EDRIFT ELECTRIC PRIVATE LIMITED

Development of a 3.3 kW, 48V Single-Phase On-Board Charger for Electric Motorcycles .

1. Context and Background

India is the largest two-wheeler market globally, and electrification of this segment is central to national decarbonization goals. Under initiatives such as the FAME India Scheme, electric two-wheelers (E2Ws) are witnessing rapid adoption, particularly in urban and semi-urban regions. A significant percentage of electric motorcycles operate on 48V battery architectures due to cost advantages, safety considerations, and ease of maintenance.

Despite vehicle growth, charging technology for 48V platforms remains underdeveloped. Most existing systems use low-power (1–1.5 kW) off-board chargers, leading to extended charging times (4–8 hours). Higher power 3.3 kW OBC technologies are well established for high-voltage passenger EVs but are not optimized for low-voltage, high-current 48V motorcycle applications. Additionally, many charger modules are imported and not designed for Indian grid conditions, where voltage fluctuation (180–270V AC) and high ambient temperatures are common.

This project proposes the development of a **3.3 kW, single-phase, 48V On-Board Charger (OBC)** tailored for electric motorcycles and optimized for Indian operating conditions, starting from **Technology Readiness Level (TRL) 3**.

2. Current TRL Status

At present, the project is at **TRL-3: Analytical and Experimental Proof of Concept**, characterized by:

- Completion of initial topology selection studies.
- POC of Active PFC + Isolated DC-DC converter at workbench is completed.
- Analytical validation of high-current 48V output feasibility.

Experimental validation under real grid conditions has not been conducted. Proto production, protections circuits, Pre-compliance Testing, reliability testing and certification, is to be completed.

3. Problem Statement

There is currently no widely available, indigenously designed, compact 3.3 kW on-board charger optimized for 48V electric motorcycles operating under Indian grid and environmental conditions.

Key technical gaps include:

- Efficient management of high output current at 48V (≈70A range)
- Maintaining ≥93% efficiency in low-voltage, high-current conversion
- Thermal management within compact motorcycle chassis constraints
- High power factor (≥0.98) under wide input voltage variation.
- EMI/EMC compliance in a cost-sensitive product category.
- Smart BMS integration for safe fast charging.

Addressing these gaps requires targeted research beyond simulation-level validation.

4. Research Gap and Innovation Potential

While 3.3 kW OBCs exist for high-voltage EVs (200–400V systems), the design challenges for 48V systems are fundamentally different due to:-

Significantly higher output current requirements, Increased conduction losses, Thermal density constraints, Magnetics optimization challenges, Packaging limitations in motorcycles.

Therefore, innovation opportunities include: Advanced high-frequency magnetic design to reduce copper losses, Optimized digital control for adaptive PFC under grid fluctuation, Novel thermal architecture for compact enclosures, Modular, scalable charger design for multiple 48V platforms, Localization strategies. The project has strong potential to create a differentiated, India-specific charger platform.

5. Scope of Work and TRL Advancement Plan

The project aims to progress from **TRL-3 to TRL-6/7** through structured research, validation, and field testing.

Phase 1: Detailed Design & Engineering (TRL-3 → TRL-4)

- Finalize topology (PFC + LLC / PSFB)
- Detailed magnetics design
- Thermal simulation refinement
- PCB layout design
- Digital control algorithm development

Outcome: Lab-scale subsystem validation.

Phase 2: Prototype Fabrication & Lab Validation (TRL-4 → TRL-5)

- Fabrication of integrated 3.3 kW OBC prototype
- Controlled laboratory testing
- Efficiency and PF validation
- Thermal performance testing
- Grid fluctuation endurance testing

Outcome: Integrated system validated in relevant laboratory environment.

Phase 3: Environmental & Compliance Testing (TRL-5 → TRL-6)

- EMI/EMC compliance testing
- Vibration and thermal cycling
- Protection system validation
- BMS communication integration

Outcome: Prototype demonstrated in relevant operational environment.

Phase 4: Field Trials with OEM Partner (TRL-6 → TRL-7)

- Installation in electric motorcycle
- Real-world charging performance evaluation
- Reliability data collection

- Design refinement for pilot production

Outcome: Technology demonstrated in operational environment.

6. Technical Targets

- Input: 180–270V AC, single phase
- Output: 48V DC (42–58V programmable)
- Rated Power: 3.3 kW
- Efficiency: ≥93%
- Power Factor: ≥0.98
- Protection: OVP, UVP, OCP, OT
- Communication: CAN interface
- Operating Temperature: Up to 50°C ambient

7. Expected Impact

Successful development will:

- Reduce charging time
- Improve uptime for commercial fleet users
- Strengthen domestic EV component manufacturing under Make in India
- Reduce import dependency in EV power electronics
- Improve grid power quality via active PFC
- Support national electrification goals

8. Conclusion

This project addresses a clearly defined technological gap in India's electric two-wheeler ecosystem. Through a structured research, prototyping, validation, and field deployment pathway, the proposed 3.3 kW, 48V On-Board Charger aims to advance to TRL-6/7 and deliver a commercially viable, high-efficiency, indigenously developed solution. The problem is technically significant, supported by market demand, and structured for systematic progression toward scalable industrial deployment.