COMPARATIVE PERFORMANCE EVALUATION OF MULTIPORT DC/AC INVERTERS FOR DISTRIBUTED GENERATION APPLICATIONS

IOANNIS RODITIS

EFTICHIOS KOUTROULIS

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING TECHNICAL UNIVERSITY OF CRETE CHANIA, GREECE

INTERNATIONAL CONFERENCE ON MODERN CIRCUITS AND SYSTEMS TECHNOLOGIES (MOCAST)

INTRODUCTION

- Renewable energy sources ,in combination with power systems having the capability of storing electric energy, are increasingly used in distributed generation applications.

- The photovoltaic generators and battery banks are the most frequently used types of energy production and storage unit respectively.

- Multiport DC/AC inverters are required for the integration of renewable energy sources and energy storage systems with the electric grid and local loads.

PROBLEM STATEMENT

- The performance of the existing three-port DC/AC converters (TPC) in terms of the leakage ground current and battery ripple current has not yet been investigated.

- In this paper a comparative performance evaluation of various non-isolated three-port DC/AC converters' topologies with PV and battery bank as energy sources in distributed generation applications is presented.

PERFORMANCE EVALUATION FACTORS

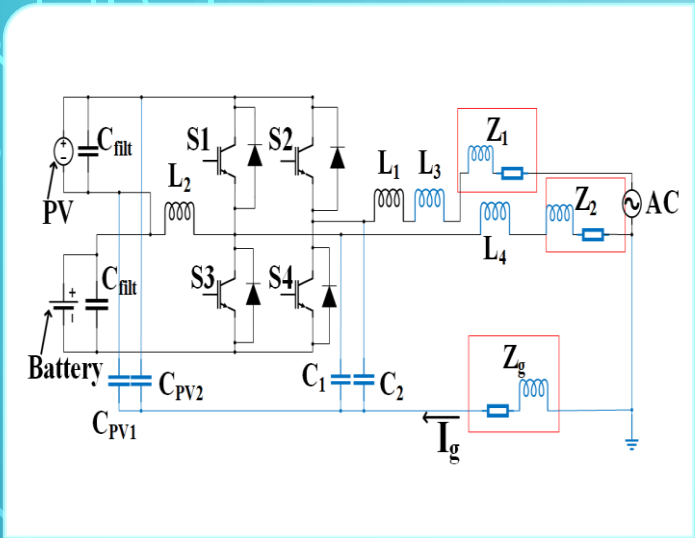
- A leakage ground current can reduce the efficiency of power conversion and deteriorate the quality of the current injected into the electric grid.

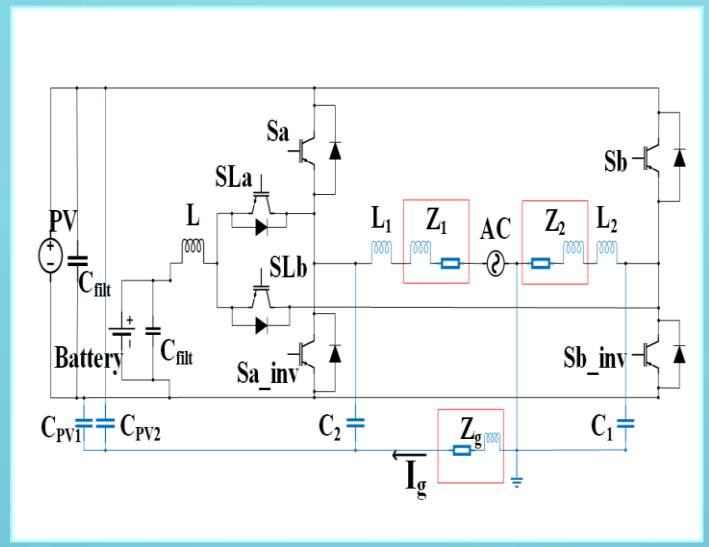
- A ripple is developed in the DC current of the battery bank during charging and discharging, which affects the lifetime of the battery bank.

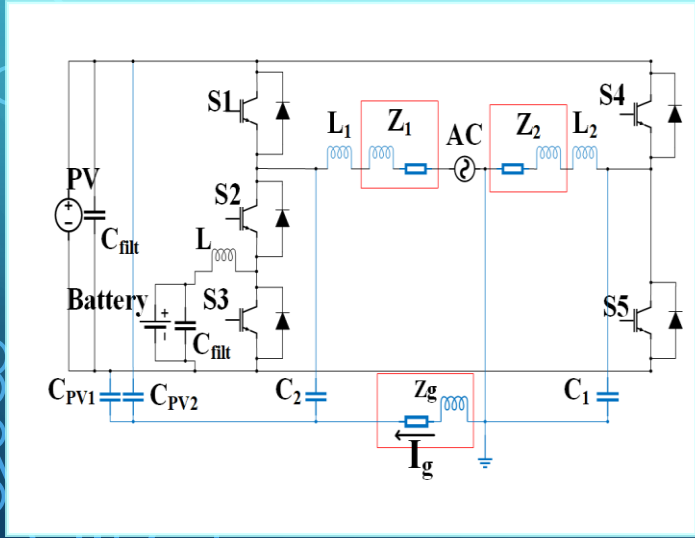
SIMULATION

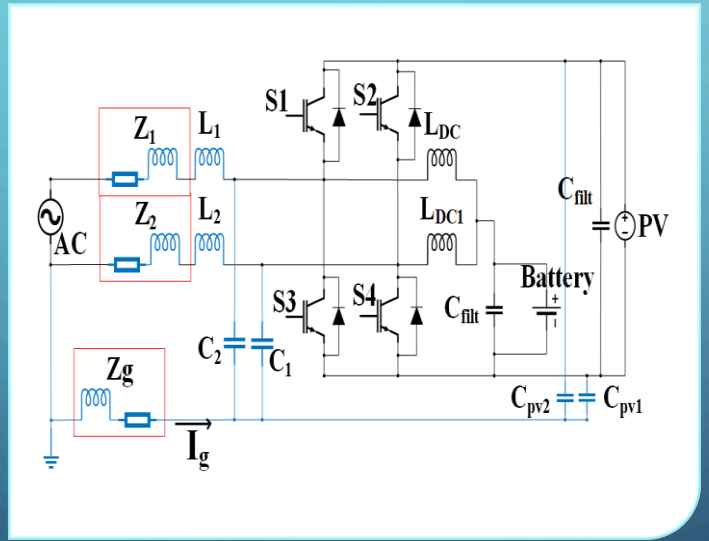
- The same battery bank and PV source models were used for all TPC topologies.
- The battery bank is being charged by the PV source.
- The switching frequency has been set equal to 20 kHz.
- Operation at 2kW.
- Matlab/Simulink.

SIMULATED CIRCUITS

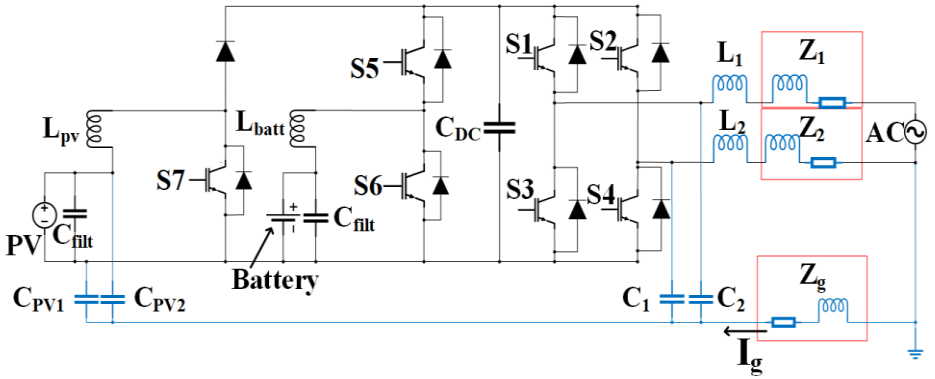


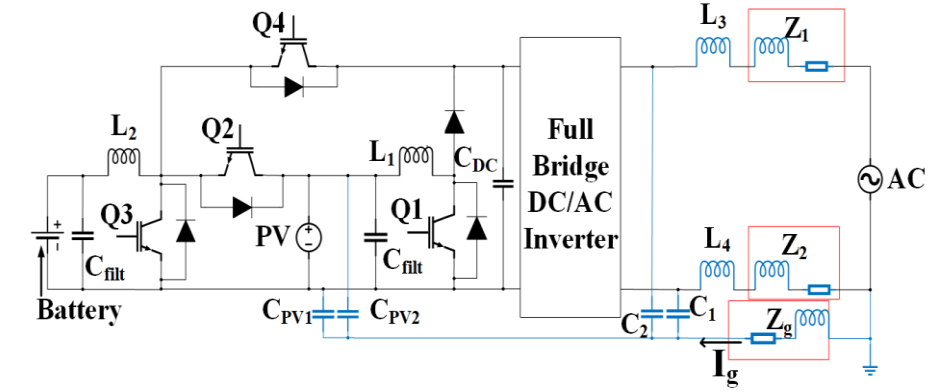


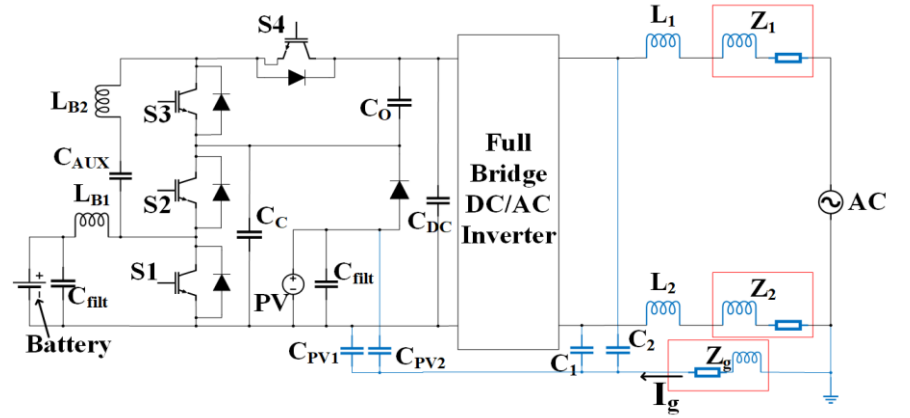




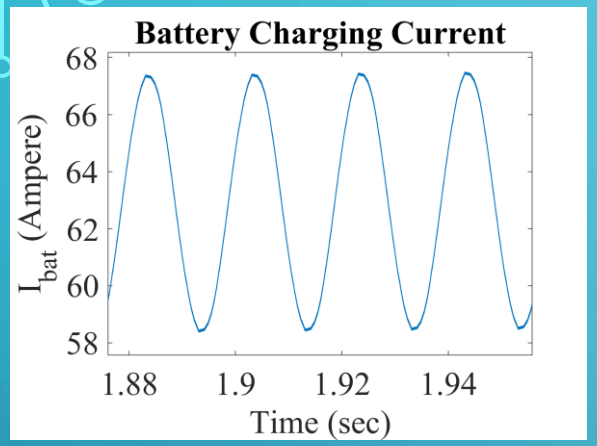
SIMULATED CIRCUITS (II)

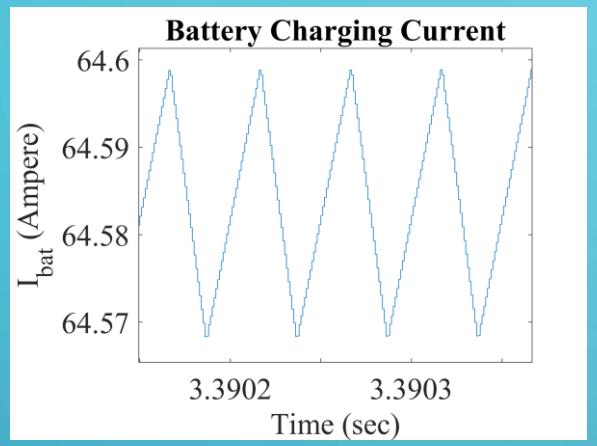


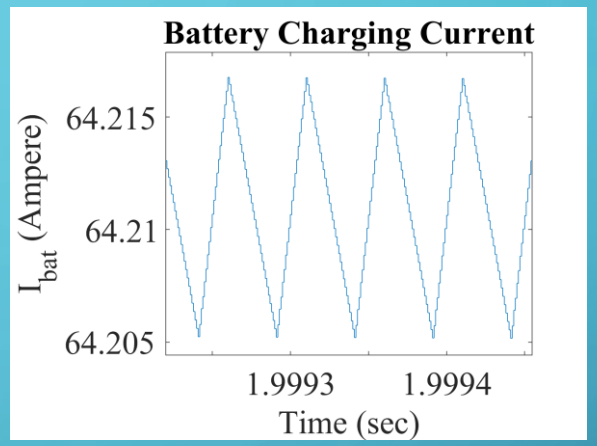


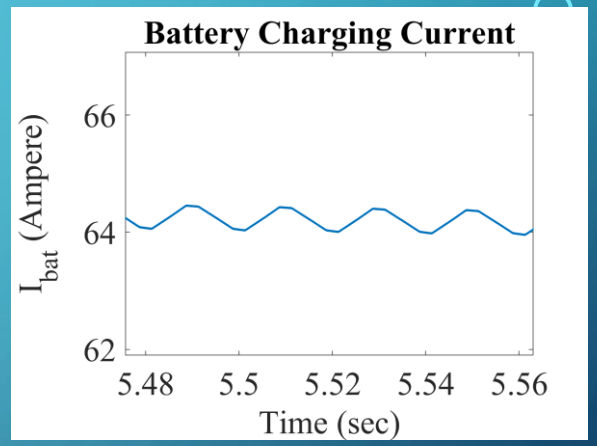


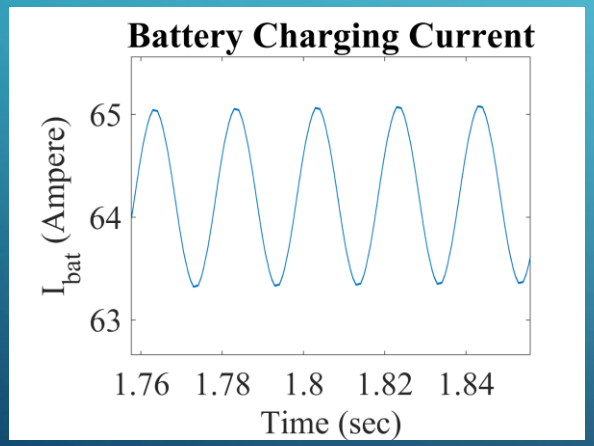
SIMULATION RESULTS – BATTERY CHARGING CURRENT

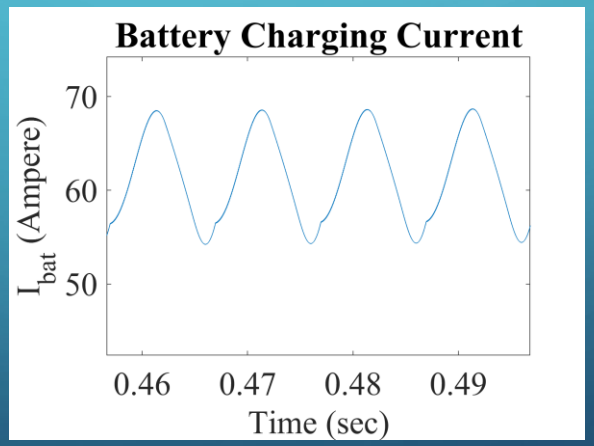


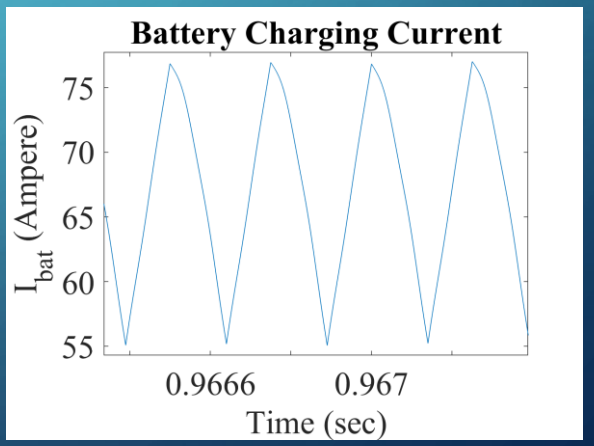




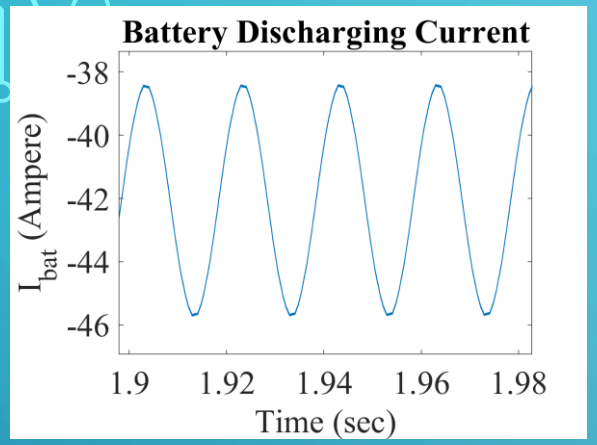


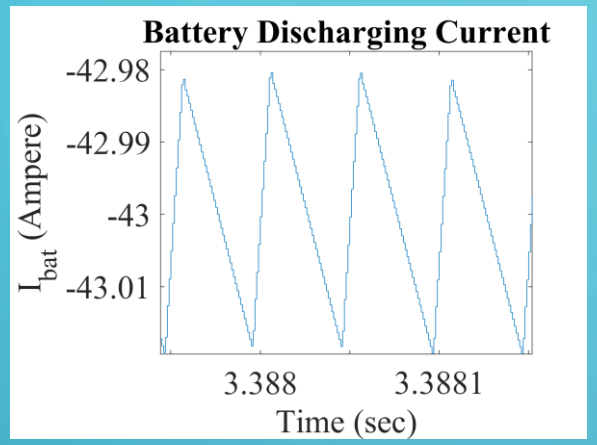


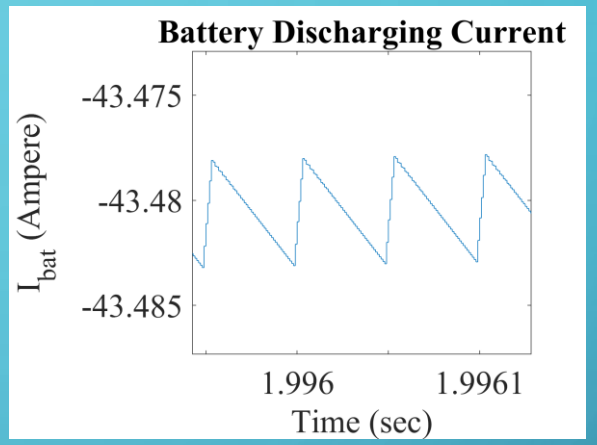


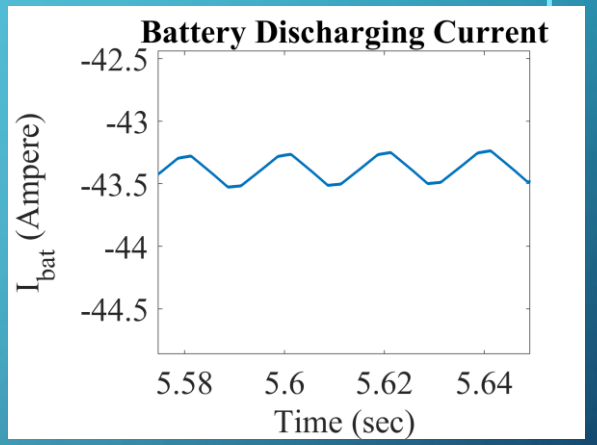


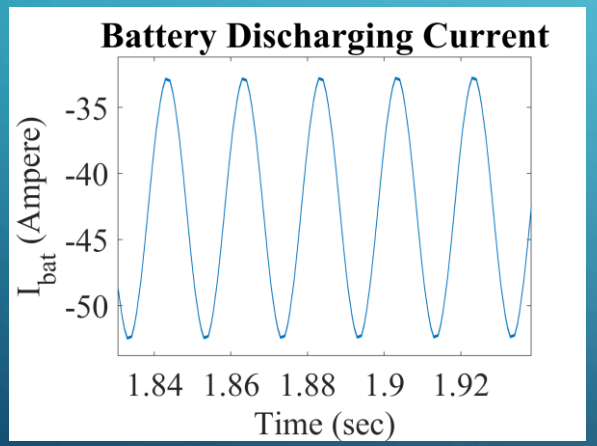
SIMULATION RESULTS – BATTERY DISCHARGING CURRENT

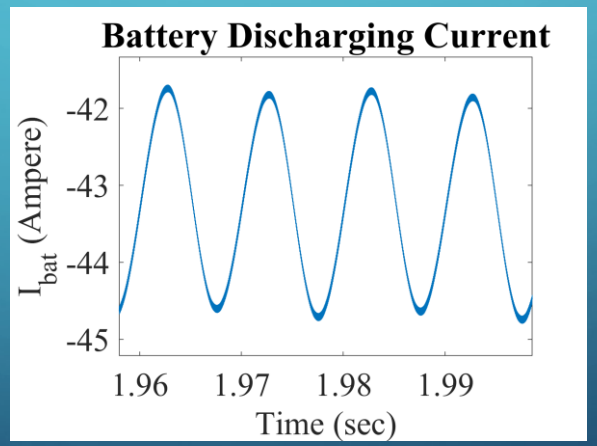


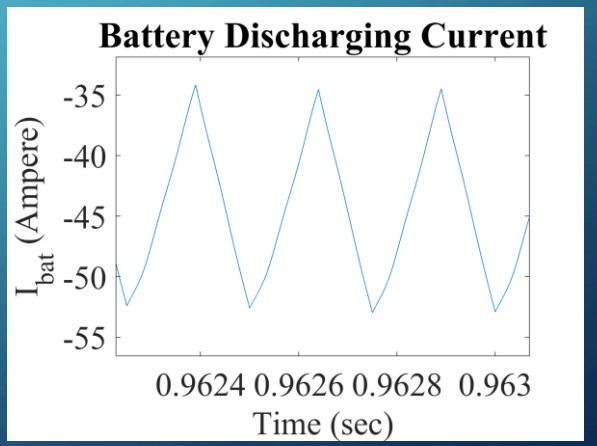




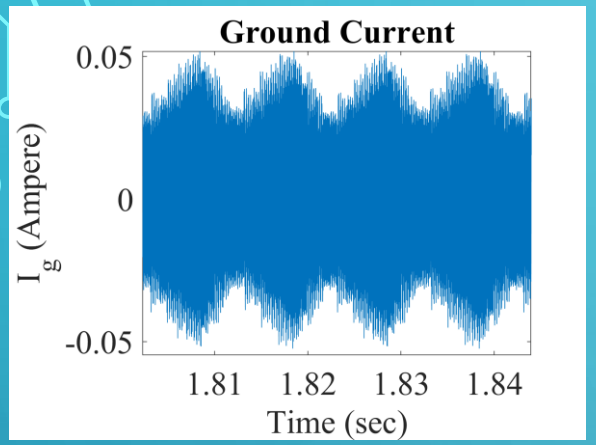


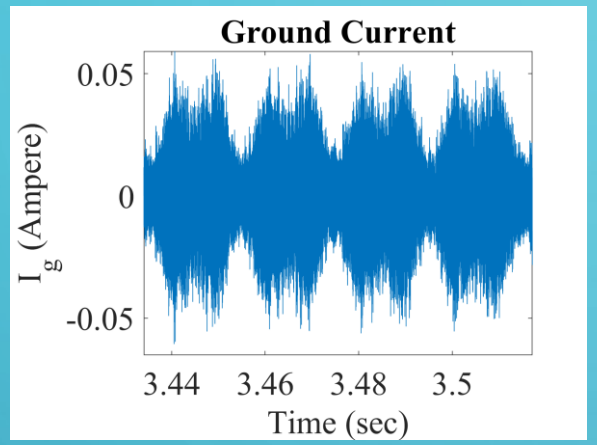


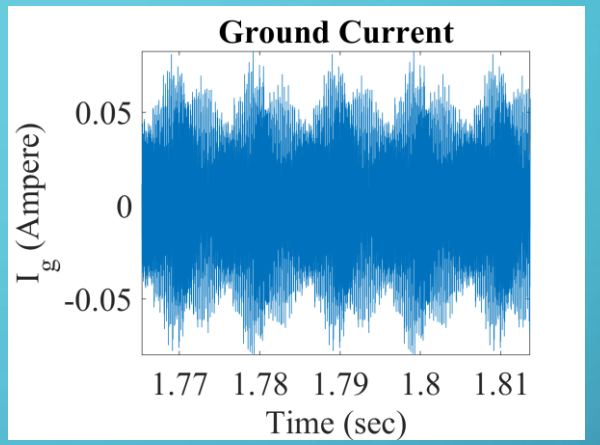


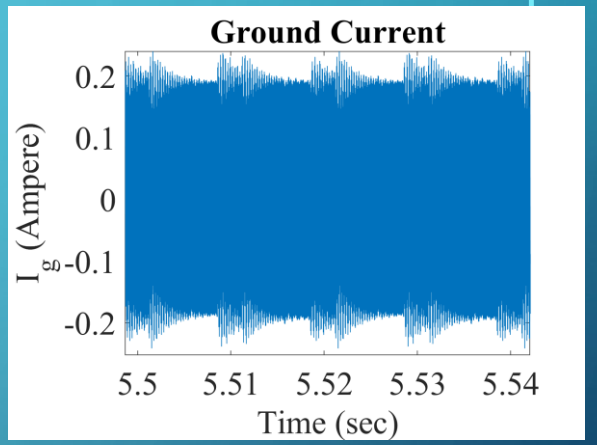


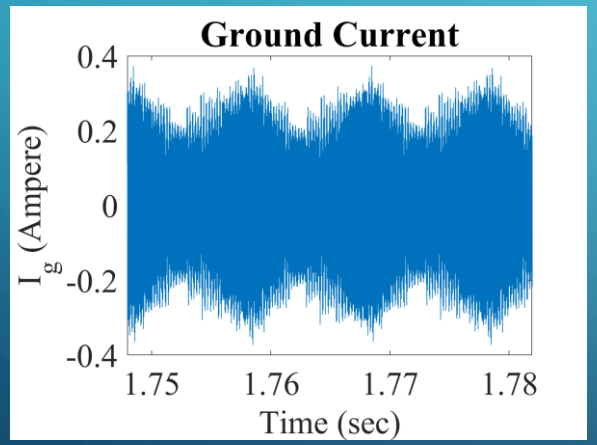
SIMULATIONS RESULTS- GROUND LEAKAGE CURRENT

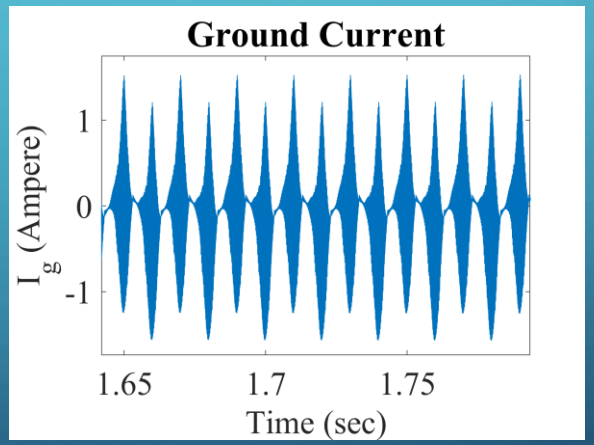


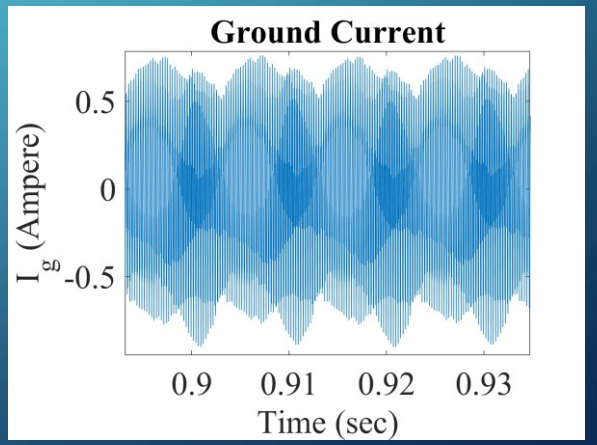












SIMULATION RESULTS-PERFORMANCE METRIC

Topology	Performance metric			
	Battery charging current ripple (p-p, in A)	Battery discharging current ripple (p-p, in A)	Fundamental frequency of battery ripple current (Hz)	Leakage ground current (RMS, in mA)
Ref. [6]	9.1	7.35	50	20.14
Ref. [7]	0.031	0.044	20000	25
Ref. [8]	0.02	0.007	20000	30
Ref. [9]	0.4	0.27	50	120
Ref. [10]	1.9	19.5	50	231.2
Ref. [11]	14	3.2	100	420
Ref. [12]	22	17	5000	394

CONCLUSIONS

- A comparative study of various alternative non-isolated DC/AC TPC topologies has been performed, in terms of the ripple current during (dis)charging of the battery bank and the leakage ground current.

- The simulation results demonstrated that the ripple current during charging and discharging of the battery bank, as well as its frequency, vary significantly among the DC/AC TPC topologies studied.

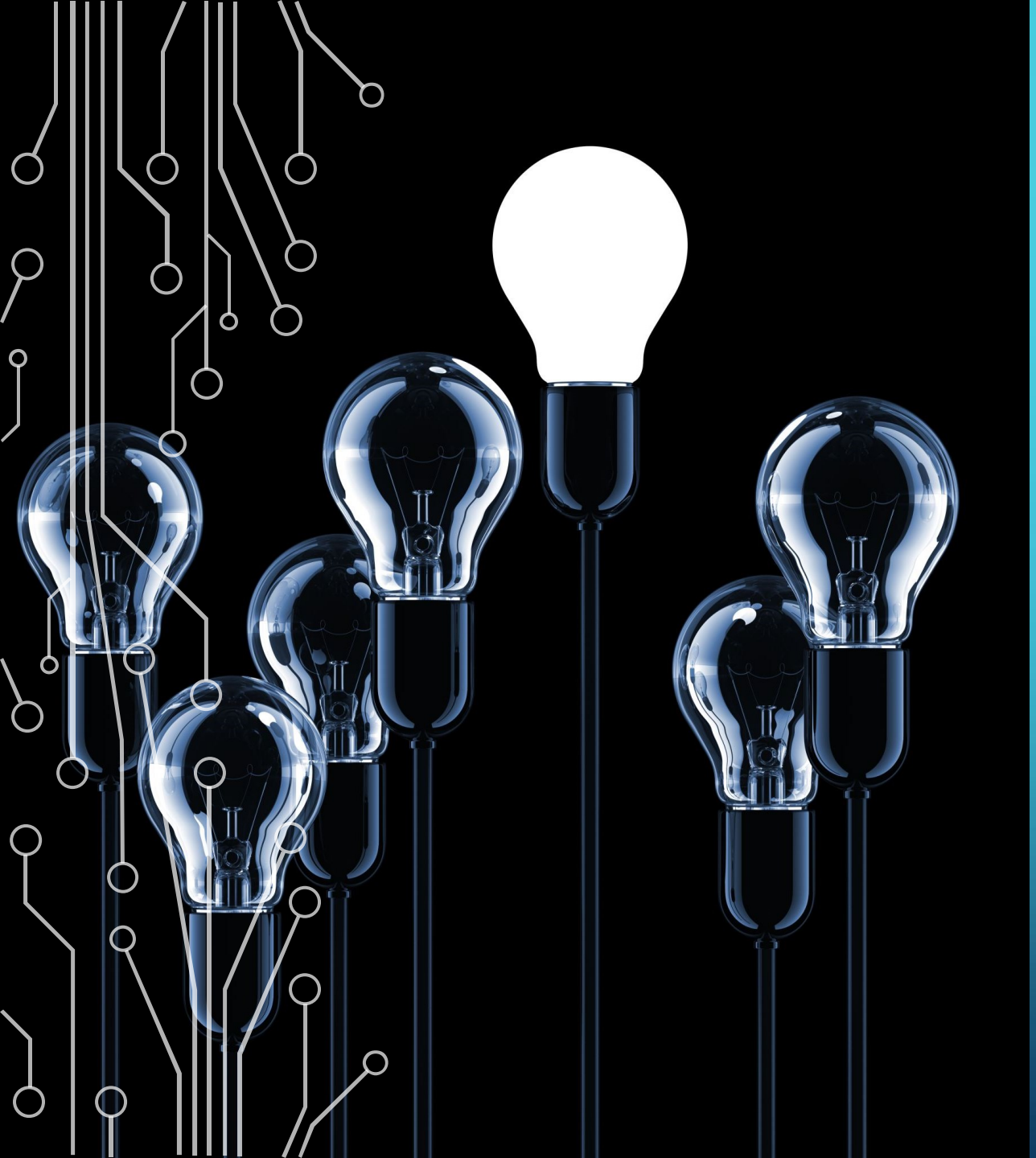
- The leakage ground current developed in two of the DC/AC TPC topologies under study does not fulfill the limitation set by the VDE 0126-1-1 standard.

FUTURE WORK

- The TPC topology can be selected by the designer for implementation considering these results and the specifications of the target application.
- This work contributes towards the future implementation of multiport DC/AC inverters, where the battery bank ripple current and the leakage ground current are minimized.

ACKNOWLEDGEMENT

This research has been co-financed by the European Regional Development Fund of the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH - CREATE - INNOVATE (project code: T2EDK-01775).



THANK YOU FOR YOUR ATTENTION!!