xidian Univ, China  
Zhi Ning CHEN, Nat Univ Singapore, Singapore  
Tie-jun CUI, Southeast Univ, China  
Yingjie Jay GUO, Univ Technol Sydney, Australia  
Wei-dong HU, Beijing Inst Technol, China  
Jun-gang MIAO, Beihang Univ, China  
Raj MITTRA, Univ Centr Florida, USA  
Shi-wen YANG, Univ Electron Sci Technol China, China  
Ping ZHANG, Beijing Univ Posts Telecommun, China

- 97 Analysis and design of transformer-based CMOS ultra-wideband millimeter-wave circuits for wireless applications: a review  
Yi-ming YU, Kai KANG
- 116 Filtering antennas: from innovative concepts to industrial applications  
Yun-fei CAO, Yao ZHANG, Xiu-yin ZHANG

#### Research Articles

- 128 Analysis and design of novel wideband and high efficiency millimeter-wave antenna arrays for 60-GHz applications  
Kai-lai WU, Yuan YAO, Xiao-he CHENG, Jun-sheng YU, Tao YU, Xiao-dong CHEN
- 144 Miniaturized Rotman lens with applications to wireless communication  
Bao-hua SUN, Qiu-yan LIANG, Gao-nan ZHOU
- 159 Optimal design of a large dual-polarization microstrip reflectarray with China-coverage patterns for satellite communications  
Gang ZHAO, Yong-chang JIAO, Guan-tao CHEN
- 174 Integrated 60-GHz miniaturized wideband metasurface antenna in a GIPD process  
Hai-yang XIA, Jin-can HU, Tao ZHANG, Lian-ming LI, Fu-chun ZHENG

#### Correspondences

- 182 MIMO handset antenna for 5G/WLAN applications  
Yong CHENG, Jing LU, Bing-qing SHENG
- 188 5G evolution promoting innovation of antenna systems  
Feng GAO, Peng GAO, Wen-tao ZHU, Chen-xi ZHANG, Xian-kun MENG, Run-hong SHAN



*Front. Inform.  
Technol. Elec-  
tron. Eng.*