

**DESIGN AND IMPLEMENTATION OF A MULTI-PORT  
POWER CONVERTER TOPOLOGY FOR DC  
NANO-GRID**

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# DESIGN AND IMPLEMENTATION OF A MULTI-PORT POWER CONVERTER TOPOLOGY FOR DC NANO-GRID

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## Declaration

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## Abstract

This thesis presents a novel multi-port power converter topology for DC nano-grid applications. The proposed topology integrates energy sources, loads and energy storing elements using DC-link and magnetic coupling using a single converter. As a result, it has fewer component counts and conversion stages than the individual converters for each element in the nano-grid, which paves the way for a more efficient system.

The first part of this thesis presents a PV converter topology designed and developed in the laboratory. This circuit topology integrates two PV modules and boosts the input voltage into a 120V DC voltage level. However, switching loss of the converter is significant due to the hard-switching operation. Therefore, switching control strategy of the converter has been modified to minimize switching losses with the assistance of the existing parasitic elements. The operation of the power converter with the proposed switching control strategy is mathematically analyzed and verified using simulation results. The design is further validated using the experimental results obtained using a 250 W hardware prototype.

Moreover, a bi-directional high step-up/down converter is designed and developed to integrate an energy storing element into the system. The bi-directional converter step downs 120 V DC link voltage to an extremely low voltage (10-16 V DC) to charge a Li-ion battery pack. When the solar power is not available, the proposed converter discharges the Li-ion battery to regulate the 120 V DC link. The operation of the battery interfacing converter is validated and verified using both simulation and experimental results.

The conclusions and suggestions for the further development have been presented at the end of this thesis.

***Index terms***— Bi-directional power converters, DC-DC converters, high step-up/down converters, multi-port power converters, renewable sources, soft-switching.

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## List of Abbreviations

Abbreviation	Description
AC	Alternating Current
BMS	Battery Management System
CC	Constant Current
CCM	Continuous Conduction Mode
CV	Constant Voltage
DC	Direct Current
DCM	Discontinuous Conduction Mode
EMI	Electro-Magnetic Interference
HF	High Frequency
IEC	International Electrotechnical Commission
LED	Light Emitting Diode
LC circuit	Inductor Capacitor circuit
MIMO	Multiple Input Multiple Output
MISO	Multiple Input Single Output
MPPT	Maximum Power Point Tracking
PCB	Printed Circuit Board
PV	Photovoltaic
PWM	Pulse Width Modulation
RCD	Resistor Capacitor Diode
RMS	Root mean Square
SIMO	Single Input Multiple Output
SISO	Single Input Single Output
SoC	State of Charge
SRC	Series Resonant Converter
SWT	Small Wind Turbine
ZCS	Zero Current Switching
ZVS	Zero Voltage Switching