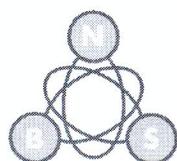


XLIX INTERNATIONAL SCIENTIFIC CONFERENCE ON INFORMATION, COMMUNICATION AND
ENERGY SYSTEMS AND TECHNOLOGIES



iCEST 2014

Proceedings of Papers

Volume 1

Serbia, Niš, June 25 - 27, 2014

**ICEST 2014 - XLIX INTERNATIONAL SCIENTIFIC CONFERENCE ON
INFORMATION, COMMUNICATION AND ENERGY SYSTEMS AND
TECHNOLOGIES, Serbia, Niš, June 25 - 27, 2014**

Proceedings of Papers - Volume 1 of 2 volumes

Editor: Prof. Dr. Bratislav D. Milovanović

Technical Editor: Dr. Zoran Ž. Stanković

Technical Co-Editor: Aleksandra Đorić

Technical Support: Vladica Đorđević, Miloš Kostić, Ana Aleksić

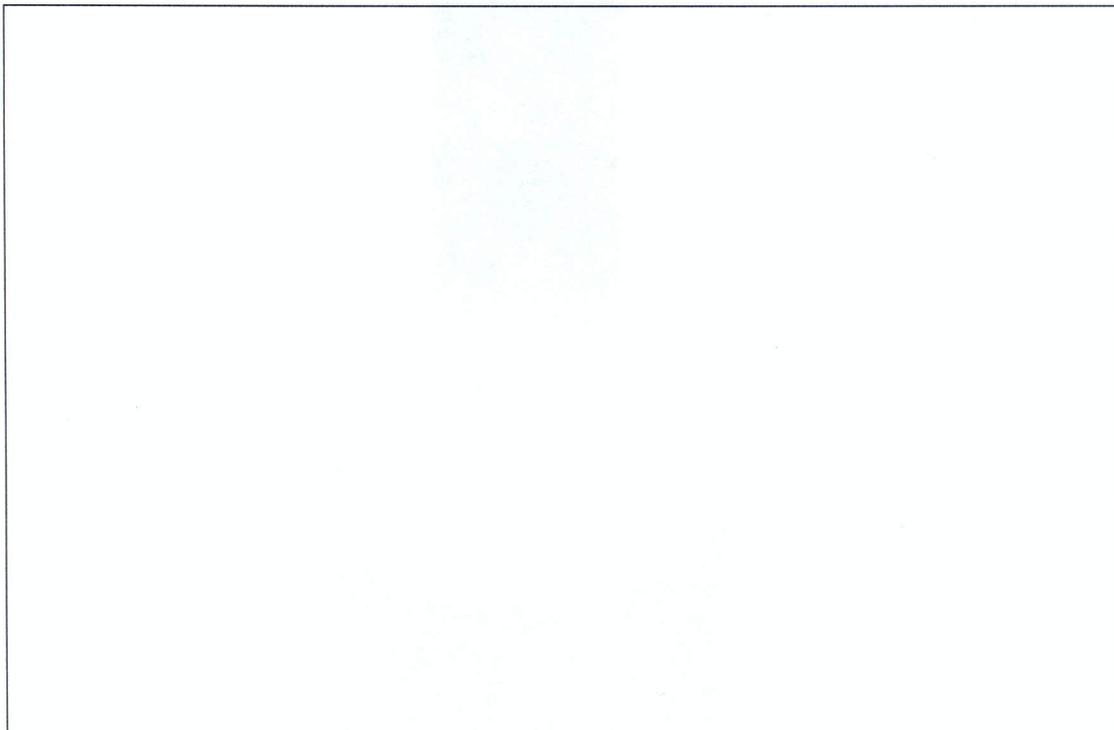
Published by: Faculty of Electronic Engineering, University of Niš, Serbia

Printed by: NAIS PRINT Design, Niš, Serbia

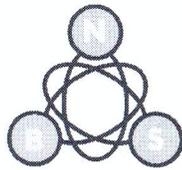
Number of copies printed: 50

Printing of this edition has been financially supported by
Serbian Ministry of Education, Science and Technological Development

ISBN: 978-86-6125-108-5



**XLIX INTERNATIONAL SCIENTIFIC CONFERENCE ON INFORMATION,
COMMUNICATION AND ENERGY SYSTEMS AND TECHNOLOGIES**



iCEEST 2014

organized by



**University of Niš,
Faculty of Electronic Engineering,
Serbia**



**Technical University-Sofia,
Faculty of Telecommunications,
Bulgaria**



**University St. Kliment Ohridski- Bitola,
Faculty of Technical Sciences
Macedonia**

under auspices of

- **Serbian Ministry of Education, Science and Technological Development**

in cooperation with

- **Academy of Engineering Sciences of Serbia**
- **Serbia and Montenegro IEEE Section**

TECHNICAL PROGRAM COMMITTEE

Chairman:

B. Milovanović University of Niš, Serbia

Vice-chairmen:

R. Arnaudov Technical University of Sofia, Bulgaria
C. Mitrovski University "St. Kliment Ohridski", Bitola, Macedonia

Members:

N. Acevski University "St. Kliment Ohridski", Bitola, Macedonia
I. Atanasov Technical University of Sofia, Bulgaria
M. Atanasovski University "St. Kliment Ohridski", Bitola, Macedonia
M. Bakmaz University of Belgrade, Serbia
A. Bekiarski Technical University of Sofia, Bulgaria
W. Bock University of Ottawa, Canada
O. Boumbarov Technical University of Sofia, Bulgaria
V. Češelkoska University "St. Kliment Ohridski", Bitola, Macedonia
D. Denić University of Niš, Serbia
V. Demirev Technical University of Sofia, Bulgaria
R. Dinov Technical University of Sofia, Bulgaria
D. Dimitrov Technical University of Sofia, Bulgaria
K. Dimitrov Technical University of Sofia, Bulgaria
T. Dimovski University "St. Kliment Ohridski", Bitola, Macedonia
D. Dobrev Technical University of Sofia, Bulgaria
I. Dochev Technical University of Sofia, Bulgaria
B. Dokić University of Banja Luka, Bosnia and Herzegovina
N. Dončov University of Niš, Serbia
D. Drača University of Niš, Serbia
T. Eftimov Plovdiv University "Paisii Hilendarski", Bulgaria
N. Gospić University of Belgrade, Serbia
V. Georgieva Technical University of Sofia, Bulgaria
G. Iliev Technical University of Sofia, Bulgaria
I. Iliev Technical University of Sofia, Bulgaria
M. Ivković University of Novi Sad, Serbia
Z. Jakšić IHTM Institute, Belgrade, Serbia
D. Janković University of Niš, Serbia
N. Janković University of Niš, Serbia
M. Jevtić University of Niš, Serbia
B. Jokanović Institut of Physics, Belgrade, Serbia
I. Jolevski University "St. Kliment Ohridski" Bitola, Macedonia
L. Jordanova Technical University of Sofia, Bulgaria
Z. Jovanović University of Niš, Serbia
V. Katić University of Novi Sad, Serbia
B. Kolundžija University of Belgrade, Serbia
Z. Konjović University of Novi Sad, Serbia
M. Kostov University "St. Kliment Ohridski" Bitola, Macedonia
R. Kountchev Technical University of Sofia, Bulgaria
M. Lutovac Singidunum University, Serbia
J. Makal Tech. University of Byalistok, Poland
N. Malesh-Ilić University of Niš, Serbia

TABLE OF CONTENTS

VOLUME 1

ORAL SESSIONS

TELECOMMUNICATIONS SYSTEMS AND TECHNOLOGY

TST.1	Capacity Bounds of Lozenge Tiling Constraints	3
	B. Vasić, A. Krishnan <i>University of Arizona, USA</i>	
TST.2	New Iterative Method for Optimization of Quasilogarithmic Quantizer for Laplacian Source	7
	Z. Perić, A. Jovanović, M. Tančić <i>University of Niš, Serbia</i>	
TST.3	Analysis of some Wavelength Assignment Techniques in WDM Optical Networks	11
	S. Miladić, G. Marković* <i>University of East Sarajevo, Bosnia and Herzegovina</i> <i>*University of Belgrade, Serbia</i>	
TST.4	Performance Analysis of RF/FSO System with Interference at the Relay	15
	A. Cvetković, M. Petković, J. Anastasov <i>University of Niš, Serbia</i>	
TST.5	Performance Analysis of SIM-FSO System over Gamma-Gamma Atmospheric Channel	19
	M. Petković, N. Zdravković, Č. Stefanović, G. Đorđević <i>University of Niš, Serbia</i>	
TST.6	Comparative Cost-Capacity Analysis of the Advanced Wirellesses Heterogeneous Broadband Networks	23
	V. Nikolikj, T. Janevski* <i>Vip operator, Macedonia</i> <i>*University "Ss. Cyril and Methodius", Macedonia</i>	
TST.7	Improving Performance of Multimedia Web Transfer over WAN Connections.....	27
	H. Valchanov, M. Angelov <i>Technical University of Varna, Bulgaria</i>	
TST.8	An Approach of QoS by Admission Control of VoIP over WLANs	31
	V. Aleksieva <i>Technical University of Varna, Bulgaria</i>	

INFORMATICS AND COMPUTER SCIENCE

ICS.1	An Exact Interactive Method for Solving Multiple Objective Integer Problems	37
	V. Guliashki, L. Kirilov <i>Institute of Information and Communication Technologies, Bulgaria</i>	
ICS.2	Resource Allocation for Maximum Performance and Minimum Cost for 3-tier SaaS Application in Azure	41
	S. Ristov, M. Gusev, B. Koteska, G. Velkoski* <i>University "Ss. Cyril and Methodius", Macedonia</i> <i>*Innovation LLC, Macedonia</i>	
ICS.3	Avatar Concepts in Self Healthcare Systems	45
	M. Gusev, S. Ristov, A. Guseva* <i>University "Ss. Cyril and Methodius", Macedonia</i> <i>*Innovation LLC, Macedonia</i>	

ICS.4	Lexico-Semantic Collaborative Learning Framework.....	49
	M. Jovanović, D. Todosijević <i>University of Niš, Serbia</i>	
ICS.5	Definition of Transposition Base Opening System With the Algorithm of Machine Learning	53
	V. Vučković <i>University of Niš, Serbia</i>	
ICS.6	Models of Inductive Reasoning	57
	M. Ilić, V. Stanković* <i>College of Agriculture and Food Technology, Prokuplje, Serbia</i> <i>*University of Niš, Serbia</i>	
ICS.7	Prediction of the Stock Market Trend using LS-SVM based on Technical Indicators	61
	I. Marković, J. Stanković, M. Stojanović*, M. Božić <i>University of Niš, Serbia</i> <i>*College of Applied Technical Sciences, Serbia</i>	

COMPUTER SYSTEMS AND INTERNET TECHNOLOGIES I

CIT I.1	Evaluation of Application Level Mechanism for Reliable Smart Objects Communications	67
	I. Atanasov, M. Ivanov, E. Pencheva <i>Technical University of Sofia, Bulgaria</i>	
CIT I.2	An Approach to Design Web Services for Remote Entity Management	71
	I. Atanasov, N. Krastanov, E. Pencheva <i>Technical University of Sofia, Bulgaria</i>	
CIT I.3	Web Services Deployment in Microsoft Azure Cloud Computing Platform	75
	E. Srbinska, P. Mitrevski <i>University "St. Kliment Ohridski", Macedonia</i>	
CIT I.4	Multipurpose Cloud-based Distance Learning Laboratory: A Case Study.....	79
	A. Donevski, S. Ristov, M. Gusev <i>University "Ss. Cyril and Methodius", Macedonia</i>	
CIT I.5	Parallelization of Machine Learning Methods Using CUDA.....	83
	G. Velkoski, M. Simjanoska*, S. Ristov*, M. Gusev* <i>Innovation LLC, Macedonia</i> <i>*University "Ss. Cyril and Methodius", Macedonia</i>	
CIT I.6	Data Mining Methodology for Web Users' Demographic Data Prediction.....	87
	V. Gega, I. Jolevski* <i>University for Information Science and Technology, Macedonia</i> <i>*University "Ss. Cyril and Methodius", Macedonia</i>	
CIT I.7	Improved Deflection Routing Method for Bufferless Networks-on-Chip.....	91
	I. Stojanović, M. Jovanović, S. Đošić, G. Đorđević <i>University of Niš, Serbia</i>	

COMPUTER SYSTEMS AND INTERNET TECHNOLOGIES II

CIT II.1	Realization of Universal HW/SW Module for Integration of Medical Laboratory Devices into Medical Information System.....	97
	A. Milenković, D. Janković, M. Stojković, A. Veljanovski, P. Rajković <i>University of Niš, Serbia</i>	
CIT II.2	Processing of Big Spatio-Temporal Data using MapReduce.....	101
	D. Stojanović, N. Stojanović <i>University of Niš, Serbia</i>	
CIT II.3	Incremental Development of e-Learning Systems for Mobile Platforms	105
	M. Frtunić, L. Stoimenov, D. Rančić <i>University of Niš, Serbia</i>	

CIT II.4	An Approach for Producing Long Term Statistics based on Weather Radar Data.....	109
	V. Mihajlović, M. Kovačević, D. Rančić <i>University of Niš, Serbia</i>	
CIT II.5	Comparison of Different Wireless Sensor Network Node Technologies.....	113
	M. Srbinovska, C. Gavrovski, V. Dimcev, Z. Kokolanski <i>University "Ss. Cyril and Methodius", Macedonia</i>	
CIT II.6	Immediate Assessment based Semantic e-Learning Evaluation Approach.....	117
	D. Todosijević, M. Jovanović <i>University of Niš, Serbia</i>	
CIT II.7	One Solution for Building Reconfigurable Multi-Projection Systems using the Adobe AIR Platform	121
	M. Radmanović, D. Tatić, D. Gajić <i>University of Niš, Serbia</i>	

RADIO COMMUNICATIONS, MICROWAVE TECHNIQUE AND ANTENNAS

RMA.1	ANN based Inverse Electro-Mechanical Modeling of RF MEMS Capacitive Switches	127
	T. Ćirić, Z. Marinković, T. Kim*, L. Vietzorreck*, O. Pronić-Rančić, M. Milijić, V. Marković <i>University of Niš, Serbia</i> <i>*TU München, Germany</i>	
RMA.2	Broadband Microstrip Doherty Amplifier Design and Linearization	131
	A. Đorić, A. Atanasković*, N. Maleš-Ilić*, B. Milovanović*, K. Blau** <i>Innovation Centre of Advanced Technology, Serbia</i> <i>*University of Niš, Serbia</i> <i>**Ilmenau University of Technology, Germany</i>	
RMA.3	A New Procedure for Extraction of Noise Wave Parameters of Microwave FETs	135
	V. Đorđević, Z. Marinković*, V. Marković*, O. Pronić-Rančić* <i>Innovation Centre of Advanced Technology, Serbia</i> <i>*University of Niš, Serbia</i>	
RMA.4	TLM Method with Z-transforms - Efficient Tool for Dispersive Anisotropic Structures Modelling.....	139
	M. Kostić, N. Dončov, Z. Stanković <i>University of Niš, Serbia</i>	
RMA.5	Band Gap Evaluation for Single, Dual and Triple Band Electromagnetic Band Gap Structures with Applied Geometrical Modifications	143
	I. Iliev, M. Nedelchev, E. Markov <i>University of Sofia, Bulgaria</i>	
RMA.6	Calculation of an Input Impedance of a Coax-fed Microstrip Circular Antenna using the TLM.....	147
	J. Joković, T. Dimitrijević, N. Dončov, B. Milovanović <i>University of Niš, Serbia</i>	
RMA.7	Dielectric Substrate Thickness Impact on Frequency Properties of Monopole Sierpinski Gasket Antenna	151
	P. Petkov, B. Bonev, T. Dimova <i>Technical University of Sofia, Bulgaria</i>	
RMA.8	Design Considerations for Splash Plate Reflector Antenna	153
	P. Petkov <i>Technical University of Sofia, Bulgaria</i>	

SIGNAL PROCESSING

SP.1	Power Disturbances Simulation and Analysis in Wavelet Domain	157
	M. Kostov, B. Gegov, M. Atanasovski*, M. Petkovski*, C. Mitrovski <i>University "St. Kliment Ohridski", Macedonia</i> <i>*Faculty of Technical Sciences, Bitola, Macedonia</i>	
SP.2	Comparison of Novel Designed Class of CIC FIR Filter Functions with Classical CIC Filters	161
	B. Stošić, V. Pavlović, D. Milić <i>University of Niš, Serbia</i>	
SP.3	ECG Signal Acquisition and Filtering	165
	M. Veljković, I. Janjić, D. Milić, D. Milović <i>University of Niš, Serbia</i>	
SP.4	Image Deblurring Methods and Image Quality Evaluation.....	169
	V. Guliashki, D. Dimov <i>Institute of Information and Communication Technologies, Bulgaria</i>	
SP.5	Combining Features by Query-time Weights Determination for Image Retrieval.....	177
	N. Neshov <i>Technical University of Sofia, Bulgaria</i>	
SP.6	Method for Colorization of the Original Photographs of Nikola Tesla.....	181
	V. Vučković, S. Spasić <i>University of Niš, Serbia</i>	
SP.7	The Effect of the Contrast Enhancement Processes on the Structural Entropy of Colonoscopic Images	185
	G. Csizmadia, S. Nagy <i>Szechenyi Istvan University, Hungary</i>	

WIRELESS COMMUNICATIONS

WC.1	Receiver Induced Intermodulation Interference in GSM-900	191
	P. Petkov, K. Angelov, I. Iliev, B. Bonev, V. Poulkov <i>Technical University of Sofia, Bulgaria</i>	
WC.2	Parametrical Analysis of DVB-T channels	195
	L. Jordanova, G. Karpov, D. Dobrev <i>Technical University of Sofia, Bulgaria</i>	
WC.3	Algorithms for APSK Constellation Optimization	199
	L. Jordanova, L. Laskov, D. Dobrev <i>Technical University of Sofia, Bulgaria</i>	
WC.4	Outage Performance of Dual-Hop AF Relaying System in Weibull-gamma Fading Environment.....	203
	J. Anastasov, A. Cvetković, D. Milović, D. Milić <i>University of Niš, Serbia</i>	
WC.5	Dynamic Characteristics of Selection Combining Receiver with Different Decision Algorithms	207
	D. Drača, A. Panajotović, N. Sekulović* <i>University of Niš, Serbia</i> <i>*College of Applied Technical Sciences, Serbia</i>	
WC.6	Comparative Performance Studies of Laboratory WEP IEEE 802.11g PTP Links	211
	J. Carvalho, C. Pacheco, H. Veiga, A. Reis <i>University of Beira Interior, Portugal</i>	
WC.7	Analysis of the SC Macrodiversity Reception in the Presence of Gamma Shadowed Nakagami-m Fading	215
	N. Simić, M. Milovanović, D. Milović <i>University of Niš, Serbia</i>	

ELECTRONIC COMPONENTS, SYSTEMS AND TECHNOLOGIES

EL.1	Start-Stop Ring Oscillators for GALS Designs	221
	G. Jovanović, M. Stojčev <i>University of Niš, Serbia</i>	
EL.2	FPGA Implementation of Digital PLL-based Frequency Synthesizer with Programmable Frequency Dividers	225
	M. Kovacheva, E. Stoumenov, I. Pandiev <i>Technical University of Sofia, Bulgaria</i>	
EL.3	Design and Realization of a Flexible Mains Switching Power Supply	229
	Z. Živanović, V. Smiljaković <i>IMTEL Komunikacije AD, Serbia</i>	
EL.4	Design and Realization of a Low Noise Power Converter	233
	Z. Živanović, V. Smiljaković <i>IMTEL Komunikacije AD, Serbia</i>	
EL.5	Verilog - A Noise Macromodel of Current Feedback Operational Amplifier with Improved Speed and Accuracy	237
	G. Valkov <i>Technical University of Sofia, Bulgaria</i>	
EL.6	Subtraction Procedure for ECG Drift Removing: High Level Synthesis with Compaan	241
	T. Shoshkov <i>Technical University of Sofia, Bulgaria</i>	

VOLUME 2

POSTER SESSIONS

COMPUTER SCIENCE AND INTERNET

CSI.1	Using IT Management Processes for Achieving Better Efficiency in the IT Service	247
	Y. Mitev, L. Kirilov <i>Institute of Information and Communication Technologies, Bulgaria</i>	
CSI.2	Technology Transfer Office “ICT for Energy Efficiency”: A Factor for Open Innovations	251
	R. Andreev, J. Doshev, I. Stoyanov <i>Institute of Information and Communication Technologies, Bulgaria</i>	
CSI.3	Usability Model for Evaluating the usability of Web-based GIS Applications	255
	N. Đorđević, D. Rančić, R. Simić, <i>University of Niš, Serbia</i>	
CSI.4	Development of Software Program for Direct Insertion into MySQL Database from Communication Interface	259
	G. Goranov, R. Hristova* <i>Technical University of Gabrovo, Bulgaria</i> <i>University of Sofia “St. Kliment Ohridski”, Bulgaria</i>	
CSI.5	Telemetry System for WRC Sport Cars. Mobile Part.	263
	H. Nenov, G. Hristova, P. Georgiev <i>Technical University of Varna, Bulgaria</i>	

CONTROL SYSTEMS

CS.1	Comparison Analysis of the Heading Accuracy of GPS, e-Compass and Gyroscope	267
	R. Miletiev, R. Kenov, I. Simeonov, E. Iontchev*	
	<i>Technical University of Sofia, Bulgaria</i>	
	<i>*Higher School of Transport "T. Kableshkov", Bulgaria</i>	
CS.2	Dynamic Compensation of the Gyro bias by e-Compass	271
	R. Miletiev, R. Kenov, I. Simeonov, E. Iontchev*	
	<i>Technical University of Sofia, Bulgaria</i>	
	<i>*Higher School of Transport "T. Kableshkov", Bulgaria</i>	
CS.3	Study on Control System of Permanent Magnet Linear Synchronous Motor	274
	B. Markov, V. Panov*	
	<i>University of Food Technologies, Bulgaria</i>	
	<i>Technical University of Sofia, Bulgaria</i>	
CS.4	Modular Development of Linear Induction Motor Control in Simulink Enviroment	278
	B. Markov	
	<i>University of Food Technologies, Bulgaria</i>	
CS.5	Evaluation of the Influence of the Human Factor on the Reliability of the Information and Control Systems in the Electric Power Industry	282
	Z. Hubenova, V. Gergov*	
	<i>Space Research and Technology Instit., Bulgaria</i>	
	<i>*Univ. of Transport "Todor Kableshkov", Bulgaria</i>	
CS.6	Generalized Forces of the Robotic System with Fractional Order Thermoviscoelastic Element	286
	M. Cajčić, M. Lazarević*	
	<i>Mathematical Institute of the Serbian Academy of Sciences and Arts, Serbia</i>	
	<i>*University of Belgrade, Serbia</i>	
CS.7	Models of Objects of Control in the System for Monitoring and Dispatching on Metropolitan-Sofia	288
	E. Dimitrova	
	<i>Univ. of Transport "Todor Kableshkov", Bulgaria</i>	
CS.8	Design a Simple Hardware in the Loop Test-bed Platform for Educational Purposes	292
	M. Petkovski, A. Jurukovski*	
	<i>Faculty of Technical Sciences Bitola, Macedonia</i>	
	<i>*Mining and Energy Combine, Macedonia</i>	

ENGINEERING EDUCATION

EE.1	A Case Study Approach in Microcontroller Education	299
	V. Rankovska	
	<i>Technical University of Gabrovo, Bulgaria</i>	
EE.2	E-learning Module for Computer-aided Design in Moodle Platform	303
	G. Marinova, N. Stoyanov	
	<i>Technical University of Sofia, Bulgaria</i>	
EE.3	Various Approaches to Teach and Learn the Computer Architecture and Organization Cours	307
	G. Armenski, S. Ristov, M. Gusev, M. Kostoska	
	<i>University "Ss. Cyril and Methodius", Macedonia</i>	
EE.4	A Simple Hydraulic System as a Laboratory Equipment for Demonstrating On-Off Control	311
	M. Ristović, S. Labura, M. Naumović*	
	<i>University of East Sarajevo, Bosnia and Herzegovina</i>	
	<i>*University of Niš, Serbia</i>	

EE.5	Laboratory Equipment for Hydrogen Energy Education 315
	S. Letskovska, K. Seymenliyski, P. Rahnev*
	<i>Burgas free University, Bulgaria</i>
	<i>*As. Zlatarov University, Bulgaria</i>

RADIO COMMUNICATIONS, TELECOMMUNICATIONS TECHNOLOGY AND ELECTROMAGNETICS

RTE.1	Complexity of the McEliece Cryptosystem based on GDBF Decoder for QC-LDPC Codes 321
	O. Al Rasheed, D. Drajić, P. Ivaniš, G. Đorđević*
	<i>College of Applied Technical Sciences, Serbia</i>
	<i>*University of Niš, Serbia</i>
RTE.2	Probability of Collision in a Cooperative Relay Diversity Scheme in Nakagami Fading Channel 325
	N. Milošević, B. Dimitrijević, Z. Nikolić
	<i>University of Niš, Serbia</i>
RTE.3	Level Crossing Rate of Nakagami-m Signal Envelope Subjected to Gamma Shadowing 329
	D. Đošić, Č. Stefanović, D. Milić, D. Radenković, P. Spalević
	<i>University of Niš, Serbia</i>
RTE.4	Performance Analysis of MAMD Algorithms with QoS Parameters in Heterogeneous Network 333
	R. Dobrev
	<i>Technical University of Sofia, Bulgaria</i>
RTE.5	Simulation Estimation of Network and Quality Characteristics in Video Transmission over LTE Network 337
	G. Mihaylov, T. Iliev
	<i>University of Ruse "Angel Kanchev", Bulgaria</i>
RTE.6	Indoor Propagation Path Loss Modeling for Wireless Sensor Networks 341
	S. Savov, Z. Ganev
	<i>Technical University of Varna, Bulgaria</i>
RTE.7	ANN Model for DOA Estimation of Correlated Signals using Circular Antenna Array 343
	M. Stoilković, Z. Stanković*, B. Milovanović*, N. Dončov*
	<i>Innovation Centre of Advanced Technology, Serbia</i>
	<i>*University of Niš, Serbia</i>
RTE.8	Localization of Mobile Users Stochastic Radiation Nature by using Neural Networks 347
	Z. Stanković, N. Dončov, I. Milovanović*, J. Russer**, B. Milovanović, M. Stoilković***
	<i>University of Niš, Serbia</i>
	<i>*Singidunum University, Serbia</i>
	<i>**Technical University of München, Germany</i>
	<i>***Innovation Centre of Advanced Technology, Serbia</i>
RTE.9	Design of a Printed Antenna Array in Rectangular Corner Reflector with Cosecant Square-Shaped Beam Pattern 351
	M. Milijić, A. Nešić*, B. Milovanović
	<i>University of Niš, Serbia</i>
	<i>*IMTEL Komunikacije AD, Serbia</i>
RTE.10	Electromagnetic Modeling in Combination with Wave Digital Approach for Efficient Analysis of Microstrip Bandpass Filters with a Dual-Passband Response 355
	B. Stošić, N. Dončov
	<i>University of Niš, Serbia</i>
RTE.11	Three-Wire Star-Shaped Grounding Electrode in the Vicinity of the Semi-Cylindrically Shaped Ground Inhomogeneity 360
	N. Cvetković, D. Vučković, M. Stojanović, A. Ristić
	<i>University of Niš, Serbia</i>

DIGITAL SIGNAL PROCESSING

DSP.1	Research and Analysis of Methods for Localization of Audio Sources	367
	V. Hristov, S. Pleshkova-Bekjarska <i>Technical University of Sofia, Bulgaria</i>	
DSP.2	MIPFD Algorithm for Image Fire Detection	373
	B. Prlinčević, Z. Milivojević*, D. Brodić** <i>Polytechnic School for Vocational Studies, Serbia</i> <i>*College of Applied Technical Sciences, Serbia</i> <i>**University of Belgrade, Serbia</i>	
DSP.3	Image Edge Detection as Part of the Feature Extraction for Neural Network Realized with LabVIEW Application	377
	L. Docheva <i>Technical University of Sofia, Bulgaria</i>	
DSP.4	Digital Image Filtering with LabVIEW	381
	L. Docheva <i>Technical University of Sofia, Bulgaria</i>	
DSP.5	Robustness of SVD Watermarks in Video Sequences Encoded with H.264/AVC	385
	Z. Milivojević, Z. Veličković <i>College of Applied Technical Sciences, Serbia</i>	

ENERGY SYSTEMS AND EFFICIENCY

ESE.1	The Influence of the Power Systems from the Neighboring Countries, on the Fault Currents in the Macedonian Power System	391
	Lj. Trpezanovski, M. Atanasovski, M. Milosevski <i>Faculty of Technical Sciences Bitola, Macedonia</i>	
ESE.2	Station for Emulation of Load and Electrical Motors Testing	395
	M. Rosić, M. Božić, M. Bjekić <i>University of Kragujevac, Serbia</i>	
ESE.3	Modelling Self-excitation Overvoltage in an Induction Motor With Individual Compensation of Reactive Power	399
	M. Radić, Z. Stajić <i>University of Niš, Serbia</i>	
ESE.4	Multicriteria Analysis of the Smart Grid Project Efficiency	403
	A. Janjić, L. Velimirović*, S. Savić, M. Stanković <i>University of Niš, Serbia</i> <i>*Mathematical Institute of the Serbian Academy of Sciences and Arts, Serbia</i>	

MEASUREMENT SCIENCE AND TECHNOLOGY

MST.1	Acquisition System for Generation of the Test Signals with Standard Harmonic Disturbances	409
	M. Simić, D. Živanović, D. Denić, G. Miljković <i>University of Niš, Serbia</i>	
MST.2	Using Multifunction DAQ and LabVIEW for the Development of a Single-Channel EEG for Multiple Sclerosis Detection	413
	V. Mihaylov, K. Dimitrov, Y. Velchev, T. Mitsev <i>Technical University of Sofia, Bulgaria</i>	
MST.3	Model Development for Digital Stochastic Measurement of Noised EOG Signals	417
	J. Đorđević-Kozarov, P. Sovilj*, D. Mitić, V. Vujičić*, D. Radenković <i>University of Niš, Serbia</i> <i>*University of Novi Sad, Serbia</i>	

MST.4	Based on CPLD Programable Counter for Experimental Digital Electrical Energy Meter Part 2	421
	N. Draganov, T. Angelova <i>Technical University of Gabrovo, Bulgaria</i>	
MST.5	Artificial Neural Network-based Classification of Volatile Organic Compounds for Indoor Air Quality Control	425
	G. Georgiev, Z. Nenova, S. Ivanov <i>Technical University of Gabrovo, Bulgaria</i>	
MST.6	Experimental Digital Three-Phase Check Electrical Energy Meter Part 1	429
	N. Draganov <i>Technical University of Gabrovo, Bulgaria</i>	
MST.7	Research of Transmission Loss Properties of Thin Layered Sound Reduction Systems for Building Partition Elements	433
	T. Nedkov, S. Pleshkova-Bekjarska <i>Technical University of Sofia, Bulgaria</i>	
MST.8	The Acoustic Analysis of a Single Room	437
	V. Stojanović, Z. Milivojević, S. Dimitrijević <i>College of Applied Technical Sciences, Serbia</i>	

ELECTRONIC MATERIALS, COMPONENTS, SYSTEMS AND TECHNOLOGIES

ELT.1	Synthesis of Zeolite NaA with Facets by the Sol-gel Technology	443
	D. Georgiev, I. Petrov, T. Michalev, I. Pejchev <i>As. Zlatarov University, Bulgaria</i>	
ELT.2	The Removal of Cu(II) Ions from Aqueous Solutions on Synthetis Zeolite NaA	446
	T. Michalev, I. Petrov, I. Pejchev <i>As. Zlatarov University, Bulgaria</i>	
ELT.3	Electrical Properties of Piezo Polymer Nanocomposites and its Application	450
	L. Borisova, D. Kiryakova, A. Atanassov <i>As. Zlatarov University, Bulgaria</i>	
ELT.4	Impact of the Isolation Gap Position on the Voltage Gain Characteristics of Disc-Shaped Piezoelectric Transformers	454
	N. Nedev, Z. Nenova, T. Nenov <i>Technical University of Gabrovo, Bulgaria</i>	
ELT.5	High Frequency Inductive Power Transfer Device for Ultrasonic Applications	458
	N. Madzharov <i>Technical University of Gabrovo, Bulgaria</i>	
ELT.6	Efficiency Investigations of DC-DC Converter Supplying Power Amplifiers	463
	T. Brusev, B. Nikolova, G. Kunov, S. Vuchev <i>Technical University of Sofia, Bulgaria</i>	
ELT.7	Two-parametrical Control of Series Resonant DC-DC Converters that Operate with Common Load	467
	A. Vuchev, N. Bankov <i>University of Food Technologies, Bulgaria</i>	
ELT.8	Control Characteristics of High-Voltage Resonant DC/DC Converter	471
	N. Bankov, Y. Madankov, A. Vuchev <i>University of Food Technologies, Bulgaria</i>	
ELT.9	Three-Phase Soft-Switched Quasi Resonant DC Link Inverter for Motor Drive Application	475
	D. Spirov, N. Komitov <i>University of Food Technologies, Bulgaria</i>	

ELT.10	Matlab-Simulink Model of Three Phase BUCK Rectifier with Sinusoidal PWM	479
	G. Kunov, S. Vuchev <i>Technical University of Sofia, Bulgaria</i>	
ELT.11	Microprocessor-based Apparatus for Electrical Stimulation of Ruminant Meat	483
	I. Maslinkov, K. Kolev <i>University of Food Technologies, Bulgaria</i>	
ELT.12	A Microprocessor System for Food Quality Evaluation by Hyperspectral Images Processing	487
	K. Kolev <i>University of Food Technologies, Bulgaria</i>	
ELT.13	Preparation of Germanium Photo Detectors and Photovoltaic	491
	S. Letskovska, K. Seymenliyski <i>Burgas free University, Bulgaria</i>	

Efficiency Investigations of DC-DC Converter Supplying Power Amplifiers

Tihomir Brusev¹, Boyanka Nikolova², Georgi Kunov³ and Stoyan Vuchev⁴

Abstract – In the modern battery powered mobile communication devices output transmitted power is changed in wide range. Most of the energy in such electronic systems is consumed from power amplifier (PA). By increasing of power amplifier's efficiency significantly could be increased the overall efficiency of those portable devices. The widespread used method is modulation of collector voltage (V_{cc}) of PA. Using switching-mode dc-dc converter the operated voltage of power amplifier could be dynamically changed. In this paper are presented investigation results of dc-dc converter, which can be used for dynamically regulation of collector voltage of PA.

Keywords – dc-dc converter, efficiency, Cadence, CMOS technology.

I. INTRODUCTION

The modern mobile communication electronic devices transfer data in the wide frequency range. One of the most critical parameter is their efficiency because of the limited battery resources [1]. Therefore power consumption of the system's building blocks has to be minimized. Most of the energy is consumed from power amplifier. Improving of transmitted power efficiency of this single component can help to increase the battery run time.

Power amplifiers (PAs) used in the portable communication devices have to be linear because the distortions have to be minimized. In order to fulfill this requirement class-A PAs are usually used. They are linear, but the maximum possible theoretical efficiency of those circuits is only 50 %. Their best efficiency can be achieved when the output signal of power amplifier swings from rail to rail [2]. Therefore results closed to 50 % could be reached if collector voltage (V_{cc}) is changed dynamically as a function of output signal's amplitude.

The regulations of power amplifier's collector voltage V_{cc} can be performed by high frequency voltage regulators. The optimal choice is switching-mode dc-dc converters because

¹Tihomir Brusev is with the Faculty of Telecommunications, Technical University of Sofia, Kl. Ohridski 8, 1797 Sofia, Bulgaria, E-mail: brusev@ecad.tu-sofia.bg.

²Boyanka Nikolova is with the Faculty of Telecommunications, Technical University of Sofia, Kl. Ohridski 8, 1797 Sofia, Bulgaria, E-mail: bnikol@tu-sofia.bg.

³Georgi Kunov is with the Faculty of Electronic Engineering and Technologies, Technical University of Sofia, Kl. Ohridski 8, 1797 Sofia, Bulgaria, E-mail: gkunov@tu-sofia.bg.

⁴Stoyan Vuchev is with the Faculty of Electronic Engineering and Technologies, Technical University of Sofia, Kl. Ohridski 8, 1797 Sofia, Bulgaria, E-mail: vu4ev_100yan@abv.bg.

they are high efficient circuits. Collector voltage (V_{cc}) of power amplifier is smaller than battery voltage during most of the operation time of portable electronic devices. The focus of that paper is switching-mode buck dc-dc converter, suitable for dynamic output voltage regulation.

In Section II are presented the challenges and problems connected with efficiency improvement of power amplifiers used in the new mobile communication devices. Theory information about dc-dc converters is given also in the same section. Received investigation results of buck dc-dc converter, which can dynamically adjust V_{cc} voltage of PA, are presented in Section III. The whole switching-mode regulator system is designed for integrated circuits (IC) applications in CMOS technology.

II. POWER AMPLIFIER AND DC-DC CONVERTER IN MOBILE ELECTRONIC DEVICES

The new cellular technology is 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE). High data rate and high quality is ensured for mobile communications devices [3]. Therefore the increased customer requirements for more function of the portable electronic devices at low cost can be satisfied. For example nowadays online gaming, mobile television, multimedia streaming is available in the cellular phones.

LTE supports several channel bandwidths, which are: 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, and 20MHz. Long Term Evolution maintain earlier 3GPP technology such as code division multiple access CDMA, wide-band code division multiple access/high-speed packet access WCDMA/HSPA, time division synchronous code division multiple access TD-SCDMA.

The most important parameters for modern generation mobile electronic devices are liner output power and high efficiency. Low energy consuming building blocks is challenge to the overall system design in order to be achieved longer battery run time [4].

A. Power Amplifier

Power amplifiers can work as a linear circuit with poor efficiency or as a circuit with better efficiency, but with distortion. Obviously trade-off between linearity and efficiency is needed when appropriate class of PA is selected from the designers [5]. Usually for RF power amplifiers in the new generation portable electronic devices is used class-A PA.

The easiest way is PA to be powered directly from battery. This is not efficient method because the mobile electronic devices work at different output powers level. The voltage

regulators, which change their outputs according to the required signal being transmitted, are used. The efficiency of power amplifier is increased if collector voltage is adjusted.

The power added efficiency (PAE) is a parameter which describes the RF power amplifier efficiency:

$$PAE = \frac{P_{out} - P_{in}}{P_{DC}}, \quad (1)$$

where P_{out} is a output power of PA, P_{in} is a input power of PA and P_{DC} is a dc power which is delivered to PA. These parameters express how dc power is transformed to the RF power.

Different techniques are used for improving the efficiency and linearity of power amplifier [2]. The average power tracking and envelope tracking are different method used to adjust collector voltage V_{cc} as function of the transmitted output power. In the Fig. 1 are shown the principle of operation of those two techniques.

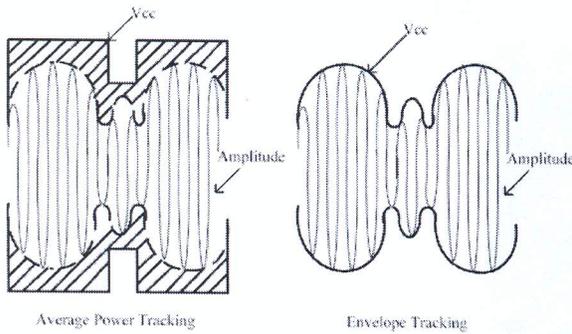


Fig. 1. Average power tracking and envelope tracking techniques.

Envelope tracking method is faster than average power tracking. The shaded area in average power tracking techniques is proportional to the power dissipation. As can be seen from the picture in Fig. 1 consumed energy in average power tracking is bigger compare to envelope tracking. Dissipated power is smaller if V_{cc} is closed to the output voltage amplitude. Envelope tracking mechanism is more efficient than average power tracking.

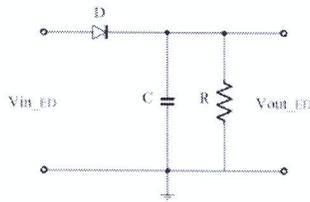


Fig. 2. Envelope detector.

For amplitude detection of the transmitted signal are used envelope detectors. The control system of dc-dc converter receives information from those circuit's blocks and adjust the output voltage of the regulator to the desired level [6]. One of

the circuits, which can be used for the envelop detectors (ED), is shown in Fig. 2.

The circuit is simple and includes a diode and a RC (resistor-capacitor) filter. The designers have to choose values of R and C to satisfy the condition:

$$f_{signal} < \frac{1}{2\pi RC} \ll f_{carrier}, \quad (2)$$

where $f_{carrier}$ is a carrier frequency and f_{signal} is a base band signal frequency.

Linear voltage regulators have low efficiency when output voltage is not close to the input voltage. Because of the different powers of the transmitted signal, collector voltage V_{cc} of PA has to vary in order to be increase the efficiency. Therefore switching-mode dc-dc converter is better choice for voltage regulator's circuit.

B. DC-DC Converter

The efficiency of PA, which is the most energy consumed circuits in the modern portable electronic devices, can be increased by decreasing of power dissipation. Voltage regulator, which can control V_{cc} , is used.

High efficient voltage regulator is needed to improve the overall efficiency of the mobile devices. Linear regulators have simple structure and occupied small silicon area, but they have great energy dissipation, which is transformed in heat.

During most of the time collector voltage of power amplifier is less than battery voltage. Therefore switching-mode buck dc-dc converter is considered as a circuit, which can ensure dynamic regulation of collector voltage of power amplifier. Theoretically they have very high efficiency. The switching frequency f_s of the dc-dc converter should be much higher than base band signal frequency. In Fig. 3 is shown schematic of synchronous buck dc-dc converter.

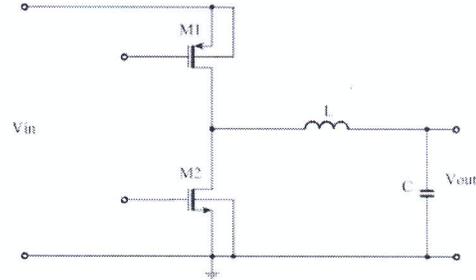


Fig. 3. Synchronous buck dc-dc converter.

Higher switching frequency f_s leads to increasing of switching power losses and decreasing of efficiency of the buck converter. The dc-dc converter efficiency is equal to:

$$\eta = \frac{P_{out}}{P_{in}}, \quad (3)$$

where P_{out} is a average output power of the regulator (output voltage of synchronous buck dc-dc converter in Fig. 3 is applied to collector of PA); P_{in} is a average input power of the regulator (input voltage of synchronous buck dc-dc converter in Fig. 3 is battery voltage of the mobile electronic devices).

The conducting losses in the MOS transistors are proportional to the switching frequency f_s and the rms-value of the current flowing through the device [7]. This relationship is given below:

$$P_{MOS} = k_1 I_{rms}^2 + k_2 f_s, \quad (4)$$

where k_1 and k_2 is are technology dependent coefficient, which are taking into account the size of the power MOS transistors, as well as the resistive and the capacitive losses associated with the MOS structure. Small inductor ripple current will result in smaller rms-value of the current through the MOS structure, and it will respectively lead to better efficiency.

III. INVESTIGATIONS RESULTS OF DESIGNED BUCK DC-DC CONVERTER

Buck dc-dc converter is designed with Cadence on CMOS process for low voltage integrated circuits applications. The switching frequency f_s of the circuit should be much higher than 20 MHz, which is larger base band supported from LTE. A Pulse-Width Modulation (PWM) control technique is used to regulate the two transistors in power stage of synchronous buck dc-dc converter. The schematic of designed switching-mode regulator is shown in Fig.4.

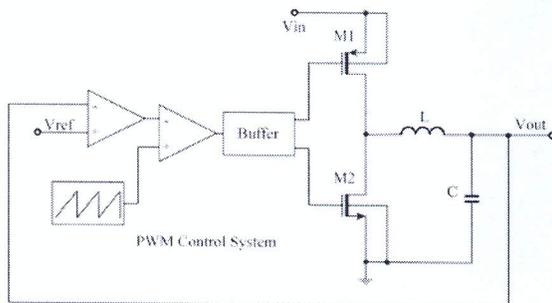


Fig. 4. Schematic of buck converter system designed on CMOS process.

The switching frequency f_s determined from ramp generator is equal to 76.2 MHz. Output voltage of the regulator has to be dynamically adjusted as function of transmitted signal from power amplifier.

The ability of designed buck converter to react at fast changes of reference voltage V_{ref} is examined. In Fig. 5 are presented received simulations results when voltage reference jumps from 0.5 V to 1.3 V. As can be seen from the picture output voltage of the buck converter is stabilized at the new desire level for approximately 1.5 μ s.

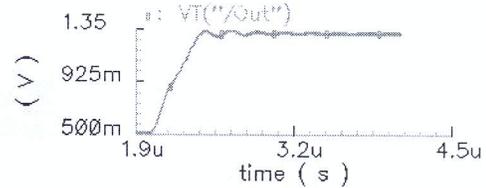
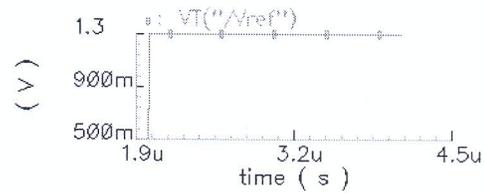


Fig. 5. Reaction of buck converter when voltage reference V_{ref} jumps from 0.5 V to 1.3 V.

In Fig. 6 are shown waveforms of ramp generator's signal and output voltage V_{out} of dc-dc converter, when V_{out} is stabilized. The reaction of the regulator when V_{ref} is changed from 1.3 V to 2.8 V is investigated. The received simulations results are presented in Fig. 7.

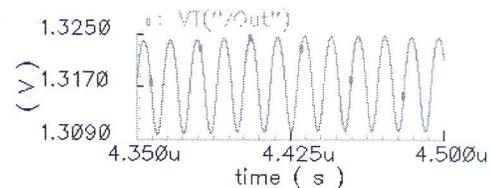
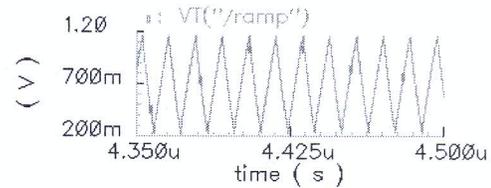


Fig. 6. Waveforms of V_{ramp} and V_{out} and when V_{ref} jumps from 0.5 V to 1.3 V.

As can be seen from the picture presented in Fig. 7 output voltage V_{out} is stabilized for approximately 1.5 μ s.

High switching frequency f_s is key parameter for dc-dc converters, which have to change dynamically their output voltages according to the transmitted power level of mobile devices. On the other hand switching power losses of the voltage regulators are proportional to f_s . High switching frequency of buck converter can helps also for fully integration of whole regulator system together with other circuit's block of the mobile electronic devices.

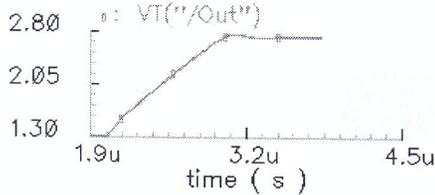
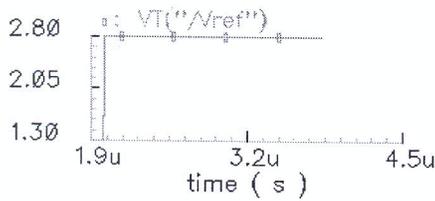


Fig. 7. Reaction of buck converter when voltage reference V_{ref} jumps from 1.3 V to 2.8 V.

The efficiency investigations of the designed buck converter system at different output voltages are performed. The received results are presented in Table 1.

TABLE I
EFFICIENCY RESULTS OF BUCK CONVERTER AT DIFFERENT OUTPUT VOLTAGES

Vout [V]	Efficiency [%]
0.5	52.4
1.3	77.2
2.8	85

As can be seen from the Table 1, the efficiency of the buck converter is equal to 77.2 %, when output voltage V_{out} is controlled to be 1.3 V. Decreasing of the transmitted power level, which required smaller collector voltage V_{cc} of PA, leads to decreasing of the overall efficiency of the dc-dc converter.

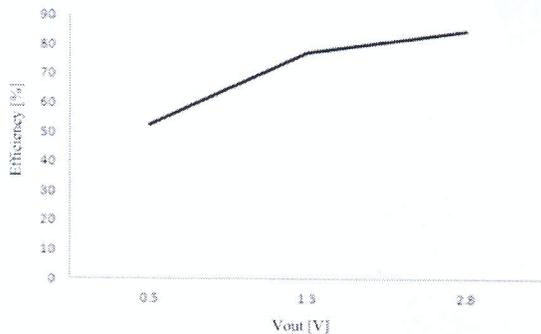


Fig. 8. Efficiency of buck converter as a function of output voltage V_{out} .

In Fig. 8 is presented graphically efficiency of the investigated circuit as a function of output voltage. When V_{out} of buck converter is controlled to be 0.5 V efficiency is 52.4 %, as well as for V_{out} equal to 2.8 V efficiency is equal to 85 %.

IV. CONCLUSION

In this paper are presented investigations results of buck dc-dc converter, which can be used for dynamic regulation of power amplifier's collector voltage in mobile portable electronic devices. The problems connected with efficiency improvement of power amplifier are discussed. The reaction of regulator's output voltage as function of reference voltage of PWM control system is examined. The switching frequency f_s of the buck converter designed with Cadence on CMOS technology is equal to 76.2 MHz. The output voltage V_{out} of investigated circuit is stabilized for approximately 1.5 μ s, when reference voltage jumps from 0.5 V to 1.3 V and from 1.3 V to 2.8 V. The efficiency of the buck converter varies from 52.4 % to 85 %, when V_{out} is respectively 0.5 V and 2.8 V.

ACKNOWLEDGEMENT

The research described in this paper was carried out within the framework of Project DUNK – 01/03 – 12.2009.

REFERENCES

- [1] T. Tuovila, T. Rahkonen, "Characterization of an envelope tracking system for mobile devices", University of Oulu, 2013.
- [2] B. Sahu and Rincón-Mora G. A., "System-Level Requirements of DC-DC Converters for Dynamic Power Supplies of Power Amplifiers", IEEE Asia-Pacific Conference on ASIC, 2002.
- [3] Y. Li, Zhu R., Prikhodko D. and Tkachenko Y., "LTE Power Amplifier Module Design: Challenges and Trends", Skyworks Solutions, Inc., 20 Sylvan Road, Woburn, MA 01801, USA.
- [4] R. Krysteva, I. Cholakova, G. Angelov, R. Rusev, T. Takov, "Simulation of a Radio-Frequency Single-Electron Transistor (RF-SET) in Cadence Spectre", Proc. of the 9th International Scientific Conference Advanced Materials and Operations 2009 (AMO '09), Vol. 2, pp. 385-388, Kranevo, Bulgaria, June 25-27, 2009.
- [5] Ó. Sverrisson, Moller P., Andersen M. and Thomsen O., *A DC-DC Converter for RF PA in WCDMA Mobile Phones*, Denmark, 2006.
- [6] F. H. Raab, B. E. Sigmon, R. G. Myers, and R. M. Jackson, "L-band transmitter using Kahn EER technique," IEEE Trans. on Microwave Theory and Techniques, Vol. 46, No.12, pp. 2220-2225, 1998.
- [7] V. Kursun, "Analysis of Buck Converter for On-Chip Integration With a Dual Supply Voltage Microprocessor", IEEE Trans. on VLSI Systems, Vol. 11, No.3, pp. 514-522, 2003.