Session Name: Electric Mobility

Title of paper

Design And Development of Grid-Tied Off-Board Intelligent Charging Station

Speaker

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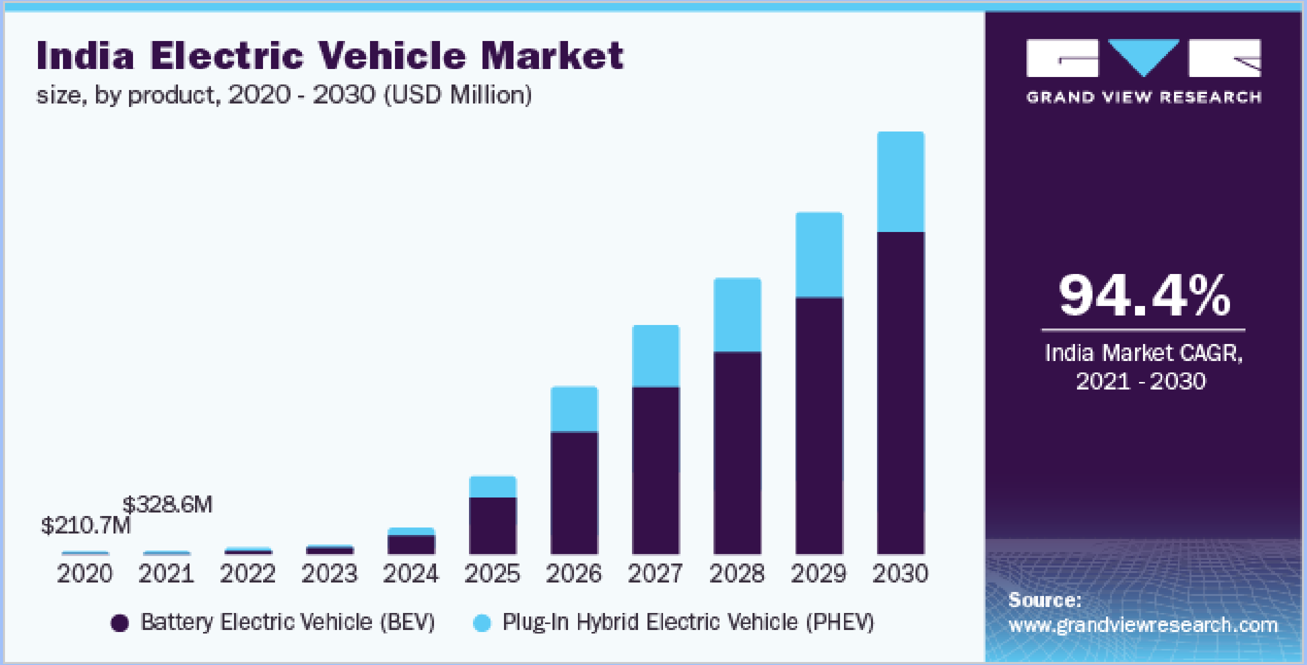
Introduction



- Growth of electric vehicle (EV) industry and future of transportation
- Role of advancements in battery technologies and charging infrastructure

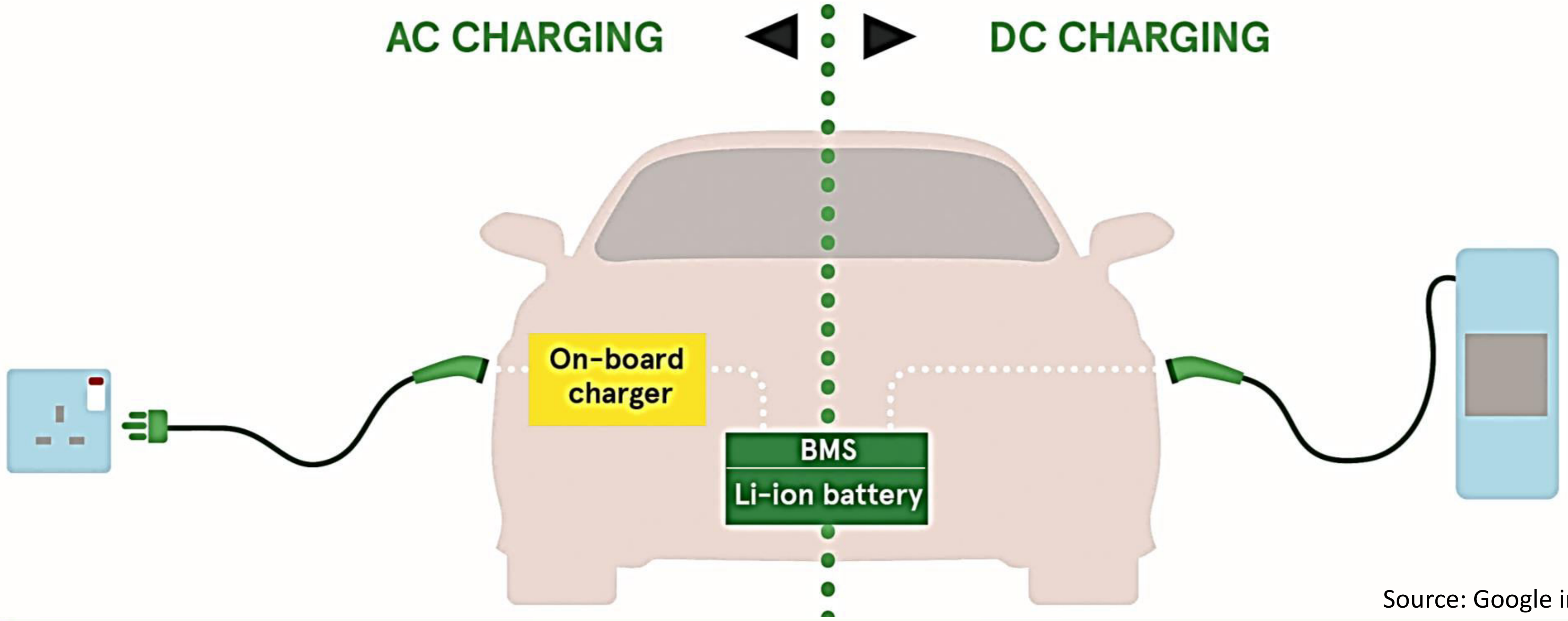
Needs

- Innovation and investment for charging technology
- Large-scale charging infrastructures

Introduction

AC charging versus DC charging

On-board versus off-board equipment



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Introduction

EV Cars	Battery Specification	Charging Methods
Tata Nexon EV	30.2 kWh, 320 volts lithium-ion battery	15A socket slow charging, fast charging also available
MG ZS EV	44.5 kWh, 364 V lithium-ion battery	DC fast charging (up to 80% in 40 minutes)
Hyundai Kona Electric	64 kWh, 356 V lithium-ion Polymer battery	DC fast charging (up to 80% in 47 minutes)
Mahindra eKUV100	15.9 kWh, 400 V lithium-ion battery	AC charging (6 hours for full charge) and DC fast charging (up to 80% in 55 minutes)
Tata Tigor EV	26 kWh, 355 V, lithium-ion battery	AC charging (8.5 hours for full charge) and DC fast charging (up to 80% in 60 minutes)
Mahindra eVerito	21.2 kWh, 318 V, lithium-ion battery	AC charging (11 hours for full charge) and DC fast charging (up to 80% in 90 minutes)
Audi e-tron	95 kWh, 396 V, lithium-ion battery	DC fast charging (up to 80% in 30 minutes with 150 kW charger)
Jaguar I-PACE	90 kWh, 394 V, lithium-ion battery	DC fast charging (up to 80% in 40 minutes with 100 kW charger)

Introduction

Technical and Economical Impacts

	On-board Charger	Off-board Charger
Energy (kW) transfer	Less	High
Problem of battery heating	Required less concern	Required high concern
Weight of EV	More	Less
Charging time	Slow	Fast
Charging power level	Low	High
Complexity in BMS design and cost	Simple and less	Complex and high
Charging flexibility	Flexible	Not flexible
Incorrect charging responsibility	No	Yes
Identification of malfunctioning of battery pack cells	Possible	Very complex

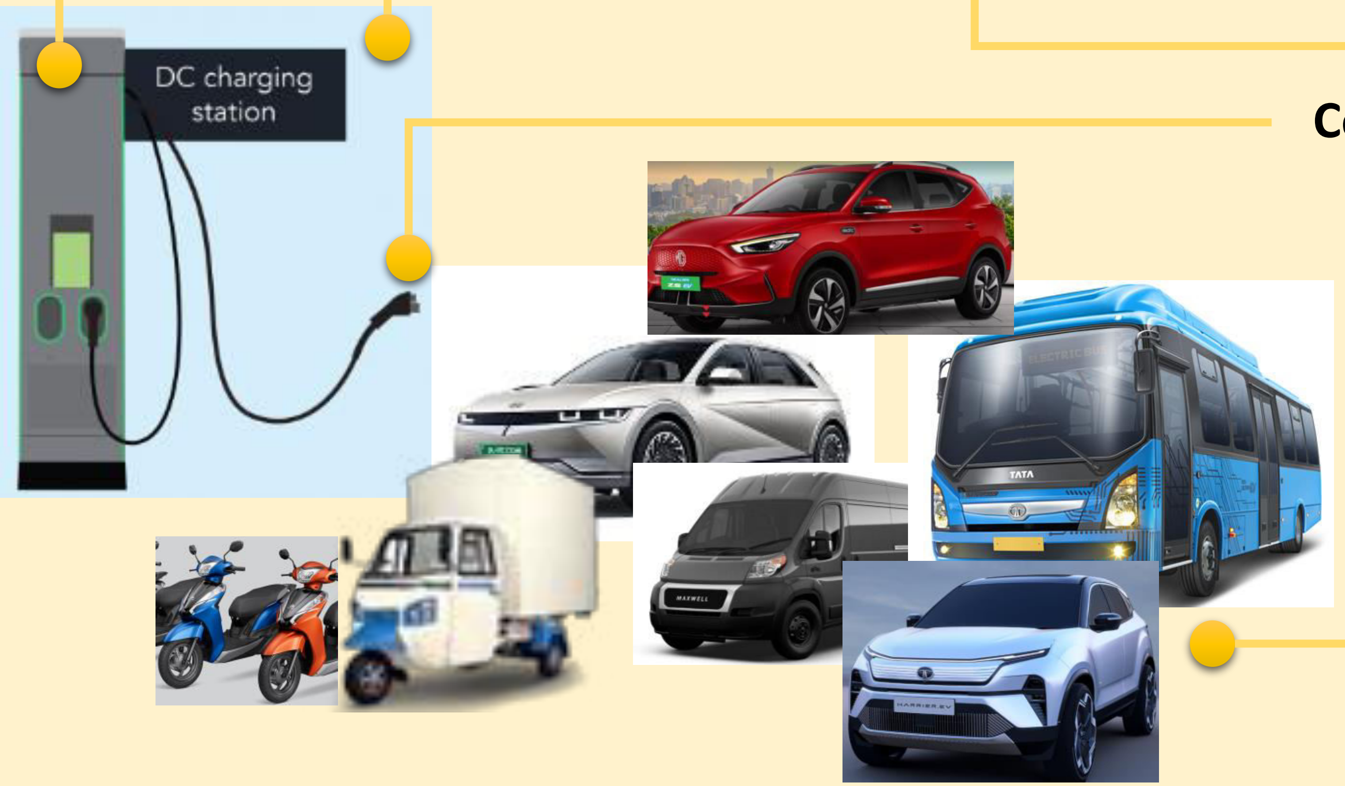
Context

Common Charging Stations

Adaptive Chargers

Common Charging Terminals

All Types of Vehicles



Relevance

- Need of universal adaptive chargers with common charging terminals
- Encouragement for establishment for charging stations as filling stations, especially in rural and remote part of country
- Motivation for e-mobility mission
- Maintenance of power quality issues at on place in power distribution networks

(such as peak load demand increases, violations of regulatory voltage limit, overloaded distribution system assets, harmonic issues, and higher power losses)

- Easy exchange of information about the battery's health in terms of state of charge, voltage, temperature, cut-off voltage, rate of charging/charging time etc
- Higher charging speeds and use by all kind of electric vehicles

Presentation on the Topic

Key features of proposed work

- Design of intelligent **off-board universal charging system** with **adaptive charging method** for various battery packs
- Design of **communication strategy** for charging terminals and battery packs
- The proposed adaptive charging method can **detect the various information from battery packs** such as type of battery, voltage, capacity, SOH and SOC level and **calculate the required charging current and voltage levels**
- The **mathematical modelling and simulation** of all required components (AC-DC, and DC-DC converters, adaptive voltage and current methods have been carried out
- An intentional delay of **1 to 5 seconds** is incorporated with **charging terminals** to fetched information from the battery packs and then supply the power

Use Case/Case Study

The present work having three major parts

(i) Design of a universal charger converters using MATLAB/SIMULINK,

(ii) Design and development of control unit and communication protocols

(iii) Testing and validation of proposed system

The appropriate charging of following batteries are demonstrated as test cases.

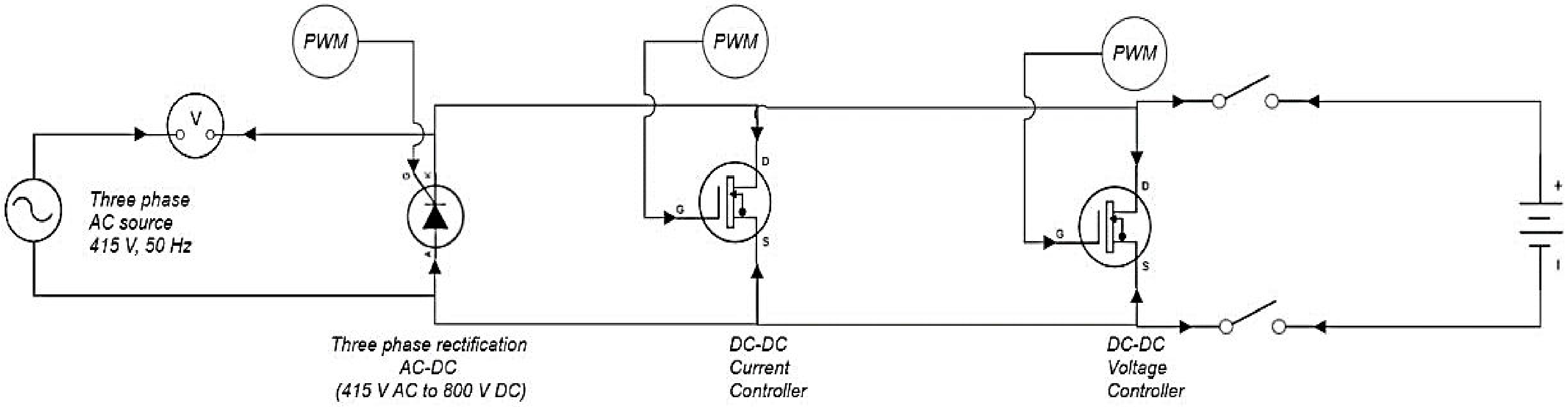
Case 1: Battery Type – 1 (Lead-acid battery)

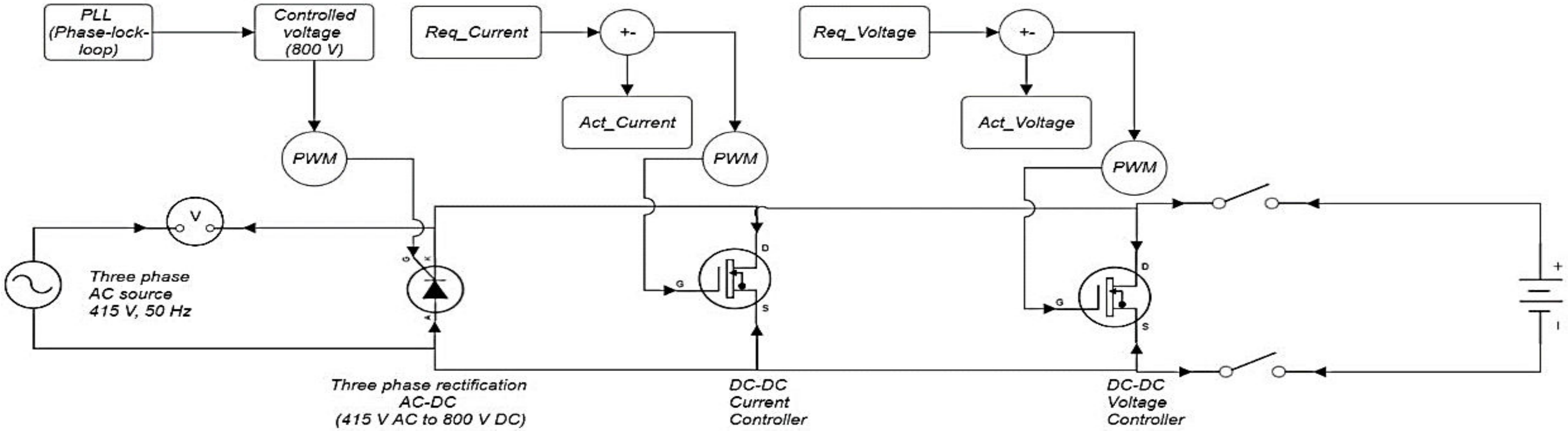
Case 2: Battery Type – 2 (Li-ion Battery)

Case 3: Battery Type – 3 (Nickel Cadmium)

Use Case/Case Study

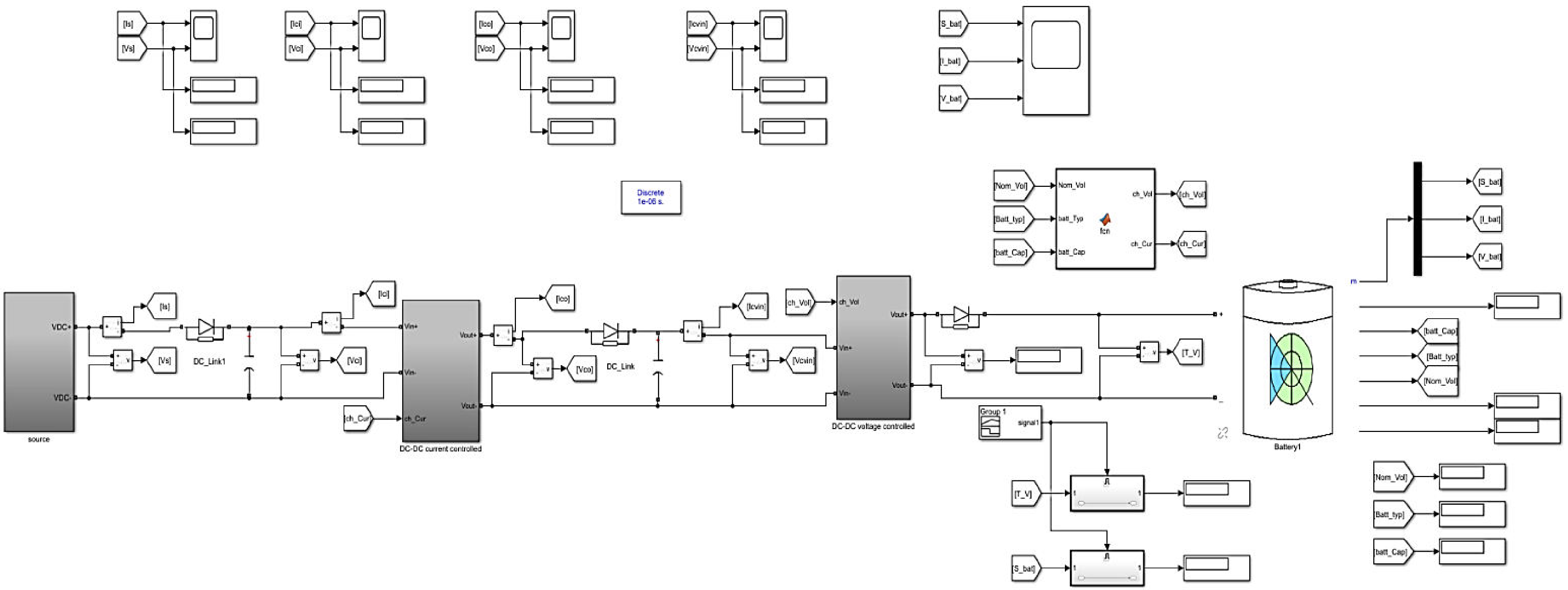
Grid-tied off-board intelligent charging station





Charging station control diagram

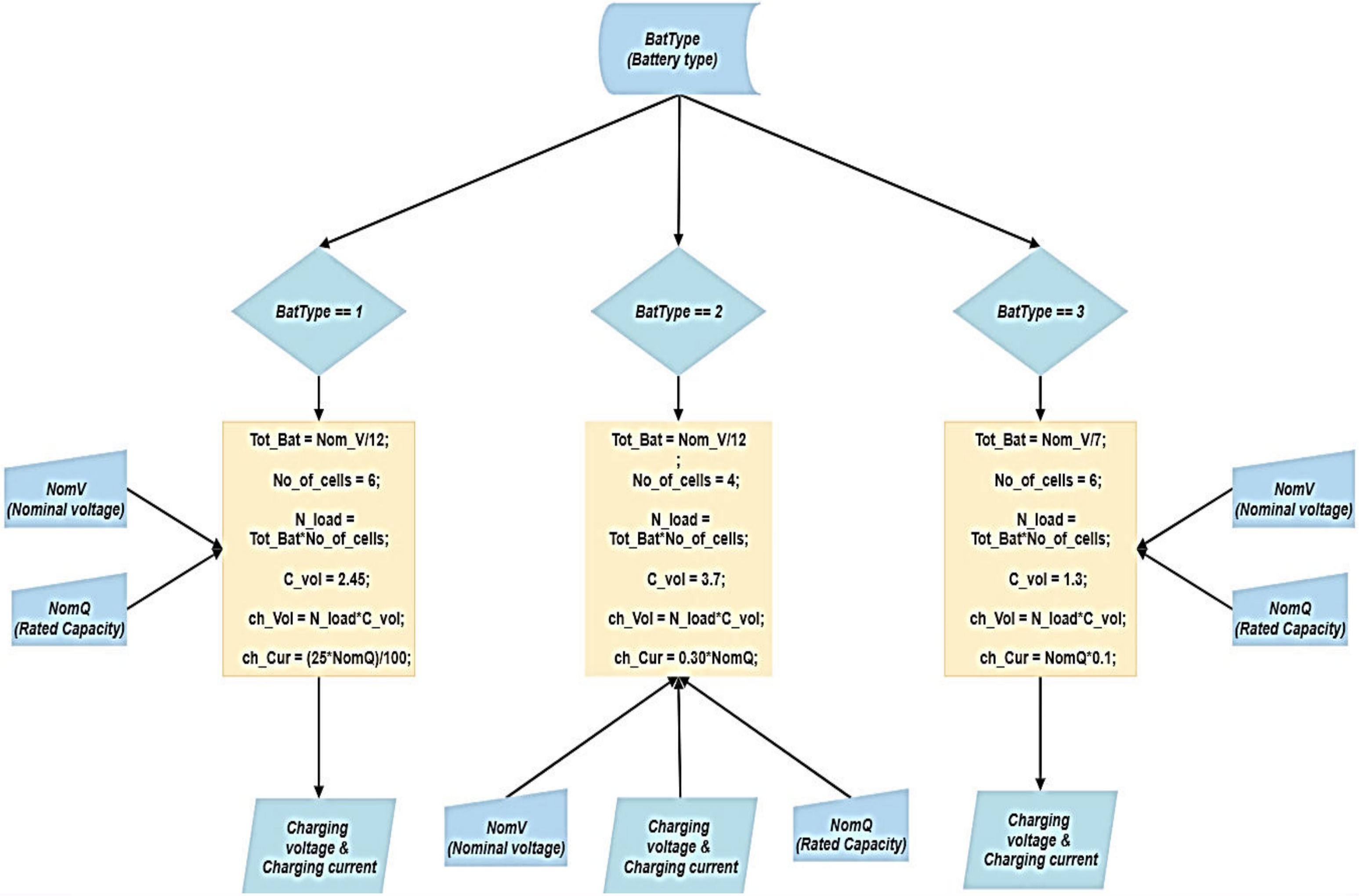
Presentation on the Topic



MATLAB/SIMULINK Model of Proposed Charging Station

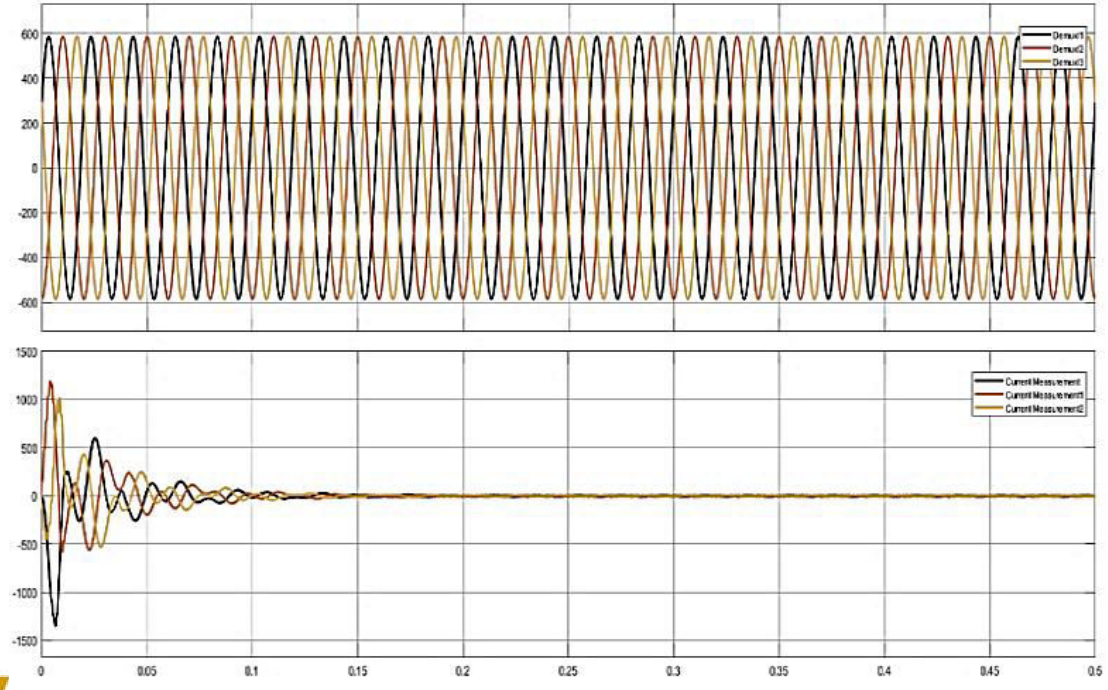
Use Case/Case Study

Algorithm for identification of Charger Control parameters

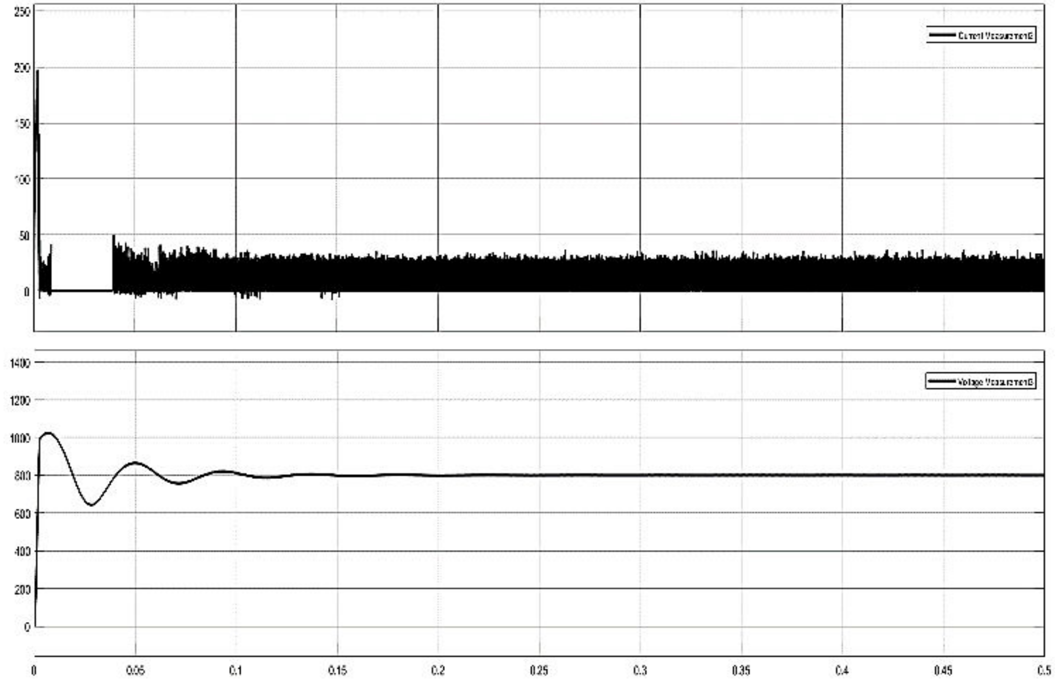


Use Case/Case Study

Test results and observations



Grid profile of the test model

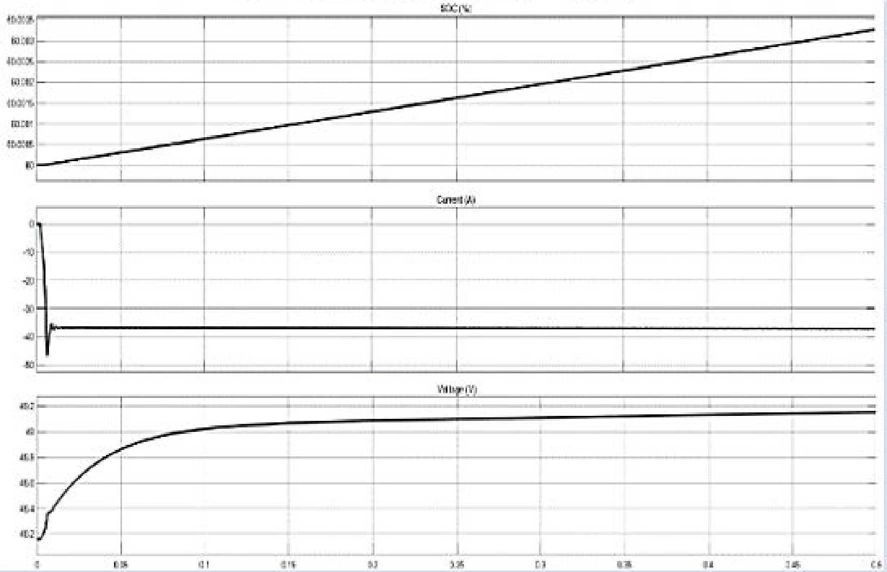
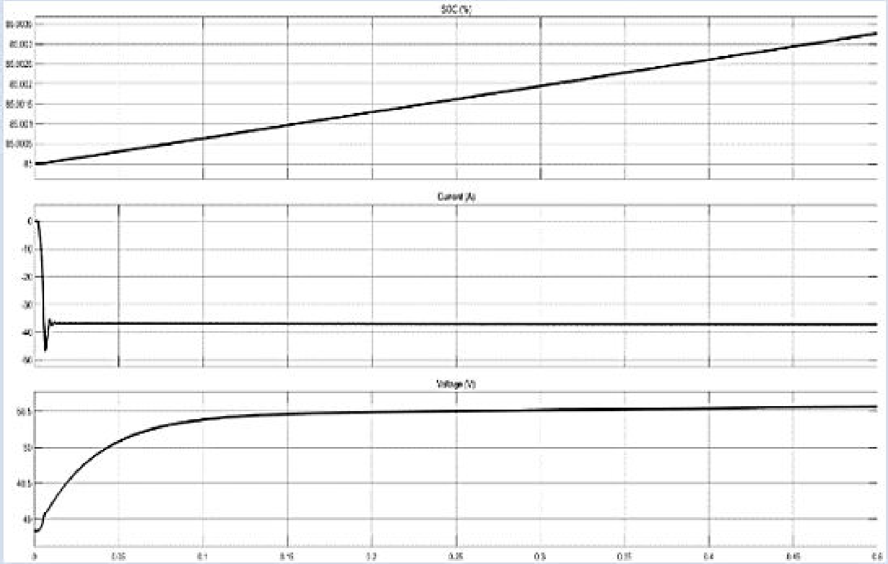


AC/DC converter output voltage and current profile at charging

Use Case/Case Study

Test results and observations

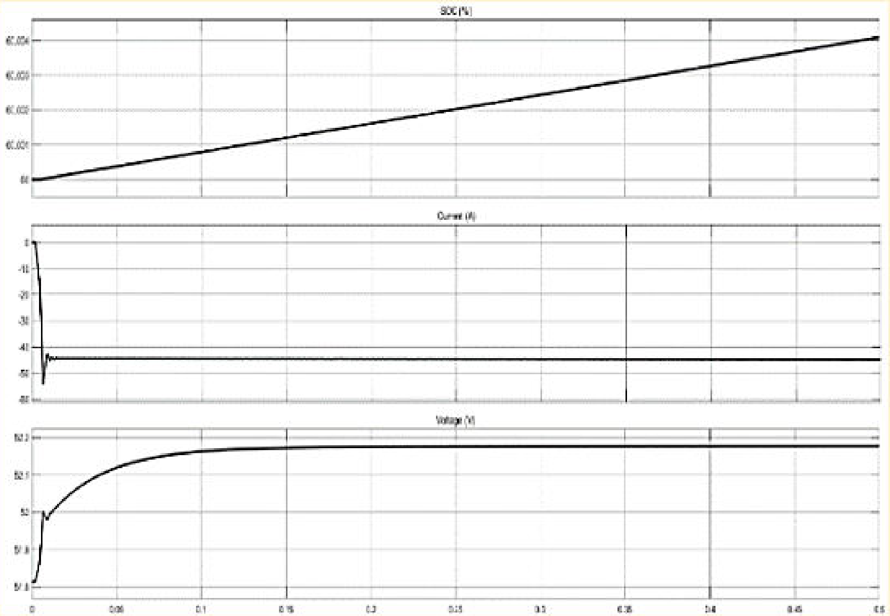
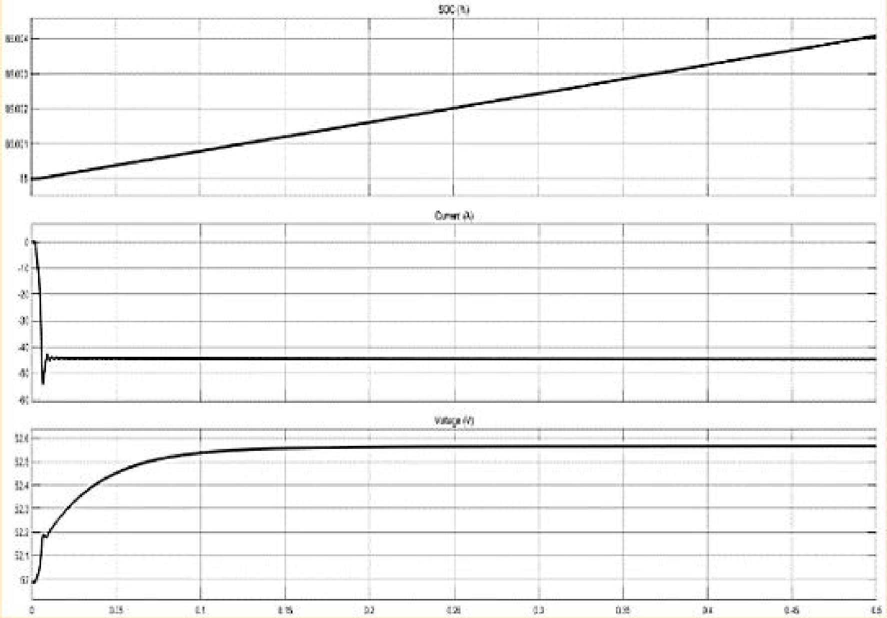
Comparison of Charging Performance (Case 1)

Battery Type	SOC Level 60% (1st case)	SOC Level 80% (2nd case)
Lead-acid battery		

Use Case/Case Study

Test results and observations

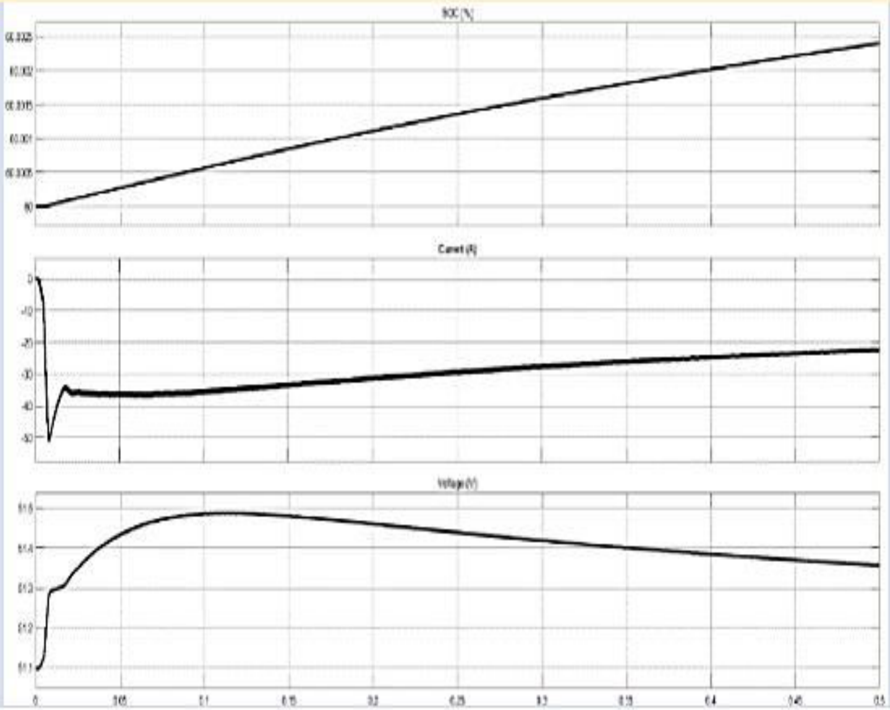
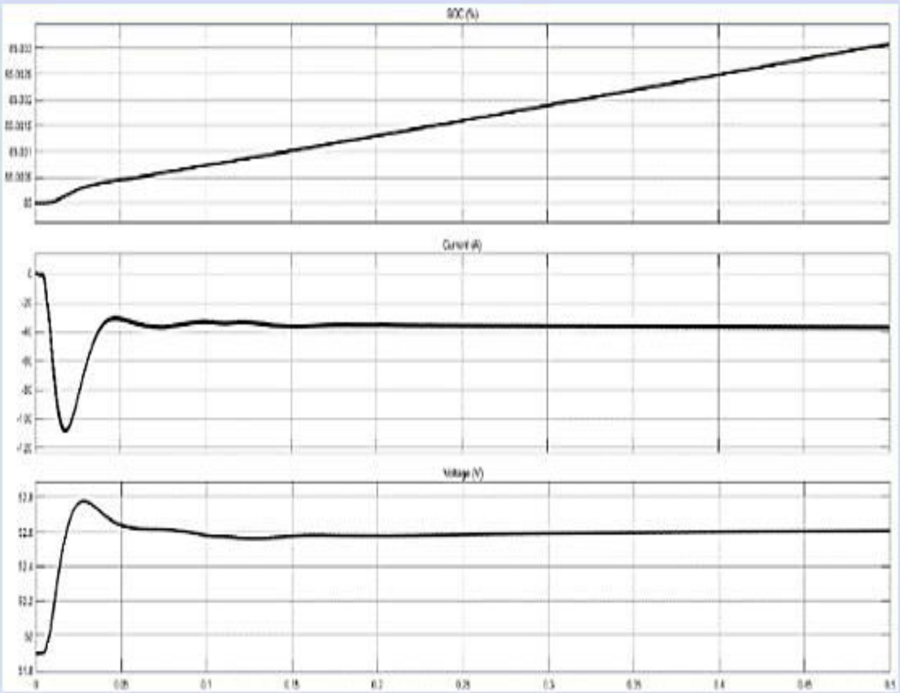
Comparison of Charging Performance (Case 2)

Battery Type	SOC Level 60% (1st case)	SOC Level 80% (2nd case)
Lithium-ion battery		

Use Case/Case Study

Test results and observations

Comparison of Charging Performance Case 3

Battery Type	SOC Level 60% (1st case)	SOC Level 80% (2nd case)
Nickel-Cadmium Battery (Ni-Cd)		

Key Takeaways/ Recommendations

The summary of the work –

- ✓Need of universal off-board chargers
- ✓Common charging terminals
- ✓Adaptive charging methodology
- ✓Tests are conducted on the following batteries:
  - Lead-acid battery
  - Li-ion battery
  - Ni-Cd battery

The proposed adaptive chargers provide optimal charging options, while the charging algorithms ensure efficient and effective charging method for maintaining battery health by avoiding overcharging and overheating.

Thank You

For discussions/suggestions/queries email:

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