Publications (Journals, Patents, Book Chapters and Conferences):

Patent Disclosures (4)

1. Raveendhra Dogga, Ravi Kumar KS, A Pandian, V. V. Sastry Vedula, Poojitha Rajana, Praveen Jugge, HIGH GAIN NON-ISOLATED BI-DIRECTIONAL DC-DC CONVERTER" Granted on 09th November, 2021 (Patent No: 418205)
2. *US Patent Disclosure*: Douglas C Hopkins, Dogga Raveendhra, "Energy Re-Circulation Circuit and Controls for Applications including Power Semiconductor Device Characterisation", Filed at Office of Technology Commercialisation and New Ventures, NCSU for US patent. Ref. No: 17126.
3. *Indian Patent*: Raveendhra Dogga, M K Pathak, "Novel Single-Stage Inverter", Application Number: 201641038706
4. *Indian Patent*: Ravi Kumar KS, Raveendhra Dogga, Nagesh Kumar, V. V. Sastry Vedula, Novel Capacitor Clamped Bidirectional DC-DC Converter, Application Number: 201641038706

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Products Developed

My research interests lie in the interface of Wide Band-Gap Devices, Renewable Energy Sources, Advanced Power Electronics, Micro-grids, Switched mode Power supply. FPGA, DSP controllers for PE Application, Power systems, and IoT based Smart Power Converters for EVs. I believe in a multidisciplinary research approach and I stand for teamwork and enjoy the enrichment of collaboration, both within my field and between fields. Finally, I hope to find an environment that will enable me to continue enjoying productive collaboration and intellectual growth.

The following section provides you further details of my research till now and the outcomes of the project.

1. Research Directions

Project 1: Electric Vehicle two-wheeler (Zunik Energies Pvt. Ltd., I-2, TIDES, IIT Roorkee)

V_{dc}= 48V/60V

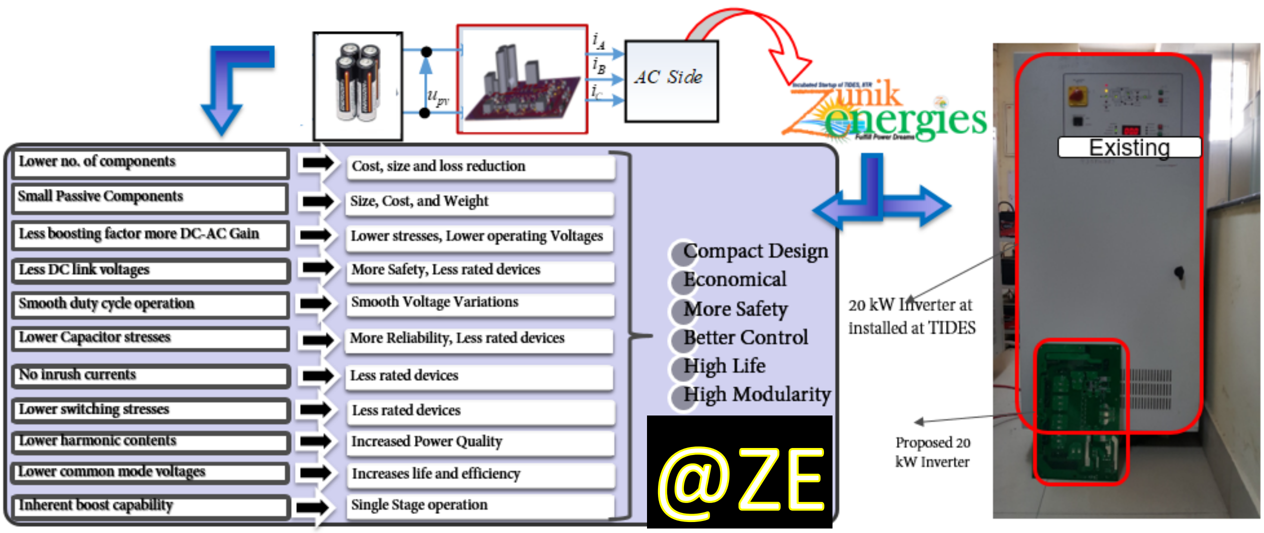
P_o=1KW

- WBG devices
- Single Stage Conversion

Compatible for 48V upto 1kW

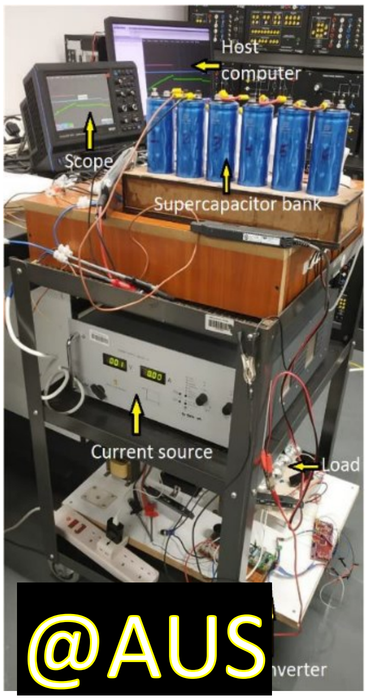
1. Compact Converter (6cm x 4cm)
2. Smooth Input Current – High Battery Life
3. Effective DC Bus utilization
4. Reduced Current stress on batteries
5. Advanced PWM techniques
6. Reduced Common mode voltages

Project 2: Solar PV Inverter with intrinsic boost abilities (Zunik Energies Pvt. Ltd., I-2, TIDES, IIT Roorkee)

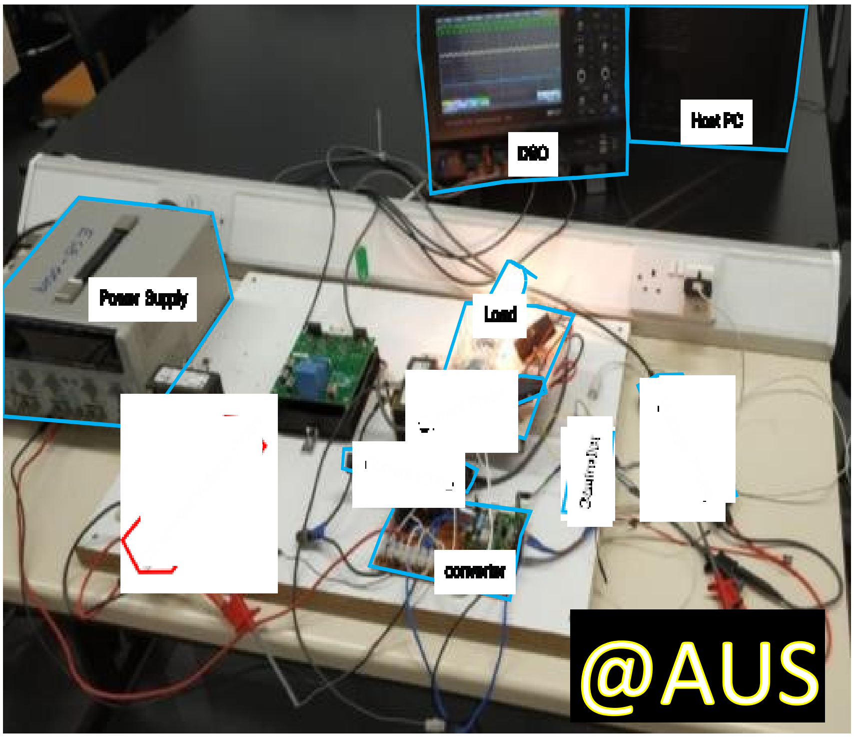


Project 3: **Super capacitor Characterization (Renewable Energy Center, American University of Sharjah, UAE)**

This project presents a simplified supercapacitor model and a universal adaptive stabilization, optimization (UAS+O) based parameter identification technique. Analytic solutions for the description of super capacitors current, voltage, subject to cyclic voltage and current sources of varying amplitudes and frequency, consistent with electric vehicle driving cycles, are developed. Supercapacitor I-V relationships show hysteresis, indicating simultaneous energy storage and dissipation mechanisms. A reduced equivalent circuit model is proposed to accurately represent hysteresis I-V characteristics. The proposed UAS+O based technique for estimating model parameters, is supported by mathematical proofs, simulation, and experimental results.



Project 4: **LC Impedance Source Bi-Directional Converter (Renewable Energy Center, American University of Sharjah, UAE)**



This project proposes an LC (Inductor and Capacitor) impedance source bi-directional DC–DC converter by redesigning after rearranging the reduced number of components of a switched boost bi-directional DC–DC converter. This new converter with a conventional modulation scheme offers several unique features, such as a) a lower number of components and b) reduced voltage stress on the capacitor compared to existing topologies. The reduction of capacitor voltage stress has the potential of improving the reliability and enhancing converter lifespan. An analysis of the proposed converter was completed with the help of a mathematical model and state-space averaging models. The converter performance under different test conditions is compared with the conventional bi-directional DC–DC converter, Z-source converter, discontinuous current quasi Z-source converter, continuous current quasi Z-source converter, improved Z-source converter, switched boost converter, current-fed switched boost converter, and quasi switched boost converter in the Matlab Simulink environment. MATLAB/Simulink results demonstrate that the proposed converter has lesser components count and reduced capacitors' voltage stresses when compared to the topologies mentioned above. A 24 V to 18 V LC-impedance source bi-directional converter and a conventional bidirectional converter are built to investigate the feasibility and benefits of the proposed topology. Experimental results reveal that capacitor voltage stresses, in the case of proposed topology are reduced by 75.00% and 35.80% in both boost and buck modes, respectively, compared to the conventional converter circuit.

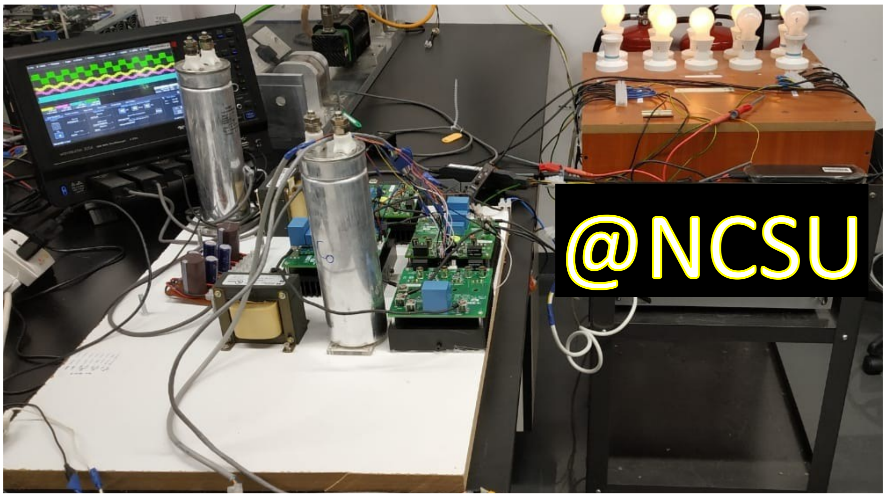
Project 5: Performance Investigation of 200KW Sic Inverter (FREEDM Systems Centre, NC State University)

The Project presents the characteristics of the latest commercial 1200V 300A SiC MOSFET modules used Agile Switch Inverter and compares its performance with Si IGBT with the same rating using experimental results and the LTSpice software environment. Our SiC MOSFET model in LTSpice gives accurate results across a wide range of temperatures. The results show that the 1200V SiC MOSFET has faster switching speed and significantly less switching loss compared to the Si IGBT. The main objective of this SiC-based project is to develop the modulation and control scheme using FGPA to investigate the performance at higher switching speeds. Moreover, the Si IGBT switching loss will increase significantly for higher operation temperature, while the SiC MOSFET switching loss has little variation over different temperatures. This project also investigated the stray inductance effect on the gate, drain, and source side and verifies its performance with Si IGBT.

Project 6: Novel Single Stage Boost Inverter (FREEDM Systems Centre, NC State University)

This Project introduces a novel type of 3-phase single stage dc-ac converter, which is controlled by sliding mode control, offers an intrinsic step up abilities. The proposed inverter is designed with the lesser number of solid-state semiconductor switches and small passive elements. Sliding mode controller (robust controller) is designed to control this power converter in order to achieve high robustness, sustain any kind of line or load variations and achieve a good dynamic response. In addition to this, the voltage across every capacitor is less when compared with existing traditional boost inverter topologies, which leads to better reliability and enhanced lifespan of the converter. This scheme also offers very less harmonic in the output voltage and currents. The proposed scheme is tested for a different line and load varying conditions on MATLAB Simulink environments as well as on a prototype. A 500W prototype has been fabricated and experimented to validate the feasibility and benefits of the system. Simulation and Experimental results reveal that proposed inverter offers better reliability, power quality and high lifetime over the existed topologies.

Project 7: Performance Investigation of 200KW Sic Inverter: (FREEDM Systems Centre, NC State University, USA)



The Project presents the characteristics of the latest commercial 1200V 300A SiC MOSFET modules used Agile Switch Inverter and compares its performance with Si IGBT with the same rating using experimental results and the LTSpice software environment. Our SiC MOSFET model in LTSpice gives accurate results across a wide range of temperatures. The results show that the 1200V SiC MOSFET has faster switching speed and significantly less switching loss compared to the Si IGBT. The main objective of this SiC-based project is to develop the modulation and control scheme using FGPA to investigate the performance at higher switching speeds. Moreover, the Si IGBT switching loss will increase significantly for higher operation temperature, while the SiC MOSFET switching loss has little variation over different temperatures. This project also investigated the stray inductance effect on the gate, drain, and source side and verifies its performance with Si IGBT.

Project 8: **Testing Circuit for Power Electronic Device Characterization: (FREEDM Systems Centre, NC State University, USA)**

A novel energy recirculation circuit utilizes the concept of energy recirculation, with the power augmentation capability, is proposed. Proposed ERSC can be used as a device in-situ testing unit, by utilizing naturally occurring high electrical stresses on devices from a low-cost low-power source to supply energy for high power testing of power electronic devices. This topology allows devices to be examined at full-power stresses without connected with high power load and also without demanding high power, by storing and recirculating the energy of the energy storage elements, which elevates the capability of source power. This converter can operate in four different modes of operation, namely, soft start, magnetize, charge and energy recirculation modes with the four active states of operations attained by two active switches of the proposed converter. Another feature of this converter is, based on the devices under test devices performance these two circuits can be designed to operate in a synchronous or asynchronous manner, i.e. faster devices or slower devices can be tested.

For in-situ testing of high current and/or voltage devices, this circuit offers several advantages such as simple circuit design, does not demand any high voltage step-up transformer for realizing high voltages/currents, can be able to operate from low voltage/ power supply, cheapest solution and also provides fast response in comparison with conventional cascaded boost/buck and cascaded buck/boost ERSCs. To validate the concept, simulations are carried for testing of 1.2KV and 100A using 100V and 8A. And, the same is going to prove with the help of a lab-made prototype.

Project 9: Improved Power Quality Transformerless Power Converters for Solar PV applications (IIT Roorkee)

To further enhance the conversion gain, coupled inductor based capacitor clamped boost inverter has been proposed. This chapter introduces coupled inductor based capacitor clamped 3-phase DC-AC boost inverter with an intrinsic step up abilities by utilizing the small passive components. The main objective of this proposed inverter is to reduce the usage of capacitors (generally preferred to increase the gain), which are a weakest reliable element in the inverter design. By shifting the filter components from ac side to intermediate place, inverter can attain boost capability as well as good power decoupling ability, since shifted capacitor acting as a good power decoupling element. Furthermore, modulating waveforms are altered such a way that voltages across the capacitors are decreased. Reduced voltage stresses on capacitors lead to better reliability and enhanced lifespan of the inverter. This inverter performance under different test conditions is compared with boost converter fed voltage source inverter (BVSI), Z-Source Inverter (ZSI), quasi Z-Source Inverter (q-ZSI), Switched Boost Inverter (SBI), Current-Fed SBI (CF-SBI), quasi SBI (qSBI), Improved ZSI (IZSI), Switched Inductor-ZSI (SL-ZSI), Switched Inductor-qZSI (SL-qZSI), Diode Assisted qZSI (DA-qZSI), Capacitor Assisted qZSI (CA-qZSI), Extended Boost ZSI (EB-ZSI), Extended Boost qZSI (EB-qZSI) and CCBI; MATLAB Simulink results demonstrated that proposed inverter capabilities are superior to above-mentioned topologies. A 1200W experimental prototype has been built to validate the feasibility and benefits of the system. Simulation and experimental results reveal that proposed inverter offers better power quality, reliability and high lifetime.

Project 10: Development of Converter System for Solar PV Power Generation: (IIT Roorkee)

Renewable energy resources will be an increasingly important part of power generation in the new millennium. The main objective of this project is to develop a power conditioning system, which can be used to extract the variable DC power from the sun. It is converted into fixed dc by using DC-DC boost converter and then converted into AC power by using 3- level diode clamped inverter, to feed AC load effectively. In this project simulation results of the FPGA Controlled Photovoltaic

(PV) power conditioning system for AC, loads are presented. The power conditioning system consists of a diode clamped three-level inverter fed by a closed-loop voltage-controlled DC-DC Boost converter. This closed-loop control of the DC-DC converter is implemented by a conventional Pulse Width Modulator (PWM) with a duty cycle ratio control method. This boost converter is designed to obtain regulated voltage from the variable DC supply. A level shifts sinusoidal PWM is used to control the multilevel inverter on FPGA.

Project 11: FPGA Controlled Diode Clamped 3-Level Inverter (IIT Roorkee)

In this project, the hardware of the Diode clamped 3-level inverter is implemented and is controlled by FPGA Controller. This 3-level inverter is mainly developed for medium-level power applications. FPGA has been preferred over a traditional microcontroller because an FPGA can work at frequencies of the order of 50MHz, while the latter can work with frequencies up to 5-6 MHz only, making the FPGA faster and more accurate in the generation of firing pulses.