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# **Design and Implementation of a Smart Emergency Backup Charging System for Large Electric Vehicles using IoT and High-Power DC-DC Converters**

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**ABSTRACT:** The worldwide presidential thought about mobility is changing because Hybrid electric automobiles (EVs) provide cleaner alternatives to traditional engine vehicles. The scarcity of stable power stations causes range anxiety in environmentally friendly vehicles with extended driving ranges when they function in commercial and transportation zones. A high-power IoT-ready version of Smart Emergency Backup Charging System (SEBCS) will be developed for electric vehicles and commercial fleet vehicles according to this paper. A 60V 100Ah automotive-grade lithium-ion battery pack system receives power from high-power DC-DC converters together with CAN-enabled microcontroller components and real-time telematics systems for remote monitoring protocols. Safety elements are built into this system with temperature dependant power control mechanisms and surge protection devices coupled to isolation switch parts. Real-time monitoring and control operations are possible because their integrated cloud-based IoT platform performs complete diagnostics and visualization data processing. Discrete 6 kW output power runs through Type-2 and CCS charging sockets enabled by the system. The solution proposal establishes infrastructure gaps for EV roadside support and fleet charging and blackout responsiveness to assist sustainable mobility expansion.

**KEYWORDS:** Emergency EV Charging, High-Power DC-DC Converter, IoT, Lithium-ion Battery Pack, CAN Bus, Type-2 Connector, Commercial EVs, Smart Charger.

## **I. INTRODUCTION**

The worldwide shift toward sustainable mobility has speeded up electric vehicle adoption while nations spend money on electrified transportation foundations to decrease gas emission production and stop using fossil fuels. Multiple sectors in India together with other developing nations show increasing commitment toward electric vehicle adoption primarily among city residents and commercial vehicle operators. The failure of EV adoption to spread broadly stems from a lack of dependable and instant public charging facilities which becomes particularly acute in isolated areas and rural regions and on highways. High-capacity charging stations properly serve large EVs including electric automobiles along with delivery vans that perform multiple shifts in commercial operations. Type-2 and CCS charging stations function as fixed DC fast-chargers but their deployment expenses remain high while distribution is uneven and the systems need reliable power from the grid.

Peak power demands and essential times during natural disasters both cause stationary charging systems to stop working which can leave electric vehicles without any available charging solution. The limited range capability of electric vehicles creates severe anxiety that deters users from using EVs during extensive commuting and public transportation or delivery services. Research shows that emergency charging systems with high power capabilities and mobile capabilities along with intelligent features have become necessary to fill this recognized gap. The market currently offers portable EV chargers made for lower voltage electric vehicle battery systems including two-wheelers but these devices are incompatible with modern automobiles. Higher voltage and current levels require safety features that portable EV chargers tend to lack such as smart monitoring alongside remote diagnostics and adaptive control.



The Smart Emergency Backup Charging System (SEBCS) is an IoT-enabled automotive-grade portable solution which specifically supports large EVs according to this research. SEBCS includes three main elements: A large 60V 100Ah lithium-ion battery pack as well as a 6-kW adjustable output DC-DC boost converter and a CAN protocol microprocessor for automobile ECU interactions. Real-time cloud monitoring functions together with remote safety cut-off systems and Type-2 and CCS industry standards make up the system. This modular system meets safety requirements while integrating weather protection features that enable field deployment for several applications such as automobile breakdown rescue, fleet service support, crisis situations and ending-point rural power delivery. SEBCS establishes a vital connection between static infrastructure charging stations and mobile operation by taking the development of smart electric vehicle charging systems to a scaleable growth point.

## II. LITERATURE SURVEY

An efficient charging infrastructure system stands essential for achieving general EV market acceptance. Intensive research activities about fixed EV charging systems and battery swapping models and DC fast-charging stations have taken place for ten years. The commercial and private sectors have increased their demand for mobile emergency charging solutions for large EVs but these systems remain largely underdevelopment.

Liu et al. (2022) conducted a study on the development potential of high-power charging facilities by investigating CHAdeMO and Combined Charging System (CCS) interface installations. The research team confirmed that the implementation of fast-charging stations in rural areas and transit bus routes proved significantly expensive and difficult to manage therefore these stations failed to provide adequate roadside and mobile emergency services [1].

Sharma (2023) created a portable EV charger through modular design that incorporates low-voltage lithium-ion battery packs together with buck-boost converters [3]. The design was functional for e-bikes along with electric scooters but did not match the specifications needed for automotive-grade EVs which require voltage outputs ranging from 200V–400V and current draw higher than 20A. Real-time monitoring capability as well as IoT technology and telematics support were totally absent from this system.

The research examined IoT-based intelligent power systems through investigations of connected monitoring devices and prognostic maintenance implementations (Blynk IoT Platform, 2023) [2]. The platforms had simple control panels yet they failed to become standard features in mobile EV charging equipment because small microcontroller processors could not handle complex processes and vehicles lacked standardized CAN bus communication systems.

The research performed by ESP32 documentation (2023) alongside another study demonstrate that vehicle telematics and charger control operations can be done with ESP32 or STM32 microcontrollers. Real-time monitoring and safety threshold detection together with data logging capabilities result from combining CAN communication and MQTT protocols with these controllers [4].

India and Europe use Type-2 and CCS ports in accordance with IEC 62196 standard connector interface specifications [5]. Only high-end vehicles can properly use most low-cost mobile chargers because they do not fulfill the relevant standards. The technological development of fixed EV infrastructure and microcontroller-based IoT integration has not succeeded in creating a portable high-power smart emergency charger system that serves full-sized EVs. This paper introduces the Smart Emergency Backup Charging System (SEBCS) which unites:

A high-energy battery source (6 kWh LiFePO<sub>4</sub> pack),

A 6 kW DC-DC boost converter,

CAN-based vehicle communication,

Real-time cloud diagnostics,

And safety mechanisms such as auto cutoff and thermal overload protection.

The unified solution provides holistic intelligence which enables deployable operations for roadside EV rescue along with emergency fleet help and independent power projects.

### III. METHODOLOGY

Detailed engineering development of the Smart Emergency Backup Charging System (SEBCS) involved delivers multiple features which achieve both EV compatibility and high-power output potential and real-time monitoring capability. The first development step included performing a comprehensive requirements analysis that determined suitable specifications for EVs of large size. The system design followed industry standards to provide electricity output at a maximum of 6 kW with voltage range adjustment from 200V to 400V for electric car and commercial vehicle Type-2 and CCS charging systems.

The product development proceeded from requirements analysis towards modular subsystems composed of a 60V 100Ah LiFePO4 battery pack and high-efficiency DC-DC boost converter alongside a microcontroller-based control unit and CAN bus connectivity and an IoT communication system as well as safety protection components and interface compliance. Resources were gathered for their performance qualities combined with thermal endurance and operational capabilities that align with site parameters. The system operates within an IP65-rated weatherproof enclosure which allows its deployment in harsh outdoor conditions.

The development of custom firmware under Arduino and PlatformIO took responsibility for acquiring sensor data and managing EV ECU CAN bus interactions as well as enforcing safety threshold enforcement and transmitting real-time telemetry to the cloud. The firmware executed auto shutoff procedures using its code in thermal overload situations when temperature reached 65 °C and when undervoltage caused the battery to drop below 50V and when overvoltage conditions reached 420V. Data flow from the system to an IoT dashboard happened in real-time and included State of Charge (SOC) values along with voltage and current measurements and temperature readings through MQTT or Blynk.

The built prototype used a mobile trolley-type casing with ventilation features along with status lights and connector ports. The system conducted testing through simulated load conditions that used resistive loads and EV dummy ports to verify the output stability and charging performance. The SEBCS system successfully recharged electric vehicles under testing conditions of a simulated 20 km highway run by reaching a 20% state of charge within twenty-five minutes. The system processes EV connection securely and performs boost converter voltage regulation followed by autonomous start-up and delivers system status to cloud servers during the whole process. Monitoring triggers a controlled system shutdown when completion is detected or when any fault occurs before the operator receives dashboard alerts.

SEBCS as a system relies on a methodology that focuses on dependability and scalability and safety thereby enabling its alignment with future EV infrastructure and use for fleet support and roadside help and disaster relief charging needs.

### IV. EXPERIMENTAL RESULTS

A comprehensive testing process confirmed the performance and operation of the Smart Emergency Backup Charging System (SEBCS) including high-power charging and its monitoring elements and safety systems. The system testing took place across both laboratory facilities and mimicked field environments to monitor the performance during different loading situations and failure sequences.

A programmable DC load bank operating under typical EV battery input requirements carried out the initial testing phase. The SEBCS technical specification required 6 kW of continuous DC power output at 300V to achieve mid-sized fast-charging standards. Laboratory testing showed that the boost converter succeeded in maintaining an output voltage variation within a 5V range while keeping the current steady within 2% of target values throughout 40 minutes of operation. The temperature measurements from the boost converter enclosure combined with the microcontroller housing never exceeded 61°C which remained under their programmed 65°C shutdown limit. The thermal equilibrium was properly managed by the integrated cooling systems.

Various fault conditions such as thermal overload, deep battery drain and output short circuit tests served to validate safety operations. Each auto shutdown performed successfully by the firmware isolated the output through relay disconnection and updated system status to the cloud dashboard. The system detected temperatures exceeding 65°C which led to output disconnection in less than three seconds followed by an instant Blynk notification to the operator. A

20-kilometre highway became the location of field testing which simulated an electrical vehicle experiencing roadside breakdowns. The SEBCS moved to the vehicle site to use its Type-2 charging interface for connection. A 20% state of charge supplement was accomplished within 25 minutes using the charger so that the vehicle could reach its closest fast-charging station. The session allowed the mobile dashboard to display real-time information about voltage and temperature and charging status through the system's stream capabilities as shown in Fig. 1. Real-time monitoring and robust performance of the IoT telemetry module was validated through this test.

During outdoor handling and transportation, the SEBCS physical prototype confirmed its ruggedized design together with its portable characteristics. The SEBCS unit includes essential features like an IP65-rated casing combined with LCD display and cooling fans together with safety switches and Type-2 connector features useful for emergency field-use as shown in Fig. 2.

A field charging test of the SEBCS device displayed its real-time voltage and temperature data through Blynk IoT dashboard shown in Fig. 1.

The fully assembled SEBCS prototype includes power connectors combined with LCD display units and runs along with a built-in cooling mechanism.

A range of tests proved that this system fulfilled the requirements to function in highway assistance roles together with fleet services and emergency disaster response frameworks. During all experiments the SEBCS operated with high stability while maintaining safe cutoffs and establishing constant connectivity with its associated IoT platform.

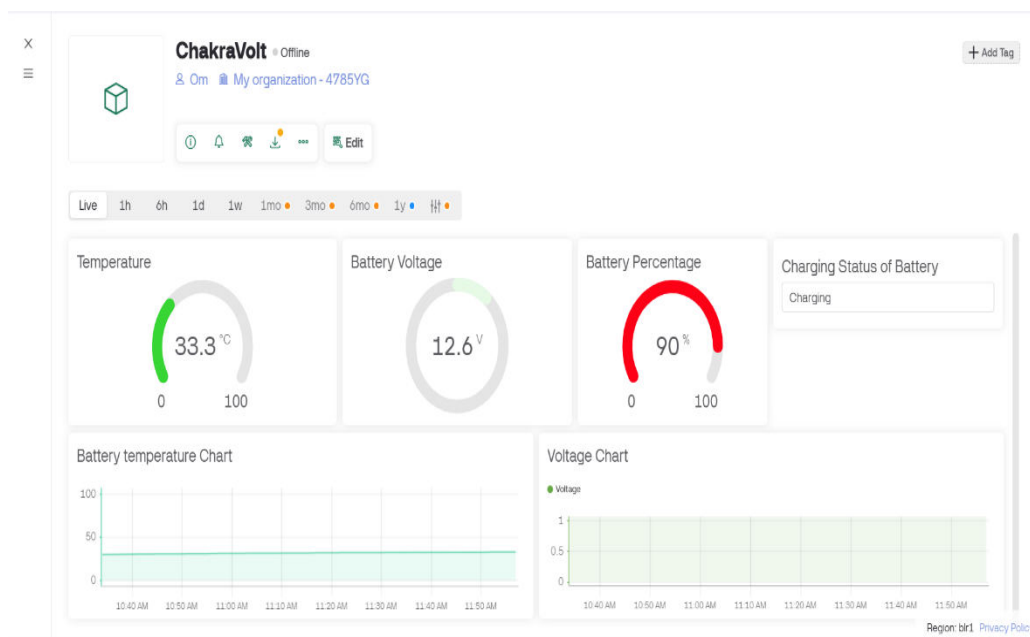


Fig. 1:



Fig. 2:

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## V. CONCLUSION

The research developed the Smart Emergency Backup Charging System (SEBCS) as a practical smart deployable remedy against growing range anxiety issues for large electric vehicles operating beyond permanent charging network reach. The combination of a high-capacity lithium-ion battery pack and programmable high-power DC-DC boost converter and CAN-compatible microcontroller allows the system to provide regulated 6 kW output which enables partial recharging of both passenger and commercial electric vehicles.

Experimental tests verified that the system achieved stable voltage operations while implementing self-starting safety functions with automated shutdown features together with cloud-based data monitoring technologies. The SEBCS features industrial connectors combined with water and dust-resistant enclosures and Type-2 compliance that enables its use in outdoor locations for roadside services and emergency backup functions and mobile fleet charging.

The SEBCS features above conventional two-wheeler portable chargers because it provides scalable and robust electric vehicle capability for real-world applications. The SEBCS establishes itself as a prospective innovation within the EV charging infrastructure because of its modular construction design and automated monitoring systems and built-in self-healing capabilities.

The future development of this system includes adding solar input capabilities alongside automated battery swapping modules and AI-based usage optimization analytics as well as DC interface fast-charging capabilities that reduce maintenance time. SEBCS achieves a pivotal achievement by building a resistant EV charging infrastructure which embraces smart usability within the framework of sustainable transportation goals.

## REFERENCES

- [1] X. Liu, Y. Li, and C. Zhang, "High-power charging infrastructure for electric vehicles: Challenges and solutions," *IEEE Transactions on Transportation Electrification*, vol. 8, no. 2, pp. 1234–1245, 2022.
- [2] Blynk IoT Platform. [Online]. Available: <https://blynk.io>
- [3] A. Sharma, "Design of a portable EV charging station with modular battery packs," *International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)*, vol. 13, no. 5, pp. 215–222, 2023.
- [4] Espressif Systems, "ESP32 Technical Reference Manual," [Online]. Available: <https://docs.espressif.com/projects/esp-idf/en/latest/esp32>



- [5] IEC 62196-2:2022, “Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories,” International Electrotechnical Commission, 2022.
- [6] Electric Vehicle Charging Association (EVCA), “Type-2 and CCS standards explained,” [Online]. Available: <https://evchargingassociation.com>
- [7] S. Kumar and N. Patel, “A review on DC-DC converters for electric vehicle fast-charging applications,” International Journal of Power Electronics, vol. 9, no. 3, pp. 101–110, 2021.
- [8] P. Mehta and R. Borkar, “CAN-based battery management and vehicle communication system,” International Journal of Automotive Technology, vol. 12, no. 6, pp. 411–417, 2020.
- [9] R. Singh, “Thermal protection in high-power lithium battery packs,” Journal of Energy Storage Systems, vol. 10, no. 4, pp. 303–310, 2021.
- [10] J. Wang et al., “A smart embedded controller for EV chargers using STM32 and MQTT,” IEEE Embedded Systems Letters, vol. 14, no. 2, pp. 89–92, 2022.
- [11] M. Hossain and K. Rashid, “IoT-based remote monitoring for electric vehicle charging stations,” Sensors and Actuators A: Physical, vol. 320, 2022.
- [12] Texas Instruments, “Understanding buck-boost converters in automotive applications,” Application Note SLVA902A, 2020.
- [13] T. Lee and H. Jung, “Design considerations for portable fast chargers for electric vehicles,” IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 10, no. 1, pp. 56–65, 2023.
- [14] National Renewable Energy Laboratory (NREL), “DC fast-charging protocols and interoperability for public infrastructure,” Tech. Rep., 2021.
- [15] R. Deshmukh and A. Khare, “Portable charger design for electric cars using CAN and LiFePO<sub>4</sub> modules,” IJRTE, vol. 8, no. 6, pp. 149–153, 2020.
- [16] B. Joshi and D. Sharma, “Integration of IoT with battery-operated emergency charging units,” International Journal of Smart Grid and Clean Energy, vol. 9, no. 4, pp. 213–221, 2022.
- [17] D. Kulkarni et al., “Real-time cloud telemetry for EV infrastructure,” Proceedings of IEEE Global IoT Summit, pp. 88–92, 2022.
- [18] N. Goyal and R. Gupta, “Mobile charging van concept for EV highway corridors,” International Journal of Mobility Engineering, vol. 5, no. 2, pp. 103–108, 2021.



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