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Abstract Index

Dieudonné Marcel Djanssou[a], Abdouramani Dadjé[a,b], Fabrice Kwefeu Mbakop[a,c], Noël Djongyang[a] ([a]Department of Renewable Energi, National Advanced School of Engineering of Maroua, University of Maroua, Cameroon, [b]School of Geology and Mining, Engineering University of Ngaoundéré, Cameroon, [c]Department of Renewable Energy and Energy Performance, Higher Institute of Agriculture, Forestry, Water and Environment, University of Ebolowa, Cameroon)

Improvement of Photovoltaic Systems with Tracking of the Maximum Power Point in Low-Irradiation Atmospheric Conditions

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This paper discusses the efficient use of photovoltaic energy in areas with low solar irradiation. To extract the maximum power at low irradiation, we used a maximum power point tracking (MPPT) algorithm based on the combination of fuzzy logic (FL) and the sliding mode (SM) associated with a Proportional-Integral (PI) regulator. The system parameters are calculated using the particle swarm optimization (PSO) technique, which thus ensures the stability of the controller. The performance of the proposed technique is compared with the conventional perturb and observe (P&O) technique in terms of tracking time and tracking efficiency at low irradiation. The simulation results prove that the technique has high tracking efficiency and less convergence time under low irradiation, with fewer power oscillations, low ripple and no overshoot.

Keywords: low irradiation, MPPT, PI regulator, fuzzy logic, PSO, sliding mode.

Soraida Sabella, Misfa Susanto, FX Arinto Setyawan (Department of Electrical Engineering, University of Lampung, Indonesia)

Interference Management Using Distance-based Clustering Method for D2D Communication Underlaying Multicell Cellular Network

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Device-to-device (D2D) communication is a technology candidate to support the next generation of cellular communication networks. D2D can potentially boost the efficiency of frequency resources and system capacity. Generally, D2D performs in-band underlaying or shares frequency channels with traditional cellular users, which can cause co-channel interference problems between these two types of users. This paper offers a clustering method solution for D2D users (DUEs) to reduce interference among DUEs. The clustering method is performed on DUEs by allocating different frequency channels in a group, in order to minimize the interference effects experienced. Thus, it is expected that through this proposed method, both D2D and cellular users can experience better signal quality with minimal interference effects. Two systems have been considered i.e., the conventional/baseline system and the system with the proposed method. The simulation results show that the signal-to-interference-plus-noise ratio (SINR) values and throughput for the system with the proposed method have increased compared to the baseline system. The SINR result obtained is 16.8 dB for the baseline system and 17.68 dB for the proposed system, resulting in an improvement of 5.4%. Therefore, applying the proposed clustering method can increase the acceptability of the desired signals for the observed DUEs. Then, the throughput value also increases by 5%, i.e., from 56.17 to 59 Mbps. This result implies that the system with the proposed clustering method increases data transmission speed better than the baseline system.

Keywords: D2D communication, in-band underlay, multicell, clustering, downlink transmission.

Yoppy[a], Dwi Mandaris[a], Aditia Nur Bakti[a], Hutomo Wahyu Nugroho[a], Yudhistira Yudhistira[a], Deny Hamdani[b] ([a]Research Center for Testing Technology and Standards, National Research and Innovation Agency, Indonesia, [b]Research Center for New and Renewable Energy, School of Electrical and Informatics Engineering, Institut Teknologi Bandung, Indonesia)

Estimating the Differential Mode Noise of a DC-DC Converter

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Electromagnetic noise emission is inevitable in a DC-DC converter due to the employed switching technique. In low frequency, the noise propagating through cabling and conductive media is called a conducted emission. A conducted emission consists of differential mode and common mode noise. It is advantageous to know an estimate of the emission level for each mode during the design phase so that suitable mitigation can be included earlier. This paper aims to focus on a method to estimate the differential mode noise emission of a DC-DC converter. The estimation is computed using the input capacitor complex impedance and the current that flows through it. As a study case, boost and buck converters are used for evaluation. The estimation and measurement results are compared. Despite differences at some frequencies, the estimated and measured results generally agree well. Because of its simplicity, the proposed method can be used as a practical tool in the EMC aspect of DC-DC converter design.

Keywords: buck converter, boost converter, complex impedance, differential mode noise, input capacitor.

Taufiqqurrachman[a,b], Mohamad Kamal Abdul Rahim[b], Dadin Mahmudin[a], Raden Priyo Hartono Adji[a], Deni Permana Kurniadi[a], Winy Desvasari[a], Sulistyaningsih[a], Fajri Darwis[a], Arief Nur Rahman[a], Prasetyo Putranto[a], Arie Setiawan[a,c], Aminuddin Rizal[d] ([a]Research Center for Telecommunication, National Research and Innovation Agency, Indonesia, [b]Advanced RF and Microwave Research Group ((ARFMRG)), Faculty of Electrical Engineering,
Universiti Teknologi Malaysia, [c]Graduate School of Engineering, Mie University, Japan, [d]Electrical Engineering Department, Politeknik Negeri Semarang)

Comparison of a Circular Patch Unit Cell Performance for Reflector Applications between Using FR4 and F4BMX220 Substrates at 3.5 GHz Frequency

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This paper presents a performance comparison of the circular patch unit cell as a unit cell for reflector application at 3.5GHz frequency using a dielectric substrate between FR4 and F4BMX220 substrates. A circular patch is chosen as the unit cell ofa reflector because it is commonly used, fabricated, and has a wider bandwidth compared to other structures. A performance comparison of the circular patch on both dielectric substrates is presented in a graph of S-parameters, reflection phase, and operating bandwidth, as well as in the table of dimensions, where the result is performed by simulation using CST software. Based on the simulated results, the F4BMX220 has a better performance compared to the FR4 in terms of the reflection value, operating bandwidth, and dielectric substrate thickness. However, a circular patch diameter when using the F4BMX220 is bigger than when using the FR4 substrate because the FR4 substrate has a higher dielectric constant than the F4BMX220, which is twice the F4BMX220 dielectric constant. Also, the F4BMX220 substrate has a narrower bandwidth compared to the FR4 substrate, which is a difference of around 0.1 GHz. The circular patch when using the F4BMX220 substrate has 0.96 of a reflection value, 0.007 of an absorption value, -6.77° of the reflection phase, and 0.24 GHz of the operating bandwidth at the normal incident wave angle (0°). Also, it can be properly worked if the incident wave angle is moving until 60°. The F4BMX220 substrate has the best performance compared to the FR4 substrate because the reflection value is much better value, even at the incident wave angle of 60°.

Keywords: Circular patch, reflector, FR4 substrate, F4BMX220 substrate.

Ersalina Werda Mukti, Agus Risdiyanto, Ant. Ardath Kristi, Rudi Darussalam (Research Center for Energy Conversion and Conservation, National Research and Innovation Agency, Indonesia)

Particle Swarm Optimization (PSO) based Photovoltaic MPPT Algorithm under Partial Shading Condition

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The efficiency of a solar photovoltaic (PV) system experiences a substantial decline when shadows obscure the PV array's surface, leading to a decrease in power production. In cases of partial shading, the PV array exhibits multiple peaks in its characteristic curve, causing inefficiencies in the traditional maximum power point tracking (MPPT) algorithm. In response to this challenge, we have proposed an optimization method for PV systems using the

particle swarm optimization (PSO) algorithm in MPPT, aiming to enhance power extraction during shaded conditions. We assessed the performance of our MPPT methods by comparing tracking time, tracking error, and efficiency with perturb and observe (P&O) and incremental conductance (IC) algorithms. We generated random shading patterns through a partial shading generator function and conducted simulations of a PV system containing ten PV modules connected to a DC dummy load via a DC-DC boost converter using MATLAB/SIMULINK. Simulation results indicated that the PSO-based MPPT method effectively located global maximum power point (GMPP) while the P&O and IC MPPT methods remained confined to local maxima. Furthermore, the PSO optimization substantially improved the PV system's efficiency by approximately 4.66% under dynamic shading conditions, albeit with a slightly slower tracking time compared to the P&O and IC MPPT methods featuring delays of 0.0025 s and 0.0105 s, respectively.

Keywords: PSO, MPPT, MATLAB/SIMULINK.

Khoirudin Fathoni, Esa Apriaskar, Nur Azis Salim, Vera Noviana Sulistyawan, Rifki Lukman Satria, Syahroni Hidayat (Department of Electrical Engineering, Universitas Negeri Semarang, Indonesia)

Design of Brushless DC Motor Driver Based on Bootstrap Circuit

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A brushless DC (BLDC) motor is a three-phase that requires electronic commutation to replace the brush function in the DC motor. This paper aims to implement BLDC motor driver integration based on bootstrap circuits using Autodesk Eagle. The study proposes an emphasis on bootstrap capacitor calculation based on the charging/discharging capacitor principle with motor speed rotation as well as the pulse width modulation (PWM) frequency and duty cycle. The driver board consists of a bootstrap circuit based on IR2110, MOSFETs, three voltage regulators, ESP32 microcontroller and ACS712 current sensor connection, logic level converter, and BLDC hall effect signal sensor conditioning. The implemented driver has a 14 ×10 cm dimension tested to drive 24 V/135 W/6000 rpm sensored BLDC motor using six steps commutation with PWM inserted programmatically in ESP 32 to drive the high side MOSFET of the driver without AND gate circuit. The effect of PWM frequency and duty cycle variation on the speed and current of the motor is investigated. The results showed that the driver with both 12 V and 24 V voltage source and 68 μF bootstrap capacitor work optimally in 20 kHz PWM frequency both in open loop and closed loop speed control tests. The motor reaches 129 W for the largest power and 5250 rpm for the fastest speed in a 24 V supply.

Keywords: BLDC motor, 3 phases motor driver, bootstrap circuit.

Evira Bella Yustiani[a], Putri Nur Anggraini[b], Shobih[b], Eri Widianto[c], Lilis Retnaningsih[b], Syoni Soepriyanto[a], Imam Santoso[a], Natalita Maulani Nursam[b] ([a]Department of Metallurgical Engineering, Bandung Institute of Technology, Bandung, Indonesia, [b]Research Center for Electronics, National Research and Innovation Agency (BRIN), Indonesia, [c]Department of Mechanical Engineering, Singaperbangsa University, Karawang, Indonesia)

Colloidal TiO_2-Modified Mesoporous Electron Transport Layer in Perovskite Solar Cells

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The electron transport layer (ETL) is a crucial part of perovskite solar cells (PSC) as it governs explicitly the charge extraction at the perovskite/ETL interface. In this study, methylammonium lead iodide-based PSCs with an n-i-p structure were fabricated and modified by adding colloidal TiO_2 into the mesoporous TiO_2 film as ETL, aiming to obtain good paste consistency that facilitates the deposition process. The effect of the colloidal TiO_2 addition on the PSC performance was investigated for ETL with different types of TiO_2 particles, i.e., Degussa P25 (the commercial TiO_2 powder comprising anatase, rutile, and amorphous phase) and pure anatase TiO_2. The physical properties of the resulting TiO_2 films were characterized using scanning electron microscopy, while the solar cell performances were analyzed using current-voltage measurement. Despite producing lower performance than the PSC made with commercial paste, the power conversion efficiency (PCE) of the PSCs could be improved with the introduction of a colloidal TiO_2 solution. An optimum condition was observed depending on the type of TiO_2 particle, where the best-performing device was achieved with a colloidal TiO_2 of 0.4 and 0.2 mL for P25 and anatase TiO_2, respectively. The PCE of the PSC with the optimum concentration of TiO_2 colloid increased to approximately 15% for P25 and significantly increased to 4 times for

anatase TiO_2, higher than the PCE of the respective samples without any colloid addition. The amount of colloidal TiO_2 in samples with P25 overall had less impact than the samples with anatase TiO_2.

Keywords: TiO_2, electron transport layer, perovskite, solar cell, colloid, power conversion efficiency.

Yusuf Affandi[a], Muhammad Yusrul Hanna[b] ([a]Instrumentation and Automation Engineering, Faculty of Industrial Technology, Institut Teknologi Sumatera, Indonesia [b]Research Center for Quantum Physics, National Research and Innovation Agency (BRIN), Indonesia)

Investigation of Thermoelectric Properties of a Two-Dimensional Janus Si_2SbBi and Non-Janus SiSb Using Computational Method Density-Functional Theory

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Two-dimensional materials are of considerable interest owing to their unique electronic and thermal properties. In this study, we investigate the thermoelectric potential of two-dimensional Janus Si_2SbBi and compare it with a non-Janus SiSb based on the first-principles density functional theory (DFT) band structure calculations. According to the first-principles calculations, both materials exhibit semiconductor properties with bandgaps of 0.728 eV (Janus Si_2SbBi) and 0.82 eV (SiSb), respectively. Having information on the energy band structure, we evaluated thermoelectric properties using the Boltzmann transport equations as a function of Fermi energy as implemented in the BoltzTraP2 code. We find a Seebeck coefficient of 1349 (1342) $\mu V/K$ for p-type (n-type) doping at T = 300 K of the Si2SbBi monolayer. The results of our study present that the Janus Si2SbBi monolayer possesses a high Seebeck coefficient and electrical conductivity, leading to a substantial power factor (PF) of 4×10^{11} W/K2ms at 300 K. The PF increases with an increase in temperature and has the highest peak value up to 7×10^{11}W/K2ms at 600 K. The results show that the Seebeck coefficient, electrical conductivity, and power factor of the Janus Si_2SbBi monolayer are greater compared to those of the non-Janus SiSb monolayer. Our study presents Janus Si_2SbBi as a potential thermoelectric candidate, highlighting its prospective use in advanced thermoelectric applications.

Keywords: Janus Si_2SbBi, non-Janus SiSb, Boltzmann transport, Seebeck coefficient, power factor.

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