

Design and implementation of a six-phase inverter for EV applications

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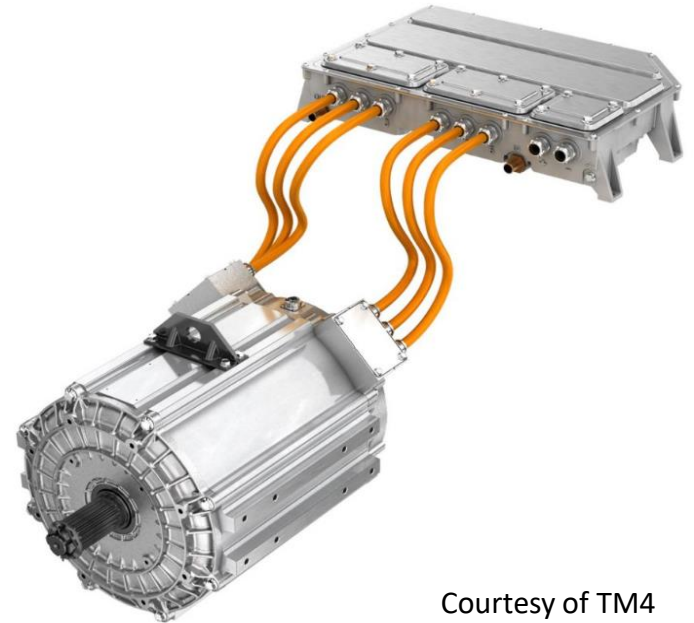
Program: ECE

Level of studies: Ph.D.

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Project Description

- The project requires building a multiphase drive for electric vehicle applications.
- Enhance the performance of the drive by exploiting the features of multiphase systems.



Courtesy of TM4

Objectives

- Develop a six-phase inverter based on the state of the art and trending research to meet the requirements of the drive.
- Reduce the size of the DC-link bank of capacitors.

Tasks/Plan

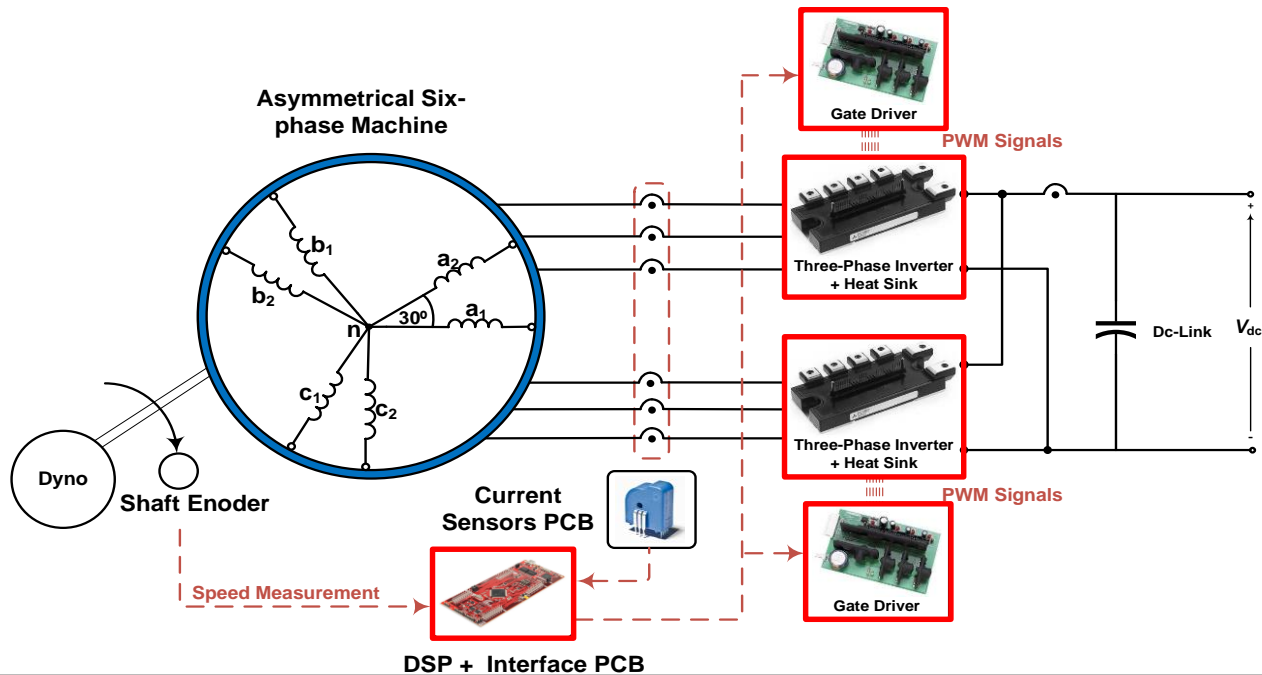
- Literature review on multiphase drives
- Design a scaled down prototype of six-phase inverter.
- Develop a code to operate the inverter.
- Highlight the features of multiphase and propose solutions to their associated drawbacks.
- Developing new method (switching/control) for the capacitor sizing reduction.

Expected Outcome & Deliverables

- Choosing the best suitable power electronics converter topology with the multiphase features.
- Implement the chosen converter with a scaled down prototype and test it with the designed machine.

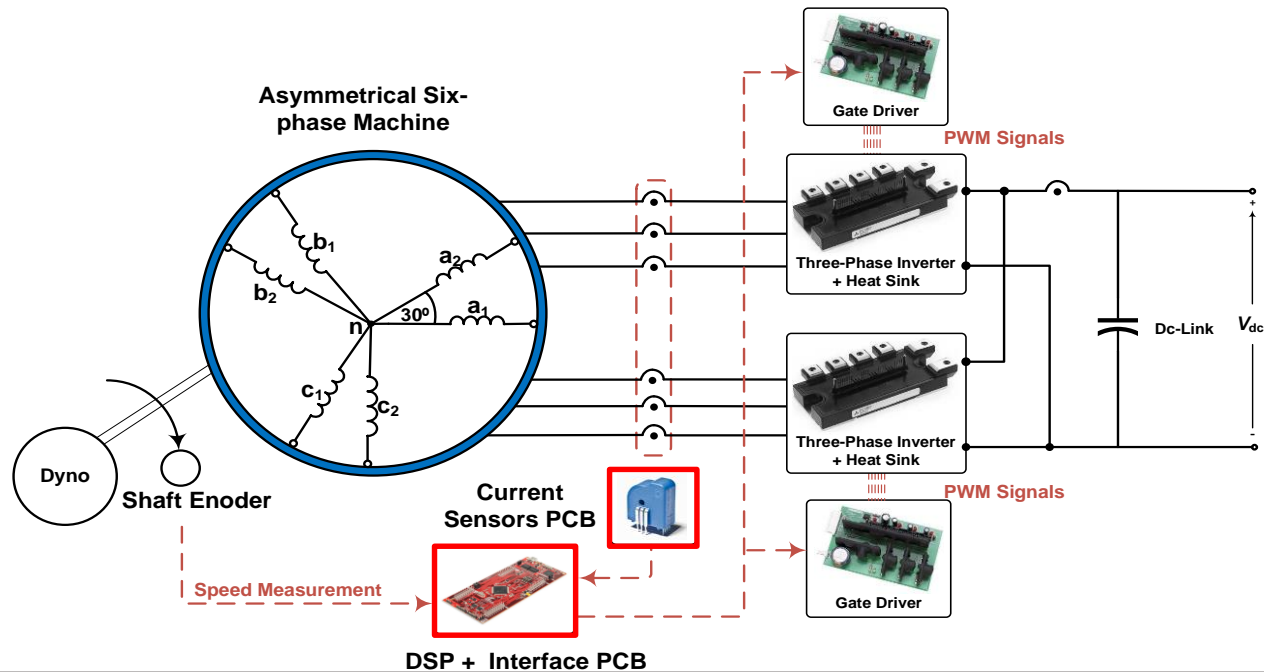
Progress Report

- Design and implementation of the six-phase inverter for the drive based on the designed machine by Windsor University.
 - The inverter is rated at 9 kW output power and 600 V dc-link voltage.
 - Design and implementation of an interface board to operate the f28397d DSP microcontroller from Texas Instruments.



Progress Report

- The modulation scheme is 24-sector Space Vector Modulation with the ability to suppress the xy harmonic currents without the need to applying additional tunable PI / PR controllers.
- Designed and implemented current sensing board suitable for the selected DSP and rated at 15A.



Publications

- A. Salem and M. Narimani, "A Review on Multiphase Drives for Automotive Traction Applications," IEEE Transactions on Transportation Electrification, vol. 5, no. 4, pp. 1329-1348, 2019.
- A. Salem and M. Narimani, "Fault-Tolerant Operation of Asymmetrical Six-Phase Motor Drives in EV Applications" accepted in ITEC 2020.
- A. Salem and M. Narimani, "Nine-Switch Current-Source Inverter-Fed Asymmetrical Six-Phase Machines Based on Vector Space Decomposition" submitted in ECCE 2020
- A. Salem and M. Narimani, "Extension of The Post-Fault Torque Range of Asymmetrical Six-Phase Drives in EV Applications Using Remedial Solution" prepared to be submitted to IEEE TTE.
- A. Salem and M. Narimani, "Space Vector Modulation of Nine-Switch Inverter-Fed Asymmetrical Six-Phase Machines Based on Vector Space Decomposition" prepared to be submitted to IEEE TIE.
- A. Salem and M. Narimani, "Model Predictive Control of Nine-Switch Inverter-Fed Asymmetrical Six-Phase Machines Based on Virtual Voltage Vectors" prepared to be submitted to IEEE TPEL.
- A. Salem and M. Narimani, "EV power train based on current-source multiphase drive" prepared to be submitted to IEEE TIE.
- A. Salem and M. Narimani, "A Space Vector Modulation Scheme for Current-Source Inverter-fed Six-Phase Loads with Single-Neutral Configuration" prepared to be submitted in IECON 2020.

Q & A

Thanks!