Design and Development of Smart-Multi-Port Fault-Tolerant High Efficiency Converter System

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Intermittent nature of renewable sources: PV, Wind, etc.

Significant developments in battery technology

Power density and efficiency: Need of the hour

A typical high-frequency interface provides high efficiency, high power density and enhanced control for the integration of source and load

In case of more than one source, a multi-port system offers all-in-one type solution

**Project Motivations**

In the process of switching to renewable sources, multi-port configuration offers an effective way to achieve enhanced performance with required sustainability.
Multi-port systems:

- Compact and highly efficient systems
- Offers higher controllability, improved integration and increased reliability of supply
- These can be categorized based on the type of main bus as:
  - DC coupled configurations
  - AC coupled configurations

Project Motivations
Objectives:

- Design and development of a smart-multi-port high frequency interface
- Design and implementations of high frequency converters
- Design of multi-port transformer to integrate:
  - PV inverter
  - Battery interfacing bidirectional converter
  - Grid interfacing converter
  - Additional dc-ports for local loads
- Performance evaluation of multi-port configuration with existing as well as newly developed converter prototypes
- Implementation of complete system with respective source and load characteristics
- On-site implementation of the developed multi-port system
Multi-port High Performance Systems

- Multi-port systems are the emerging solutions for various applications such as solid state transformer, electrical vehicles, grid integration systems, micro-grid solutions, Aviation systems, etc.

Enabling technology

Multi-port configuration leads to more compact and highly efficient system.
Preliminary work at IITB

Multi-level high frequency DAB converter prototype

Transformer

Leg-1

Leg-2

Leg-3

Primary

Secondary

Designed for 10 kHz, 2.5 kW

ML-DAB converter test results with five-levels for reduced dv/dt

Indigenously developed highly efficient SiC-based converter prototypes

E-HANPC converter

Other DAB setups

TWT-ADAB

MT-ADB

S-HANPC converter

SiC MOSFETs

Si IGBTs

Isolated gate drivers

Film capacitors

clamp space for current measurements

S1

S5

S2

S3

S6

S4

clamp space for current measurements

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E-HANPC converter

Designed for 10 kHz, 2.5 kW
Learning outcomes and achievements

- **Learning outcomes:**
  - Control aspects for various converter configurations
  - System design and integration
  - Converter topology and analysis
  - Reliability issues
  - Performance evaluation methods
  - Hardware implementations

- **Expected achievements:**
  - Development of new converter topologies
  - Proposal of novel control schemes
  - System understanding
  - Industry collaboration
  - Design methodologies and system understanding
  - Publications and patents
Thank you