2019 9th International Conference on Power and Energy Systems (ICPES 2019)

Conference Program

10 - 12 December 2019

Perth, Australia

Message from General Chair

Dear Delegates and Friends,

As the General Chair of the 9th International Conference on Power and Energy Systems (ICPES 2019), it gives me immense pleasure to welcome over 250 delegates and authors from Universities, Utilities, Industry, Government and NGOs from over 30 countries around the world to the Conference. Also, a very warm welcome to the beautiful and sunny Perth.

ICPES 2019 has been hosted by Murdoch University, IEEE Western Australian Section, and the Western Australian PES/PELS and IES Chapters. In addition, it is technically sponsored by 10 other Universities.

This year, ICPES 2019 received just below 300 paper submissions from 37 countries around the world from over 950 co-authors. Each paper was peer-reviewed by at least two to three experts in their respective fields and the acceptance decisions were based on at least two consistent recommendations, ensuring the quality and standard of the Conference. These papers are organized and will be presented in 19 oral sessions, 2 oral special sessions and 3 poster forums.

We are also privileged to have 8 distinguished keynote speakers, 3 industry forums, as well as 8 tutorial talks and 6 exhibition booths.

I would like to take this opportunity and thank all conference organizers and the financial sponsors of the conference; without their support, this conference could not have been successful.

I wish all of you a very pleasant and fruitful time at the Conference and a very enjoyable time in Perth.

Kind regards,

Farhad Shahnia

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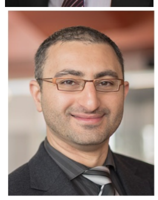

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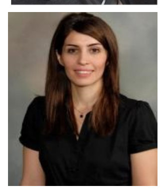

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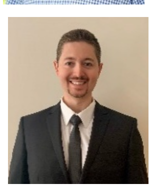

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Poster Presentations

15:00-16:00|TUESDAY, DEC 10

Poster Presentations 1		
Time: 15:00-16:00		
Board Number	**Paper ID**	**Title & Authors**
1	**1570550261**	Renewable Energy Installation: Challenges and Benefits in Oil/Gas Drilling Rigs *Abdul Siddique (Petroleum Institute, United Arab Emirates); Braham Barkat (Khalifa University, United Arab Emirates)*
2	**1570582943**	Analysis of Maximum Output of Offshore Wind Power in ZS Power Grid Considering Voltage Stability *Yikai Sun, Lijun Zhang and Bo Zhang (State Grid Zhejiang Economy Research Institute, China); Jing Zhang (State Grid Zhejiang Electric Power Co. Ltd, China); Xizhu Zhang (State Grid Zhejiang Economy Research Institute, China); Jiawei Wang, Xiaobo Liu and Ancheng Xue (North China Electric Power University, China)*
3	**1570559329**	Design and Analysis of EOT for Wireless Electricity Transmission *Hafiz Usman Tahseen and Yang Lixia (Jiangsu University, China); Madiha Farasat (University of Technology Sydney, Australia)*
4	**1570559748**	Energy Efficient C-Dump Converter with Simple Control Strategy for SRM Drive *Slamet Riyadi and Leonardus Heru Pratomo (Soegijapranata Catholic University, Indonesia)*
5	**1570564179**	An Energy Optimization and Control Strategy of Microgrids Considering the Hybrid Energy Storage System *Qianqian Che and Xingwu Yang (Shanghai University of Electric Power, China); Yu Zhang (Power Grid Planning Research Center of Guizhou Power Grid Co., Ltd., China); Qingsheng Li (State Grid Company, China); Qingming Zhao (Power Grid Planning Research Center of Guizhou Power Grid Co., Ltd., China)*
6	**1570562432**	Fault Location in Distribution Networks Using PMU Data and Interval Algorithm *Chen Fang (State Grid Shanghai Electric Power Research Institute, China); Zhixiong Shi (State Grid Shanghai Municipal Electric Power Company, China); Yang Peng, Zhi Wu and Wei Gu (Southeast University, China); Pengchen Nie (State Grid ShangHai Pudong Electric Power Supply Company, China)*
7	**1570563106**	Photovoltaic's Hotspot and Partial Shading Detection Algorithm Using Characteristic Curve's Analysis *Jirada Gosumbonggot and Goro Fujita (Shibaura Institute of Technology, Japan)*
8	**1570574481**	Modifying IEC 60909 Standard to Consider Fault Contribution from Renewable Energy Resources Utilizing Fully-Rated Converters *Rafat R Aljarrah (University of Manchester & Princess Symaya University, United Kingdom); Hesamoddin Marzooghi (University of Manchester, United Kingdom); Vladimir Terzija (Power Systems, United Kingdom); James Yu (Scottish Power Energy Networks, United Kingdom)*

Time: 15:00-16:00		
Board Number	**Paper ID**	**Title & Authors**
9	**1570563257**	Linguistic Hesitant Fuzzy Sets and Cloud Model Based Risk Assessment of Gaseous Hydrogen Storage in China *Liqi Yi and Tao Li (North China Electric Power University, China)*
10	**1570563329**	Grid Interconnection via Fractional Frequency Transmission System *Jing Li and Xiaofeng Zhang (State Grid Energy Research Institute, China); Zhi Wu and Suyang Zhou (Southeast University, China); Mengjiao Chen (North China Electric Power University, China)*
11	**1570563501**	Planning Method of Feeder Automation of Distribution Network in Mountain Area Considering Distributed Generation *Baoxuan Ye, Kangjian Wang, Zaitao Zheng, Shengda Yu and Li Zhang (Wenchang Power Supply Bureau of Hainan Power Grid Co., Ltd., China); Suchun Fan (South China University of Technology, China)*
12	**1570563534**	Research on Data Quality Evaluation Model for Wide-area Distributed Power Quality Monitoring System *Siyao Xu, Gang Zhou, Guanyuan Chen and Shanyi Xie (Guangdong Electric Power Science Academe, China); Xin Wang and Baoyi Cen (CET Electric Technology Inc., China)*
13	**1570581032**	More In-Depth Analytical Investigations of Two Effective Harmonics Filters for More Electric Marine Vessel Applications *Yacine Terriche, Muhammad Umair Mutarraf and Mojtaba Mehrzadi (Aalborg University, Denmark); Chun-Lien Su (National Kaohsiung University of Science and Technology, Taiwan); Josep M. Guerrero and Juan Vasquez (Aalborg University, Denmark)*
14	**1570563593**	CANOpen Communication of a 16.4kWh Li-ion Battery Energy Storage System for Nanogrids in Energy Community Framework *Alessandro Burgio (Independent Consultant, Italy); Daniele Menniti (University of Calabria & CEO Creta Energie Speciali SrL, Italy); Nicola Sorrentino, Anna Pinnarelli, Gaetano Polizzi, Giuseppe Barone, Pasquale Vizza and Giovanni Brusco (University of Calabria, Italy)*
15	**1570563700**	Optimal Bidding Model for an Electric Vehicle Aggregator *Xin Gong (Beijing Institute of Technology, Zhuhai, China); Kai-Hung Lu (Minnan University of Science and Technology, China); Qiangqiang Xu (Beijing Institute of Technology, Zhuhai, China)*
16	**1570574661**	Differential Fault Detection Scheme for Islanded AC Microgrids Using Digital Signal Processing and Machine Learning Techniques *Anusuya Arunan (University of New South Wales, Australia)*

Time: 15:00-16:00		
Board Number	**Paper ID**	**Title & Authors**
17	**1570563916**	A Strategy for Utilization of Reactive Power Capability of PV Inverters *Khalid Abdullah Khan and Muhammad Khalid (King Fahd University of Petroleum and Minerals, Saudi Arabia); Saifullah Shafiq (Prince Mohammad Bin Fahd University, Saudi Arabia)*
18	**1570563924**	Unbalance Loads Compensation Based on STATCOM in Microgrids *Zhihao Zhang (Technology and Engineering Center for Space Utilization, Chinese Academy of Sciences, China)*
19	**1570563937**	Effect of the Thickness of the Solid Insulators on the Creeping Discharge Propagation Under AC Voltages *W. E. P. Sampath Ediriweera, K. L. I. M. Pramod B Jayarathna and Rasara Samarasinghe (University of Moratuwa, Sri Lanka); Joseph Rohan Lucas (University of Moratuwa & General Sir John Kothalawela Defence University, Sri Lanka)*
20	**1570564032**	Two-Layer Energy Sharing Strategy in Distributed Network with Hybrid Energy Storage System *Xiao Han (University of Sydney, Australia); Lingling Sun (University of New South Wales, Australia); Guozhong Liu (Dongguan University of Technology, China); Kang Li and Zheng Fenglei (Dongguan Power Supply Bureau, China); Jing Qiu (University of Sydney, Australia)*
21	**1570564062**	A Testbed for Energy Pilferage Simulation for Medium- And Low-Voltage Electricity Distribution Networks *Leah Christina B. Alfonso, Michelle U Batad and Michael Angelo Pedrasa (University of the Philippines, Diliman, Philippines)*
22	**1570564316**	The Application of Improved Independent Component Analysis in Identification of Harmonic Sources *Feng Jin, Kang Li and Guozhong Liu (Dongguan University of Technology, China); Tao Cheng (Dongguan Power Supply Bureau, China); ZiSen Xie (Dongguan University of Technology, China)*
23	**1570574439**	Abnormal Wind Power Data Identification Based on the Improved FCM Algorithm and Considering the Influence of Wind Speed *Chen Fang (State Grid Shanghai Electric Power Research Institute, China); Zhiyu Zhang and Xiangjing Su (Shanghai University of Electric Power, China); Ping Zeng (State Grid Shanghai Electric Power Research Institute, China); Shuxin Tian (Shanghai University of Electric Power, China)*
24	**1570574775**	Recent Developments, Challenges, and Possible Action Plan for Electric Vehicle Charging Infrastructure in India *Bhushan Sharad Save (Institute of Chemical Technology, India); Mohd Adil Sheikh (Veermata Jijabai Technological Institute, India); Prerna Goswami (Institute of Chemical Technology, India)*

Time: 15:00-16:00		
Board Number	**Paper ID**	**Title & Authors**
25	**1570570910**	A System Protection Perspective for Connected Generation *Thomas E Baker (Sumatron, Inc., USA)*
26	**1570572017**	Economic and Feasibility Analysis of Planning a Community-connected Micro-grid *Yi Yang, Chenxi Zhang and Xingzhou Zhu (University of Sydney, Australia)*
27	**1570572973**	Demand-Side Management with Local Energy Sharing Model for Prosumer Communities *Prasertsak Charoen, Saher Javaid, Marios Sioutis and Yuto Lim (Japan Advanced Institute of Science and Technology, Japan); Yasuo Tan (Japan Advanced Institute of Science and Technology & National Institute of Information and Communications Technology, Japan)*
28	**1570582976**	Predictive Load Voltage Control for Four-leg Inverter with Fixed Switching Frequency *Kazi Saiful Alam, Dan Xiao, Md Parvez Akter, S M Showybul Islam Shakib and M. Fazlur Rahman (University of New South Wales, Australia)*
29	**1570573634**	Tertiary Control of Islanded Microgrids Based on a Linearized ACOPF with Losses Compensation *Long Jun, Gong Cheng and Lu Yidan (GuangXi University, China)*
30	**1570574243**	Influence of MMF Harmonics on the Iron Losses of Permanent Magnet Synchronous Machines *Andreas Echle, Urs Pecha, Gerold Schmidt and Nejila Parspour (University of Stuttgart, Germany)*
31	**1570579755**	Detection of Incipient Faults in Distribution Cables Based on Mathematical Morphology *Mingchang Huang, Chun Mo and Luliang Zhang (South China University of Technology, China)*
32	**1570585596**	Techno-economic Effects of Renewable Energy Technologies on a Microgrid System for Residential Buildings *Temitope Adefarati (University of Pretoria, South Africa); Ramesh Bansal (University of Sharjah, United Arab Emirates); Md Asaduzzaman Shoeb and Farhad Shahnia (Murdoch University, Australia)*
33	**1570559712**	Optimal Energy Scheduling of Residential Building with Battery Cost *Md Alamgir Hossain (University of New South Wales & The Dhaka University of Engineering and Technology, Australia); Hemanshu Pota (UNSW@adfa, Australia); Md Rasel Mahmud (The University of New South Wales, Australia)*
34	**1570573421**	Effects of PV Modules Temperature Variations on the Characteristic of PV Array *Gholamreza Farahani (Iranian Research Organization for Science and Technology, Iran)*

Energy Efficient C-Dump Converter with Simple Control Strategy for SRM Drive

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***Abstract*—A switched reluctance motor (SRM) has good prospects in electric drive for its beneficial features. To develop torque in SRM, its stator winding must be excited during positive slope of the stator inductance and then turned it off as soon as possible using negative voltage when the aligned position between the rotor and stator is passed. An asymmetric converter is able to achieve such processes through two switches connected to the phase winding although it results in greater voltage drop. To reduce the number of switches, a capacitor is used in C-dump converters to provide negative voltage to degrade the phase current faster during commutation. In this paper, an energy efficient C-dump converter without inductor is designed with simple control strategy. The voltage on the capacitor is used to commutate and to turn on the phase current in the beginning of the excitation for better efficiency. To verify the analysis, simulation and experimental works were done. They show the proposed control strategy is capable to control the capacitor voltage that finally affects the motor speed.**

Keywords*—*C-dump converter, switched reluctance motor, torque, electric drive, excitation

I. INTRODUCTION

Application of switched reluctance motor (SRM) in electric drive offers some advantages include its simple construction, robustness and low cost although complexity in control strategy will appear. One important requirement to apply such electric drive in electric vehicles is high torque [1],[2]. An SRM has salient rotor with no permanent magnets and stator winding whose inductance is influenced by the rotor position. By applying excitation to the phase winding during positive slope of the phase inductance, positive torque will be developed, meanwhile negative torque is generated if the phase winding excitation is given during negative slope of the phase inductance. The nature of the inductive circuit of the stator winding results in difficulties in making the high slope of the phase current. The use of an asymmetric converter topology to achieve such goal is often implemented although greater voltage drop is produced [3]-[5]. This is commonly avoided especially in low voltage converters. Alternative solutions can be applied by using C-dump converter topologies. Such converters use a capacitor voltage instead of the negative voltage to turn off the active phase winding in commutation [6]. In standard C-dump converter topology, an inductor is required to form buck chopper with the capacitor voltage which acts as the input voltage of the chopper [7], [8]. Additional losses will appear due to the inductor used in the standard C-dump converter. To overcome such a problem, C-dump converters without inductor are applied, the use freewheeling path through a switch and a diode in series connection is implemented [9]. Other modified C-dump converters were also developed. By adding a transistor into a standard C-dump converter for two phase SRM, different modes of operation can be inserted to obtain higher maximum power than the standard C-dump converter [10]. Higher voltage for stator excitation in magnetizing mode can also be achieved by connecting the DC source and dumping capacitor in series [11].

In this paper, a design of energy efficient C-dump converter without inductor using simple control strategy is proposed. Voltage on the capacitor is made greater than the DC link voltage to give higher voltage in the beginning of the excitation process and to degrade the phase current faster in the commutation. Such a strategy is able to give better efficiency. The core of the control implements digital signal controller with the phase currents and rotor position information as the input signals.

II. SWITCHED RELUCTANCE MOTOR

A switched reluctance motor consists of a salient pole rotor with no permanent magnets and windings on its stator. It works based on reluctance phenomenon. The equivalent circuit of a such motor for one phase can be represented by a stator resistance (R), an inductor (L) and back EMF (e) as depicted in Fig.1.

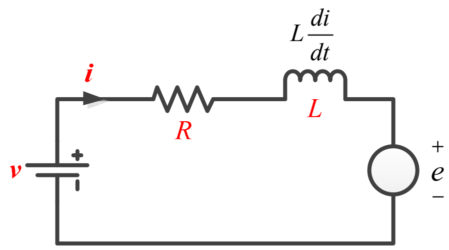

Fig. 1. Equivalent circuit of switched reluctance motor

Based on the above circuit, relationship between some parameters can be derived as

$$v = Ri + \frac{d\lambda(\theta,i)}{dt}$$

for

$$\frac{d\lambda(\theta,i)}{dt} = L\frac{di}{dt} + i\omega\frac{dL}{d\theta}$$

and

$$e = i\omega\frac{dL}{d\theta}$$

then

$$v = Ri + L\frac{di}{dt} + e \tag{1}$$

where v, i, λ, ω, θ and e are phase voltage, phase current, stator linkage flux, rotor speed, rotor position and back-EMF. Torque (T) developed by the motor is expressed as

$$T = \frac{1}{2} i^2 \frac{dL(\theta)}{d\theta} \tag{2}$$

In SRM, the rotor position will influence the stator inductance. Aligned position between the rotor and the stator results in maximum inductance of stator winding (minimum reluctance) meanwhile unaligned position will have minimum inductance (Fig.2). For 6/4 SRM, phase stator winding inductance will increase and decrease in every 360 electrical degree. Due to equation (2), the phase current excitation must be applied during the positive slope of the inductance profile to generate positive torque. Ideal phase currents to develop optimum torque for such a motor are shown in Fig.3.

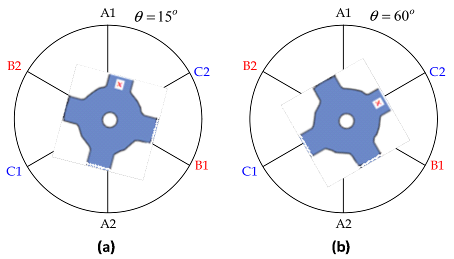

Fig. 2. Relative position between phase-C stator and rotor for 6/4 switched reluctance motor (a) unaligned position (b) aligned position

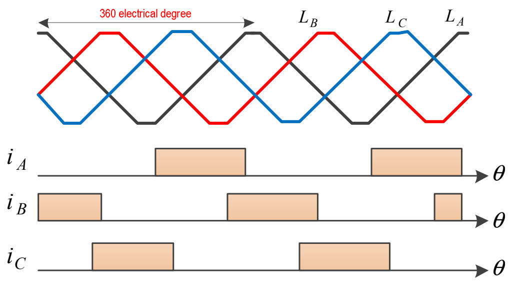

Fig. 3. Inductance profile for 6/4 switched reluctance and its ideal phase currents

Due to natural behaviour of the inductive circuit formed by the stator winding, it is too hard to have the ideal current waveforms. To make the phase current rises quickly at the beginning of the stator excitation, positive voltage with higher magnitude is required. When the aligned position is achieved, the high negative voltage must be applied to the stator winding as soon as possible. By neglecting the stator resistance, then the slope of the phase current at the beginning of the excitation is given as

$$\frac{di}{dt} = \frac{v - e}{L} \tag{3}$$

Meanwhile, the current slope during the commutating process is expressed as

$$\frac{di}{dt} = \frac{-(v + e)}{L} \tag{4}$$

III. Energy Efficient C-Dump Converter

A converter is needed to convert DC voltage into sequential voltages for SRM. To generate optimal torque in SRM, equation (3) and (4) must be used as consideration. An easy method to implement the above equations is by using an asymmetric converter. It uses two switches which are connected in series with the SRM stator winding, this will lead to higher losses and costs. Application in low voltage must consider such problems so implementation with less amount of switches in the converter will be better. The use of single switch in one phase of stator winding is impossible to provide negative voltage from DC source. A capacitor must be inserted into the converter as a tool to provide negative voltage during commutation process, converters which use such methods are classified as C-dump converter topologies. There are some types of C-dump converters, one of these is energy efficient C-dump converter without inductor. It has better features for there is no inductor, less losses and capability to give better efficiency.

Fig.4 shows an energy efficient C-dump converter without inductor to drive a three-phase SRM. The converter consists of three switches for three stator windings (S_1, S_2, S_3) and one switch S_4 to control the voltage of the dumping capacitor . The capacitor voltage must be made greater than the DC link voltage, this voltage can be used to provide positive voltage and negative voltage. Implementation of the positive voltage can be applied in the beginning of the stator winding excitation, for this voltage is greater than the DC link voltage, the stator current will increase faster. Meanwhile implementation of the negative voltage is focused to turn off the stator current faster. During excitation process, current will flow into stator winding and the part of energy is stored in the winding in the form of magnetic energy. The excitation is done by turning on the switch S_1, S_2 or S_3. Turning off the stator winding current while S_4 is still off results in the stored magnetic energy is dumped into the capacitor, hence the capacitor is in charging mode and its voltage will increase.

A method which uses the phase currents as parameters to control the capacitor voltage is proposed in this paper. This refers to the concept that the capacitor voltage is influenced by the phase currents. When the switch S_4 is turned off after the phase current tends to zero, the maximum capacitor voltage is obtained.

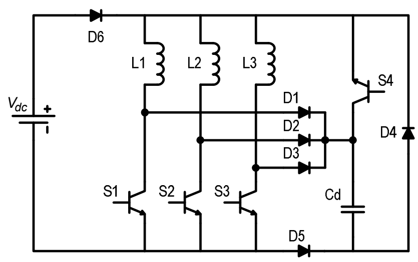

Fig. 4. Energy Efficient C-dump converter topology without inductor

To understand about how the capacitor is charging or discharging to regulate its voltage, some of operation modes are presented. As initial condition, the capacitor has voltage V_c due to the charging process from phase-B current during demagnetizing (S_4 is off-state). For the capacitor voltage is greater than the DC link voltage ($V_c > V_{dc}$), turning on the switch S_1 (during S_4 is on-state) results in the capacitor voltage serves as the excitation voltage, then the phase-A currents will increase faster in the beginning of the mode (operation mode-1). Discharging process of the capacitor makes its voltage drop. Commutation of phase-C can be done by turning off the switch S_3, in such condition the switch S_4 is automatically off, then the stored energy in phase-C stator winding will be dumped into the capacitor (operation mode-2). Two loops are formed in this mode, the magnetizing loop consists of the DC source the phase-A winding meanwhile the dump capacitor and the phase-C winding form the demagnetizing loop. At the end of this operation mode, the capacitor voltage has maximum value and the phase-C current tends to zero, such condition will make the switch S_4 turn on. In the operation mode-3, a loop consists of the dump capacitor and the phase-A winding will force the capacitor voltage drop.

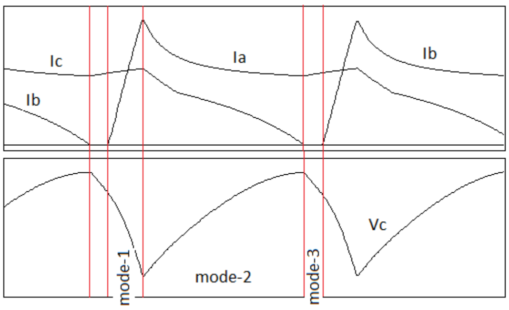

Fig. 5. Region of the operation modes for energy efficient C-dump converter

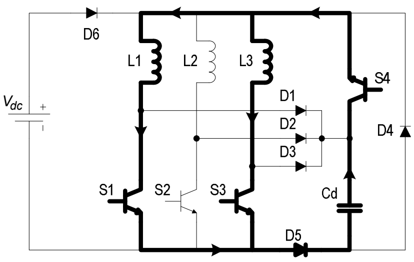

Fig. 6. The current path during the operation mode-1 of energy efficient C-dump converter

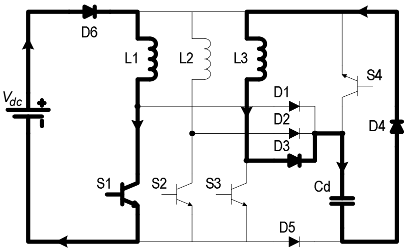

Fig. 7. The current path during the operation mode-2 of energy efficient C-dump converter

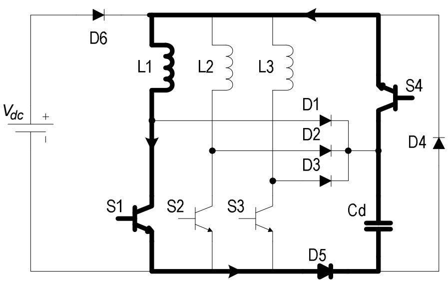

Fig. 8. The current path during the operation mode-3 of energy efficient C-dump converter

IV. The Proposed Control Strategy

Implementation of SRM drive using energy efficient C-dump is depicted in Fig.9, it consists of a motor, a controller, drivers, a converter and a DC source. Rotor position information and phase currents are required by the controller as the input signals. The sequential pulses generated based on such rotor position information must be produced to excite the phase currents. At the beginning of such magnetizing modes, the higher slope of phase currents are generated due to the capacitor voltage. Meanwhile the phase currents will be compared to the specified reference value, when the phase currents are less the specified value, the capacitor is discharged. By this process, the capacitor voltage can be kept at a specified value.

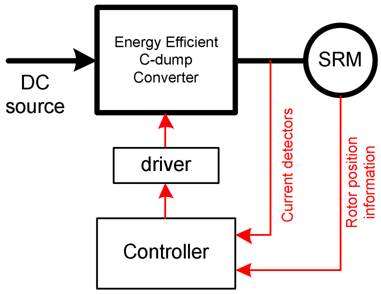

Fig. 9. Block of the SRM drive using energy efficient C-dump converter

The core of the proposed control strategy is implemented by using digital signal controller. Based on the flowchart of the proposed control strategy depicted in Fig.10, reading analog to digital converter (ADC) and rotor position information will be first done. ADC_1, ADC_2 and ADC_3 will read the phase currents of the SRM stator (i_a, i_b and i_c).

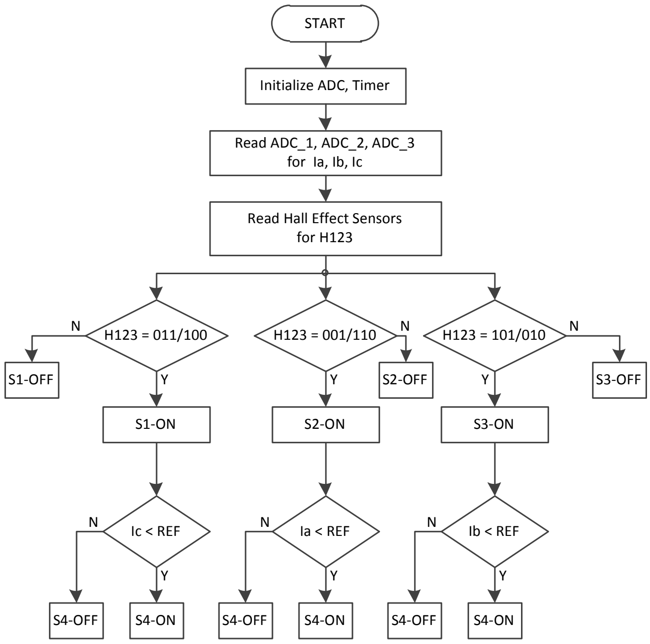

Fig. 10. Flowchart of the proposed control strategy

Three hall effect sensors provide the signals H_1, H_2 and H_3 (H_{123}). These values will be 011, 100, 001,110, 101 or 010. Sectors for each phase of the stator are determined by the values of H_{123} and there will be three possibilities, these are S_1 for phase-A stator winding, S_2 for phase-B stator winding and S_3 for phase-C stator winding. When the switches S_1, S_2 or S_3 are turned off, the phase currents will flow into the dumping capacitor (C_d), then the capacitor voltage will increase. Turning on the capacitor can be used to limit the capacitor voltage and to speed up the beginning of the stator excitation. It can be done by turning on S_4.

V. Results and Discussion

Based on the block of SRM drive and the proposed control strategy, simulation works using PSIM are presented. Parameters for simulations are depicted in Table.1. Three specified reference value of the current will be considered in these works. Comparing the phase current to the smaller specified reference value results in greater voltage on the dump capacitor, then the phase current can be turned off faster. Such condition will produce higher torque, this can be seen through the motor speed under the same load. If the switch S_4 is turned on when the phase current tends to zero, demagnetizing process with negative voltage occurs, meanwhile turning on S_4 the during the phase current which is greater than zero results in demagnetizing and freewheeling modes go on with slower commutation but it has lower capacitor voltage. Simulation works under the switch S_4 turning off at 0.1 A, 5 A and 8 A are depicted in Fig.11, Fig.12 and Fig.13 with the capacitor voltage under such conditions are marked by V_1, V_2 and V_3. The speed and capacitor voltage comparisons are presented in Fig.14 and Fig.15, they show that under the greater voltage of the dump capacitor, the greater speed of the motor is produced.

TABLE I. Parameters for Simulation Works

SRM Stator & Rotor	6/4 poles
DC Source	100 Volt
SRM Stator resistance	0.5 Ohm
Min – Max inductance	1 mH – 10 mH
Dump Capacitor	5000 uF
Load	5 Nm

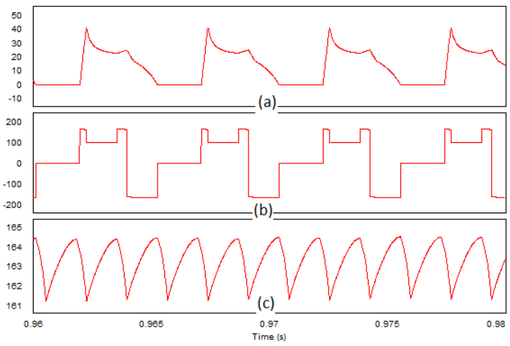

Fig. 11. Simulation results with 0.1A as the reference value (a) phase current (b) phase voltage (c) capacitor voltage

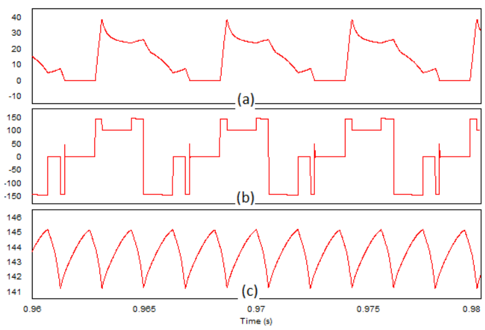

Fig. 12. Simulation results with 5A as the reference value (a) phase current (b) phase voltage (c) capacitor voltage

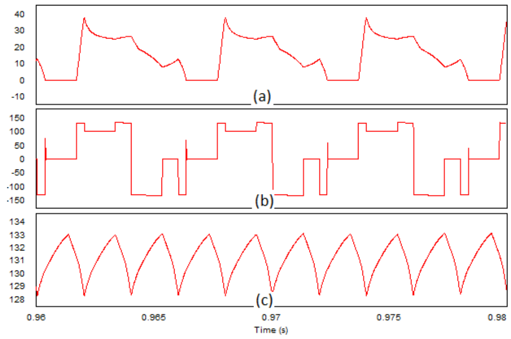

Fig. 13. Simulation results with 8A as the reference value (a) phase current (b) phase voltage (c) capacitor voltage

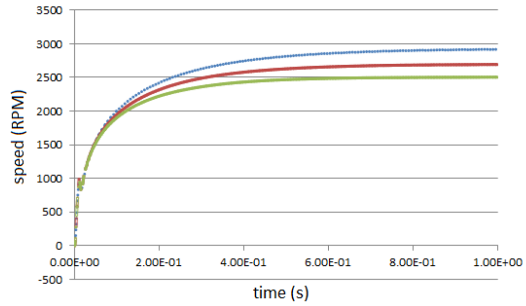

Fig. 14. Speed comparison of the simulation results for different capacitor voltage where V1>V2>V3 (a) speed under V1 (b) speed under V2 (c) speed under V3

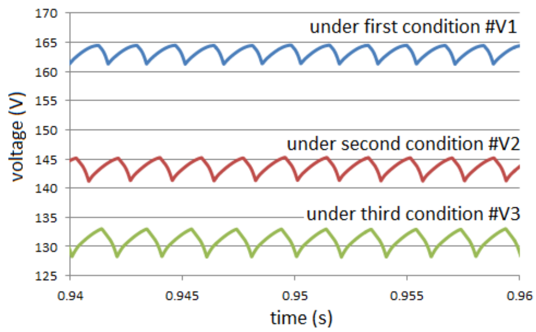

Fig. 15. Capacitor voltage comparison of the simulation results for different condition

To verify the analysis and simulation results, experimental works were also conducted using the prototype depicted in Fig.16.

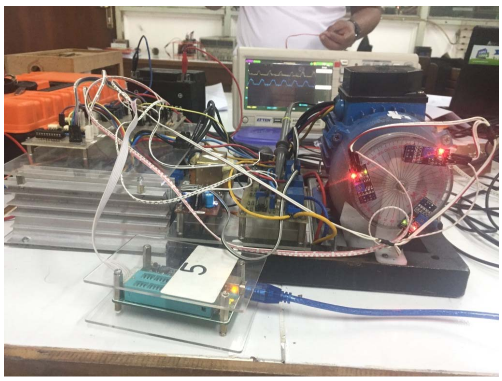

Fig. 16. Prototype of the SRM drive using energy efficient converter without inductor for experimental works

The core of the control is implemented by using microchip dsPIC30F4012. The DC source applies 30 V as the DC link of the converter, then the laboratory experiments use three different specified reference values compared to the phase currents that result in 86 V, 40 V and 32 V as the voltages on the capacitor. The motor will run at 1541 RPM under the 86 V capacitor voltage, this speed is greater than the speed under the 40 V capacitor voltage (1363 RPM) and the speed under the 32 V capacitor voltage (1335 RPM).

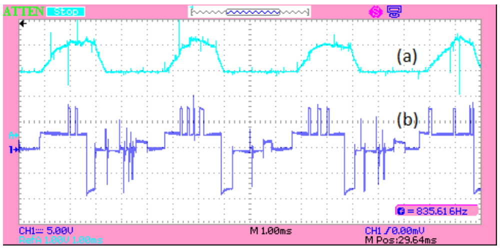

Fig. 17. Experimental results with Vc = 86 V, Vdc = 30 V and 1541 RPM (a) phase current (b) phase voltage

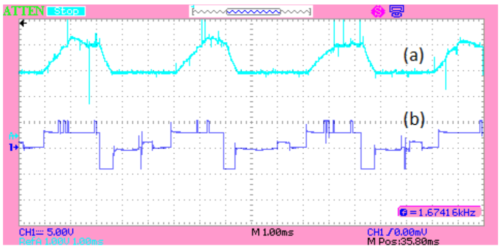

Fig. 18. Experimental results with Vc = 40 V, Vdc = 30 V and 1363 RPM (a) phase current (b) phase voltage

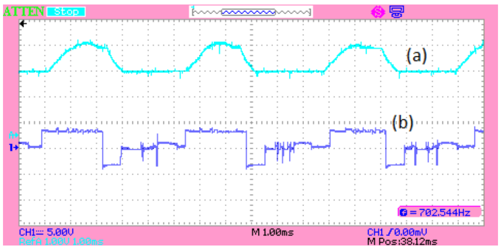

Fig. 19. Experimental results with Vc = 32 V, Vdc = 30 V and 1335 RPM (a) phase current (b) phase voltage

Due to the relationship among power (P), torque (T) and speed (ω), we have

$$P = T\ \omega \tag{5}$$

Because all the simulation and experimental works use the same load so the SRM will operate under the same torque. When the motor has higher speed, it will develop greater output power. For the same DC-link voltage is used, this means that the motor with greater output power will have better efficiency. It can also be observed by comparing the current and voltage waveforms depicted in Fig.17 and Fig.18. Demagnetizing process is represented by negative polarity of the phase voltage and the current decreases. The shorter duration of negative voltage will result in the faster degradation of the phase current. Based on the SRM torque generation, such waveforms will develop greater torque.

VI. Conclusion

Analysis and hardware implementation of the SRM drive using C-dump converter without inductor has been presented. The control strategy using the phase current values as the parameter to control the dump capacitor voltage is proposed. By detecting the phase currents and comparing them to the specified reference value, the capacitor voltage can be controlled. The simulation and experimental works show that the motor will run at greater speed under higher capacitor voltage. This can be achieved because the higher capacitor voltage can make the current at the beginning of the excitation has the greater slope and can make the phase currents go down faster at the commutation.

Acknowledgment

This work was supported by Directorate of Research and Community Service, Directorate General of Research Strengthening and Development, The Ministry of Research, Technology and Higher Education, Republic of Indonesia under the scheme of PTUPT 2019.

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PAPER PRESENTATION CERTIFICATE

This is to certify that the paper titled

"Energy Efficient C-Dump Converter with Simple Control Strategy for SRM Drive"

by

S. Riyadi, L. Pratomo

was accepted and presented in the
9th International Conference on Power and Energy Systems (ICPES 2019)
10 – 12 December 2019, Perth, Australia.

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