Multiphase Induction Motor Drives for Gear-Less Electric Vehicle Applications

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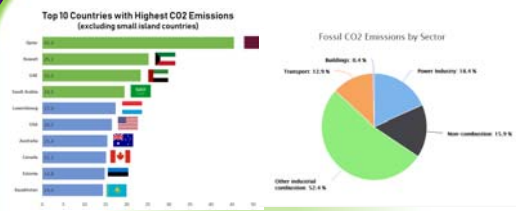
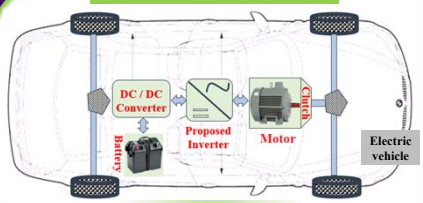
Objectives



- Fossil CO_2 emissions in Qatar were 98,990,085 tons in 2016.
- CO_2 emissions increases by 1.79% every year.
- Transportation sector, especially internal combustion engine(ICE) based cars cause for high CO_2 emissions.
- The proposed work is aimed to develop a ecofriendly transportation system, which falls in current research priorities of Qatar University and the state of Qatar.

Electric Vehicles

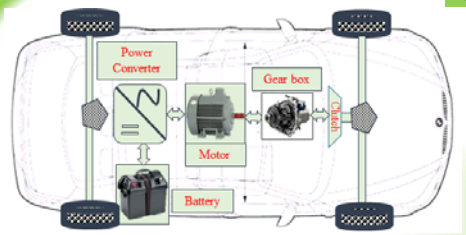


For selecting a drive for electric vehicle applications,

- Enhanced torque-speed range with high efficiency
- High power handling capability
- High torque for starting and high power for high-speed cruising
- High reliability and robustness, acceptable cost
- Volume of the machine
- Low acoustic noise and low torque ripple

Why Multi-Phase Machines??

Conventional Three Phase Induction Motor Drive for EV

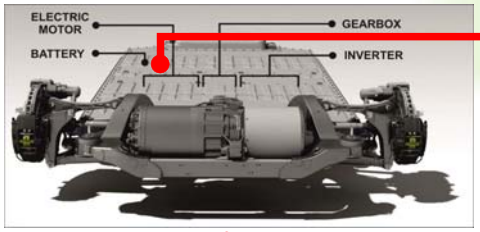


Overview of Electric Vehicle with 3-phase Induction Motors

Torque and Speed Characteristics of the Drive

With Three Phase Induction Motor Drive

- Gear box is required
- High DC link voltage, for this higher number of batteries are connected in series
- Lower reliability because of the series connected batteries as well less number of phases
- Efficiency is low
- High ratings of devices required
- Higher size of machine, higher number of batteries, requirement of gear because will increase the size of the drive

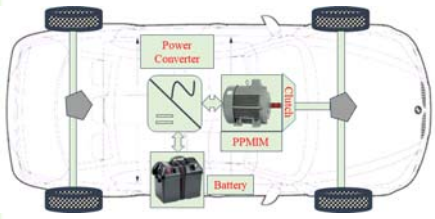


Tesla Motor Drive system for EV with 3-phase IM

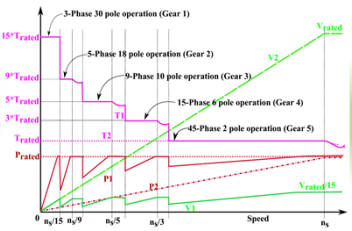
Tesla Motor Drive Battery system

Higher number of battery cells are required to meet the 600V DC bus to drive the 3-phase IM drive

Multiphase Induction Motor Drive for Gearless EV



Overview of Electric Vehicle with multiphase Induction Motors



Torque and Speed Characteristics of Pole Phase Modulated IM Drive

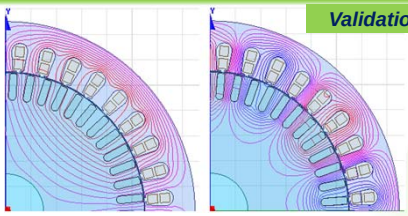
Lesser number of battery cells are required to meet the 120V DC bus to drive the 15-phase IM drive

With Multiphase Phase Induction Motor

- Gear box is eliminated because the machine itself providing enhanced torque speed profile similar to IC engine
- Higher reliability due to the parallel connected batteries and higher number of phases
- Efficiency is high
- Lower DC link Voltage
- Better power distribution/phase
- Reduced ratings of devices required

Validation of the Proposed Multiphase Induction Motor Drive for Gearless EV

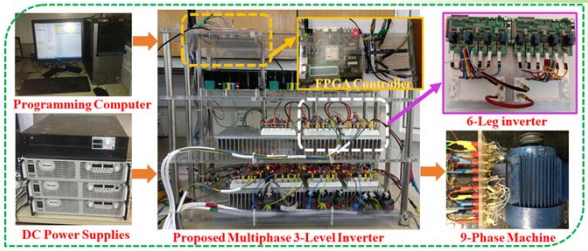
Flux line distribution of the 9-phase PPMIM Drive



6-Phase Machine 1hp

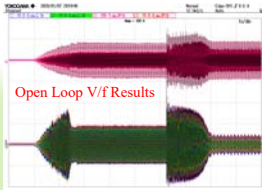
9-Phase Machine 5hp
1:3 speed ratio

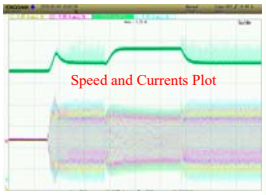
Laboratory Prototypes of 9-phase PPMIM Drive

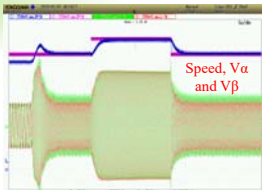


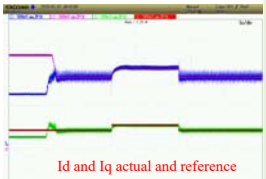
15-Phase Machine 5hp
1:3:5 speed ratio

Experimental results under IFOC vector control of 9-Phase Pole Phase Modulated IM Drive









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