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High Voltage Gain Interleaved Boost Converter with Neural Network Based MPPT Controller for Fuel Cell Based Electric Vehicle Applications

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Abstract— Due To The More Vigorous Regulations On Carbon Gas Emissions And Fuel Economy, Fuel Cell Electric Vehicles (FCEV) Are Becoming More Popular In The Automobile Industry. This Paper Presents A Neural Network Based Maximum Power Point Tracking (MPPT) Controller For 1.26 Kw Proton Exchange Membrane Fuel Cell (PEMFC), Supplying Electric Vehicle Powertrain Through A High Voltage-Gain DC-DC Boost Converter. The Proposed Neural Network MPPT Controller Uses Radial Basis Function Network (RBFN) Algorithm For Tracking The Maximum Power Point (MPP) Of The PEMFC. High Switching Frequency And High Voltage Gain DC-DC Converters Are Essential For The Propulsion Of FCEV. In Order To Attain High Voltage Gain, A Three-Phase High Voltage Gain Interleaved Boost Converter (IBC) Is Also Designed For FCEV System. The Interleaving Technique Reduces The Input Current Ripple And Voltage Stress On The Power Semiconductor Devices. The Performance Analysis Of The FCEV System With RBFN Based MPPT Controller Is Compared With The Fuzzy Logic Controller (FLC).

Index Terms— Fuel Cell Electric Vehicle, High Voltage Gain IBC, PEMFC, MPPT, RBFN.

INTRODUCTION

Due To The Environmental Pollution And Finite Reserves Of Fossil Fuels, Automobile Industries Are Showing More Interest In Fuel Cell Electric Vehicles (FCEV). The Rapid Advancements In Power Electronics And Fuel Cell Technologies Have Empowered The Significant Development In Fcevs . Fuel Cells Have The Advantages Of Clean Power Generation, High Reliability, High Efficiency And Low Noise. Depending On The Type Of Electrolyte Substance Fuel Cells Are Categorized Into Different Types Such As Proton Exchange Membrane Fuel Cell (PEMFC), Alkaline Fuel Cell (AFC), Phosphoric Acid Fuel Cell (PAFC), Solid Oxide Fuel Cell (SOFC) And Molten Carbonate Fuel Cell (MCFC). Among All Of These, Pemfcs Are Dominating The Automobile Industry Due To Their Low Operating Temperature And The Quick Startup.

FUEL CELLS

- Due To Environmental Pollution And Finite Reserves Of Fossil Fuels, Automobile Industries Are Showing More Interest In Fuel Cell Electric Vehicles (FCEV).
- Fuel Cells Have The Advantages Of Clean Power Generation, High Reliability, High Efficiency And Low Noise.
- PEMFCs Are Dominating The Automobile Industry Due To Their Low Operating Temperature And The Quick Startup.

MPPT

- The MPPT Algorithms,P&O Is Simple,Popular And Easy To Implement.P&O And Incremental Conduction Methods Produces Oscillations At Steady State Which Will Reduce Efficiency Of Fuel Cell System.
- To Overcome This Problem,Fuzzy Logic Controller And Neural Network Algorithms Are Introduced To Track MPPT With Increased Efficiency And Accuracy.
- Radial Basis Function Network(RBFN) Base MPPT Controller Is Proposed To Track MPPT Of The PEMFC.

EXISTING CONFIGURATION

- The Powertrain Architecture Of FCEV Is Shown In Fig. A Stack Of PEMFC Produces An Unregulated Low Dc Output Voltage.
- So A Boost Or Step-Up DC-DC Converter Is Required To Boost And Regulate The PEMFC Output Voltage.

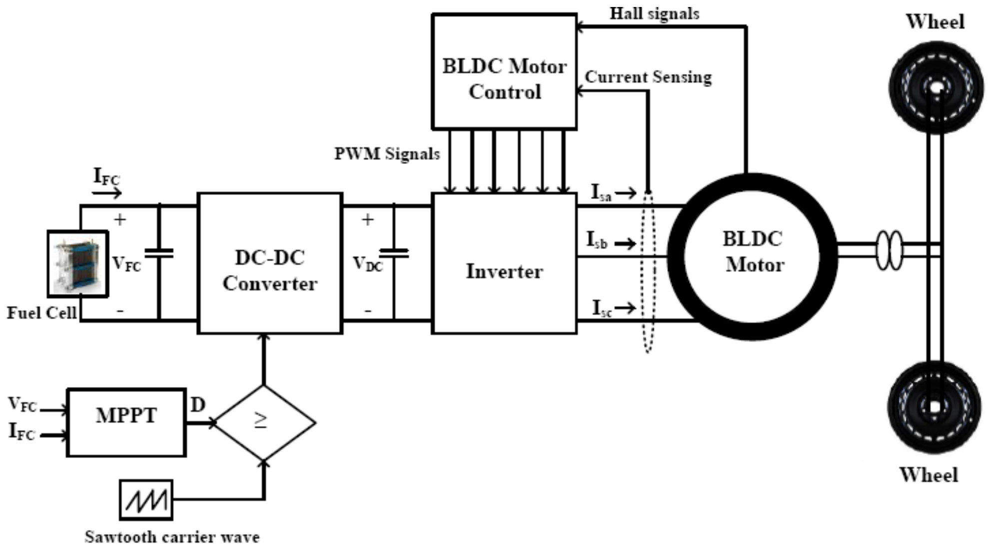
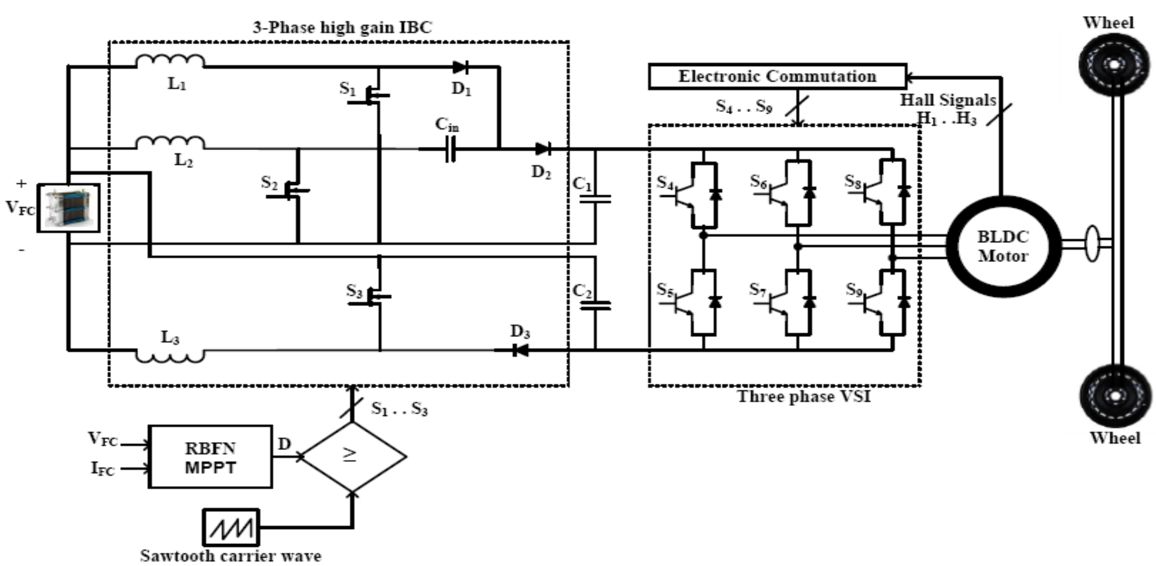


Fig . Conventional configuration of fuel cell fed BLDC motor driven electric vehicle.

DISADVANTAGES

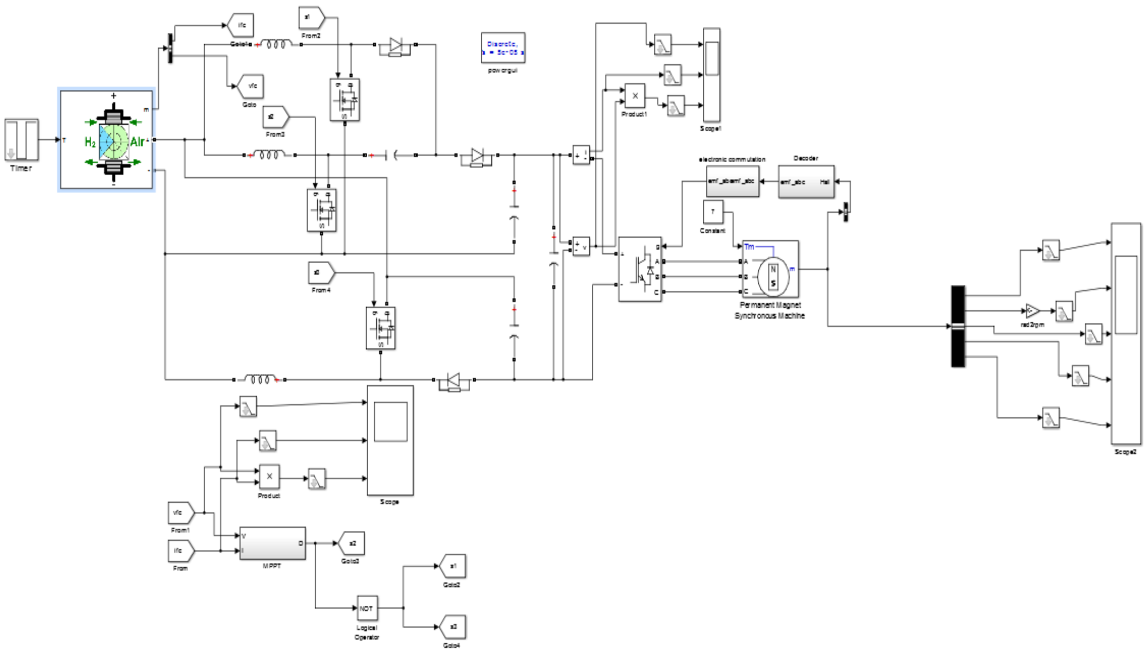
- Poor Reliability
- Less Efficiency.
- Expensive
- For Low Power Applications, The Conventional Boost Converter Is Used As A Power Electronic Interface Whereas For High Power Applications Boost Converter Might Not Be Compatible Because Of Its Low Current Handling Capability And Thermal Management Issues
- To Overcome These Problems Different High Voltage Gain Dc-Dc Converters Are Designed In The Literature.

PROPOSED CONFIGURATION



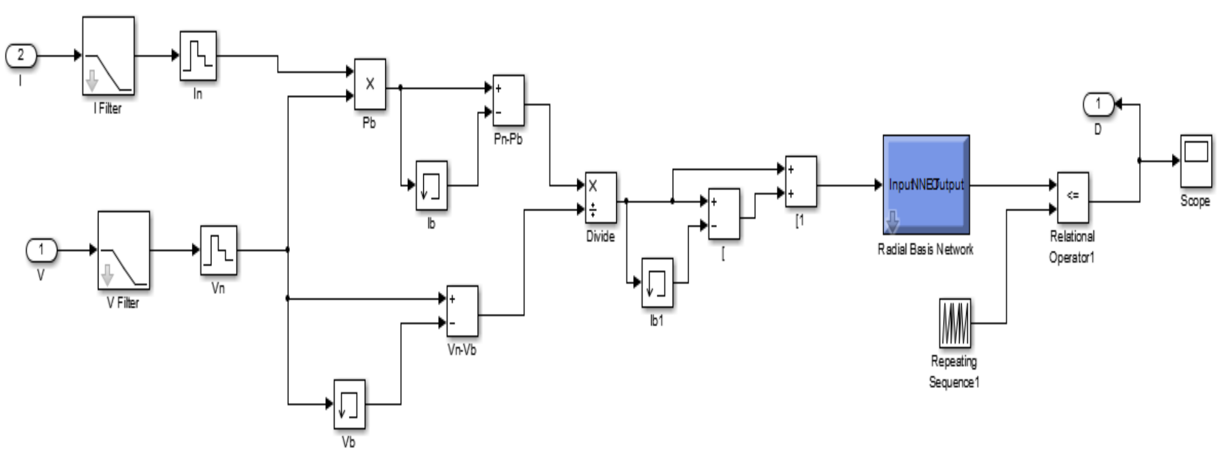
SIMULATION AND RESULT ANALYSIS

- The Performance Of The Proposed BLDC Motor Driven FCEV System Is Analyzed By Using The MATLAB/Simulink Platform.
- To Analyze The Dynamic Response Of The FCEV System, Sudden Changes In The Temperature Of The Fuel Cell Is Considered As Follows: T= 320˚K For A Period Of 0 To 0.3sec, T= 310˚K For A Period Of 0.3 Sec To 0.6 Sec And T= 330˚K For A Period Of 0.6sec To 0.9 Sec.



RBFN BASED FUEL CELL CIRCUIT

MPPT MODEL.



CONCLUSION

A Three-Phase High Voltage Gain DC-DC Converter Is Proposed For FCEV Applications. The Proposed Converter Has Reduced The Fuel Cell Input Current Ripples And The Voltage Stress On The Power Semiconductor Switches. The RBFN Based MPPT Technique Is Designed For 1.26 Kw PEMFC For Extracting The Maximum Power From The Fuel Cell At Different Temperatures. The Proposed MPPT Technique Is Compared With The FLC MPPT Controller. The Simulation Results Reveal That The RBFN Based MPPT Controller Has Tracked The Maximum Power Point Faster When Compared To The Fuzzy Logic Controller. Also, Different Performance Characteristics Of The BLDC Motor Such As Electromagnetic Torque, Speed And Back EMF Are Analyzed At Different Temperatures Of The Fuel Cell System.

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