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Research Topics for Internship

2016 / 2017

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Design, Modeling and Control of a DC/DC Boost Converter

Project description:

In this project, you will have to design, model and develop control laws for a Boost converter. The converter will be used to feed a 270Vdc bus and will be fed at its entry by a 28Vdc battery. The converter must be controlled in such a way that it delivers the desired output voltage inspite of input (battery) voltage variations.

You will be asked to accomplish the following tasks:

- Make a literature survey about DCDC Boost topologies.
- Select the most promising one and follow neccessary steps to properly desgin a converter that suits the application.
- Model the converter, calculate robust control laws and compare performance with respect to PI control.
- Validate your work through simulation on SIMULINK.

Bibliography:

[1] C. Yfoulis, D. Giaouris, F. Stergiopoulos, C. Ziogou, S. Voutetakis and S. Papadopoulou, "Optimal switching Lyapunov-based control of a boost DC-DC converter," *Control and Automation (MED), 2015 23th Mediterranean Conference on*, Torremolinos, 2015, pp. 304-309.

[2] a R. J. Wai, Y. F. Lin and Y. K. Liu, "Design of Adaptive Fuzzy-Neural-Network Control for Single-Stage Boost Inverter," in *IEEE Transactions on Power Electronics*, vol. 30, no. 12, pp. 7282-7298, Dec. 2015.

[3] Y. Nie and I. P. Brown, "Extended boost converter boundary control law based on natural switching surfaces," *2015 IEEE Energy Conversion Congress and Exposition (ECCE)*, Montreal, QC, 2015, pp. 1645-1652.

[4] Y. Berkovich and B. Axelrod, "High step-up DC-DC converter with coupled inductor and reduced switch-voltage stress," *IECON 2012 - 38th Annual Conference on IEEE Industrial Electronics Society*, Montreal, QC, 2012, pp. 453-458.

[5] R. S. Ashok, Y. B. Shtessel and J. E. Smith, "Sliding mode control of electric power system comprised of fuel cells, DC-DC boost converters and ultracapacitors," *Southeastcon, 2013 Proceedings of IEEE*, Jacksonville, FL, 2013, pp. 1-6.

[6] C. Kranz, "Complete digital control method for PWM DCDC boost converter," *Power Electronics Specialist Conference, 2003. PESC '03. 2003 IEEE 34th Annual*, 2003, pp. 951-956 vol.2.

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Design, Modeling and Control of a DC/DC Buck Converter

Project description:

In this project, you will have to design, model and develop control laws for a Buck converter. The converter will be used to feed a 28Vdc battery and will have at its input a 270Vdc bus. The converter must be controlled in such a way that it delivers the desired output voltage inspite of input DC bus voltage variations.

You will be asked to accomplish the following tasks:

- Make a literature survey about DCDC Buck topologies.
- Select the most promising one and follow neccessary steps to properly desgin a converter that suits the application.
- Model the converter and calculate robust control laws and compare performance with respect to PI control.
- Validate your work through simulation on SIMULINK.

Bibliography:

[1] B. Kiran, P. Parthiban, D. Jena and P. S. Prakash, "Design and implementation of sliding mode voltage controller for DC to DC buck converter by using hysteresis modulation and pulse width modulation," *2016 Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE)*, Bangalore, 2016, pp. 1-6.

[2] A. Abrishamifar, Ahmad Ale Ahmad and S. Elahian, "Fixed frequency sliding mode controller for the buck converter," *Power Electronics, Drive Systems and Technologies Conference (PEDSTC), 2011 2nd*, Tehran, 2011, pp. 557-561.

[3] K. Al-Hosani, A. Malinin and V. I. Utkin, "Sliding mode PID control of buck converters," *Control Conference (ECC), 2009 European*, Budapest, 2009, pp. 2740-2744.

[4] Shu-lin Liu, Yi-bo Ma and Yun-wu Zhang, "Optimal design of inductance and capacitance of output intrinsically safe Buck DC-DC converters," *Industrial and Information Systems (IIS), 2010 2nd International Conference on*, Dalian, 2010, pp. 408-411.

[5] R. Min; Q. Zhang; Q. Tong; X. Zou; X. Chen; Z. Liu, "Multi-loop Minimum Switching Cycle Control based on Non-averaged Current Discrete-Time Model for Buck Converter," in *IEEE Transactions on Power Electronics* , vol.PP, no.99, pp.1-1

[6] Nazzareno Rossetti, "DCDC Conversion Architectures," in *Managing Power Electronics:VLSI and DSP-Driven Computer Systems* , 1, Wiley-IEEE Press, 2006, pp.71-105

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Efficiency study of m-level inverter with SiC MOSFET technology

Project description:

Based on the paper which reference is given below with the following abstract[1]:
"A generalized multilevel inverter (MLI) with front end dc-dc conversion stage followed by a synchronized H-bridge is presented. By using this configuration along with the proposed embedded control, any desired number of levels (n) in the output voltage can be produced. The dc-dc conversion stage employs an asynchronous buck converter. The duty cycle of dc-dc converter is varied in the form of m-level piecewise constant (PWC) unidirectional sine wave to produce a similar output voltage across the dc-link capacitor. The unidirectional PWC voltage is made into n-level ac voltage, where n = (2m - 1), by the synchronized H-bridge. Hence, it is named as dc-dc-ac MLI. […]"
The author analyzed the power losses based on IGBT. In this project, students will do the same with SiC MOSFET technology.

TASKS:

1- Understanding of the concepts of DDA-MLI mentioned in the paper
2- Development and Simulation of the system
3- Efficiency study of the system depending on the type and technology of components used
4- Report and presentation

Bibliography:

[1] B. D. Reddy, A. N. K, M. P. Selvan, et S. Moorthi, « Embedded control of n-level DC-DC-AC Inverter », *IEEE Trans. Power Electron.*, vol. 30, n° 7, p. 3703‑3711, juill. 2015.

Efficiency study of m-level inverter with GaN MOSFET technology

Project description:

Based on the paper which reference is given below with the following abstract[1]:
“A generalized multilevel inverter (MLI) with front end dc-dc conversion stage followed by a synchronized H-bridge is presented. By using this configuration along with the proposed embedded control, any desired number of levels (n) in the output voltage can be produced. The dc-dc conversion stage employs an asynchronous buck converter. The duty cycle of dc-dc converter is varied in the form of m-level piecewise constant (PWC) unidirectional sine wave to produce a similar output voltage across the dc-link capacitor. The unidirectional PWC voltage is made into n-level ac voltage, where n = (2m - 1), by the synchronized H-bridge. Hence, it is named as dc-dc-ac MLI. […]“
The author analyzed the power losses based on IGBT. In this project, students will do the same with SiC MOSFET technology.

TASKS:

1- Understanding of the concepts of DDA-MLI mentioned in the paper
2- Development and Simulation of the system
3- Efficiency study of the system depending on the type and technology of components used
4- Report and presentation

Bibliography:

[1] B. D. Reddy, A. N. K, M. P. Selvan, et S. Moorthi, « Embedded control of n-level DC-DC-AC Inverter », *IEEE Trans. Power Electron.*, vol. 30, n° 7, p. 3703‑3711, juill. 2015.

EXPERIMENTAL CHARACTERIZATION OF A PERMANENT MAGNET SYNCHRONOUS MOTOR – IDENTIFICATION OF AN EQUIVALENT MODEL PARAMETERS AND LOSSES

DOMAIN : **Electromechanical measurements of electrical machines – Identification of losses and efficiency**

TOPIC (anglais) : Heating of electrical machines is a key characteristic of their behavior. Heat sources come mainly from energy losses during electromechanical conversions. To estimate both the efficiency and the heating of an electrical machine, it is necessary to first perform accurate measurements of the whole losses for every condition. The two main difficulties to overcome are firstly the measurements for various working conditions, depending on the speed and the torque of the machine; and secondly an identification that should give as significant separated measurements as possible, by identifying the different physical origins, namely mechanical, thermo-aerolic, electrical and magnetic ones.
The aim of this internship is to perform electromechanical measurements of the whole losses for every working condition of a synchronous motor (i.e. versus speed and torque) by identifying when possible mechanical, aerolic, electrical and magnetic losses separately. The no load condition has already been carried out by running the machine on its own. The load condition demands to couple the machine to another one used as a break.

MISSIONS :

- Perform a bibliography on electrical model and losses of synchronous motors (MS),
- Experimental set up and equipment control for the measurements,
- Exploitation of experimental data and identification of the MS parameters without load,
- Protocol and Measurement of the MS losses and efficiency with a load,
- Write a scientific and technical report.

RESULTS, MODELS AND EQUIPMENT AT DISPOSAL :

Test bench for electrical machines equipped with two machines and a speed and torque meter / Electrical sources equipped with a safety box and power converters / Electrical measurement apparatuses and computer / Softwares: MATLAB, MATAB/SIMULINK, LABVIEW.

PROFESSIONNAL PROFILE : Electrical Engineering / Bac + 4 - DURATION : 3 month
CONTACTS : Olivier Maloberti (maloberti@esiee-amiens.fr, 06-46-39-19-23 ou 03-22-66-20-43)

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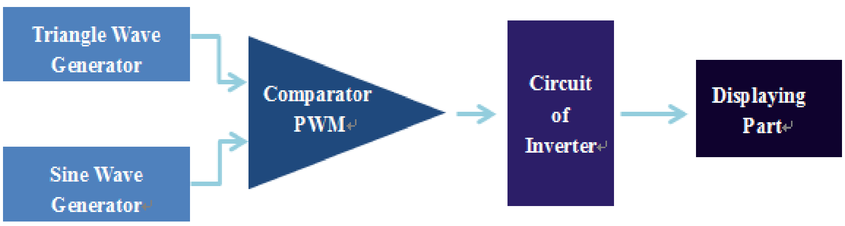
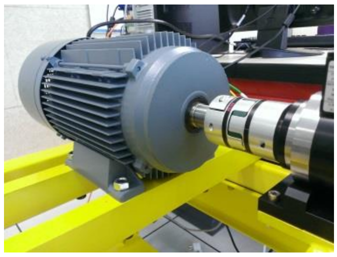
CONTROL-COMMAND OF A POWER CONVERTER TO FEED AND RUN AN ASYNCHRONOUS ELECTRICAL MACHINE USED EITHER AS A BRAKE OR A MOTOR

DOMAIN : Power electronics, control-command of power converters – electrical machines bench tests

TOPIC (anglais) : Heating of electrical machines is a key characteristic of their behavior. Heat sources come mainly from energy losses during electromechanical conversions. To estimate both the efficiency and the heating of an electrical machine, it is necessary to first perform accurate measurements of the whole losses for every condition. The two main difficulties to overcome are firstly the measurements for various working conditions, depending on the speed and the torque of the machine; and secondly an identification that should give as significant separated measurements as possible, by identifying the different physical origins, namely mechanical, thermo-aerolic, electrical and magnetic ones. To do so with the load condition demands to couple the machine to another one used as a break.
The aim of this internship is to develop the control-command of a power converter that permits to use an asynchronous electrical machine either as a break or a motor. One PWM strategy has been proposed and written in LABVIEW to command the switches in an open loop. It is required this year to program, write and test scalar and vector control laws in a closed loop for the break.





<u>MISSIONS :</u>

- Perform a bibliography on asynchronous machines (MAS) associated to inverters as a break,
- Implementation of the command and experimental test of the inverter in an open loop,
- Scalar and vector control of the inverter in a closed loop (programs and tests),
- Protocol of the MS losses and efficiency measurements with the load,
- Write a scientific and technical report.

RESULTS, MODELS AND EQUIPMENT AT DISPOSAL:
Test bench for electrical machines equipped with two machines and a speed and torque meter / Electrical sources equipped with a safety box and power converters / Electrical measurement apparatuses and computer / Softwares: MATLAB, MATAB/SIMULINK, LABVIEW.

PROFESSIONNAL PROFILE : Electrical Engineering / Bac + 4 - DURATION : 3 month
CONTACTS : Olivier Maloberti (maloberti@esiee-amiens.fr, 06-46-39-19-23 ou 03-22-66-20-43)

High efficiency CubeSat power supply with MPPT

A CubeSat is a miniaturised satellite developed to enable universities to perform space science research and exploration. The standard 10x10x10cm CubeSat is called a 1U CubeSat and is restricted to 1.33kg. The aim of this project is the conception of a CubeSat power supply. Satellites derive their main power from solar panels and store excess energy in batteries for use when the sun is blocked. Maximum peak power tracking is employed to extract the maximum power from the solar cells. The generated and stored power is then regulated for use by the satellite's various sub-systems. Battery management prevents over- or undercharging of the battery. Due to their size, CubeSats average about 3W of power. Efficiency is thus of utmost importance in the power chain.

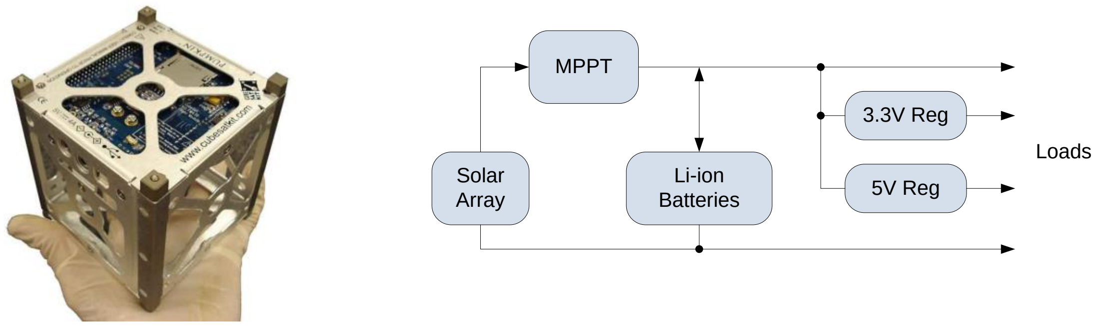


Figure 1: Block diagram of a basic power supply for a CubeSat nanosatellite

Description of Work

- Study CubeSat power sources (solar cells, battery, conversion topologies) and load profiles
- Investigate MPPT techniques
- Sizing and modelling of the solar array, battery, voltage regulators and MPPT
- Design and manufacturing of PCB
- Implement MPPT and battery management via microcontroller
- Test and evaluate power supply performance