

PIERS 2023 Prague

PhotonIcs & Electromagnetics Research Symposium
also known as Progress In Electromagnetics Research Symposium

Program

July 3–6, 2023
Prague, CZECH REPUBLIC

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15:30 **Coffee Break**

Session 2P12b
**Advanced RF and Microwave Technologies for
New Mobility Applications**

Tuesday PM, July 4, 2023
Room 12 - South Room 224

Organized by Sang-Min Han

 Chaired by Sang-Min Han, Yongchae Jeong

16:00 Miniaturized Four Port MIMO Antenna for URLLC and Virtual MIMO Applications

Osama Aziz (Ghulam Ishaq Khan Institute of Engineering Sciences and Technology); MuhibUr Rahman (Polytechnique Montreal);

16:15 Utilizing Transmission Lines for Efficient Energy Harvesting in 5G Networks

Maryam Eshaghi (University of Windsor); Rashid Rashidzadeh (University of Windsor);

16:30 The Method of De-embedding without the TRL Calibration Board

Minseong Kim (Soonchunhyang University); Sohui Kim (Soonchunhyang University); Jiwon Kim (Soonchunhyang University); Heaseong Cha (SAWNICS Co., Ltd.); Soon Hong Ahn (SAWNICS Co., Ltd.); Youna Jang (Soonchunhyang University); Dal Ahn (Soonchunhyang University);

16:45 Design of Compact and High Selective RF Front-end Module for Low-band 5G and IoT Applications

Trong-Hieu Le (Electric Power University); Manh-Cuong Ho (Electric Power University); Le-Cuong Nguyen (Electric Power University);

17:00 Compact Microwave Device Designs with DGSs for Mobility Applications

Sang-Min Han (Soonchunhyang University); Won-Sang Yoon (Hoseo University); Jongsik Lim (Sooncheonhyang University); Dal Ahn (Soonchunhyang University);

17:15 Deep Reinforcement Learning-based Auto-tuning Algorithm for Cavity Filters

Daniel Poul Mtowe (Soonchunhyang University); Seong-Ho Son (Soonchunhyang University); Dal Ahn (Soonchunhyang University); Dong Min Kim (Soonchunhyang University);

 17:30 **Magnetless Nonreciprocal Bandpass Filter Using Time-modulated Resonators**
Girdhari Chaudhary (Jeonbuk National University); Phanam Pech (Jeonbuk National University); Samdy Saron (Jeonbuk National University); Yongchae Jeong (Jeonbuk National University);

17:45 Unequal Termination Impedances Bandpass Filter Based on Different-mode Substrate Integrated Waveguide Cavity

Phanam Pech (Jeonbuk National University); Samdy Saron (Jeonbuk National University); Girdhari Chaudhary (Jeonbuk National University); Yongchae Jeong (Jeonbuk National University);

18:00 A Design of Multilayer Interdigital Bandpass Filter Using Low-temperature Co-fired Ceramic (LTCC) Technology

Sohui Kim (Soonchunhyang University); Minseong Kim (Soonchunhyang University); Dae-Ung Lee (Huba Research Institute); Hyung-Sik Park (Huba Research Institute); Youna Jang (Soonchunhyang University); Dal Ahn (Soonchunhyang University);

18:15 A Size-reduced CPW Ring Hybrid Coupler Using a Phase Converting Structure

Jongsik Lim (Sooncheonhyang University); Donghun Kang (Soonchunhyang University); Kyungmin Park (Soonchunhyang University); Gil-Young Lee (Air Force Academy); Sang-Min Han (Soonchunhyang University); Dal Ahn (Soonchunhyang University); Yongchae Jeong (Jeonbuk National University);

Session 2P13
Poster Session 3

Tuesday PM, July 4, 2023
14:00 PM - 18:00 PM
Room 13 - Congress Hall Foyer 2

 1 Glare Points in Laser Flow Cytometry
Alexander Putz (Physikalisch-Technische Bundesanstalt); M. Hussels (Physikalisch-Technische Bundesanstalt); Jonas Gienger (Physikalisch-Technische Bundesanstalt);

 2 A Single-layer Polarization-insensitive Broadband Absorber for X-band Applications
Cheng-Yen Chung (Yuan Ze University); Cheng-Nan Chiu (Yuan Ze University); Ming-Kun Hsieh (Bureau of Standards, Metrology and Inspection, Ministry of Economic Affairs); Yuan-Fu Ku (Taiwan Testing and Certification Center);

 3 Utilization of Transmission Phase Shift Method for Characterizing Properties of Material Encapsulated by Rectangular Waveguide
Sulistyaningsih (Institut Teknologi Bandung); Zulfi (Institut Teknologi Bandung); Umar Khayam (Institut Teknologi Bandung); Achmad Munir (Institut Teknologi Bandung);

Magnetless Nonreciprocal Bandpass Filter Using Time-modulated Resonators

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Abstract— Nonreciprocal bandpass filter (NBPF) allows transmission of signals in specific range of frequencies in one direction while rejecting those signals in opposite direction. The NBPFs are crucial to modern wireless communication, radar, and medical imaging systems. The NBPF can be employed to protect active devices from unwanted reflected signals, and prevent self-interference in in-band full duplex systems. Traditionally, nonreciprocal circuits such as isolators and circulators are mainly designed by using magnetic biased ferrite materials, which are costly, bulky, and unsuitable for use with integrated circuits [1, 2]. Recently, it is great interests to design magnet-less nonreciprocal circuits with affordable technologies. Active circuits such as transistor have attempted with goal of achieving nonreciprocal without ferrite material, however, these approaches suffer from poor noise figure and limited power handling [3].

In this work, we proposed a magnetless microstrip line NBPF that allow a signal to travel in only one direction using time-modulated resonators with progressive phase shift. The proposed NBPF integrates isolator and bandpass filter within same circuit [4, 5]. To achieve nonreciprocal response, modulation signals with progressive phase shift are applied to varactors, which generate the intermodulation (IM) products. When proper modulation parameters are employed, the powers at IM products can constructively collected at RF carrier frequency to provide the small forward insertion loss or destructively added up in reverse direction to provide high isolation.

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2. Seewald, C. K. and J. R. Bray, "Ferrite-filled anti-symmetrically biased rectangular waveguide isolator using magnetostatic surface wave modes," *IEEE Trans. Microw. Theory Techn.*, Vol. 58, No. 6, 1493–1501, Jun. 2010.
3. Tanaka, S., N. Shimomura, and K. Ohtake, "Active circulators: The realization of circulators using transistors," *Proc. IEEE*, Vol. 53, No. 3, 260–267, Mar. 1965.
4. Chaudhary, G. and Y. Jeong, "Frequency tunable impedance matching nonreciprocal bandpass filter using time-modulated quarter-wave resonators," *IEEE Transactions on Industrial Electronics*, Vol. 69, No. 8, 8356–8365, Aug. 2022.
5. Chaudhary, G. and Y. Jeong, "Nonreciprocal bandpass filter using mixed static and time-modulated resonators," *IEEE Microwave and Wireless Component Letters*, Vol. 32, No. 4, 297–300, Apr. 2022.