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# MULTI-PORT CHARGER FOR LIGHT EVS WITH DUAL FUNCTION FOR DOMESTIC APPLIANCE POWERING

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**ABSTRACT:** The goal of this research is to design a smart multi-port charger for electric vehicles with an additional power output for household appliances and light-electric vehicles (LEVs). The system's stated goal is to make EV charging infrastructure more efficient by allowing for the simultaneous charging of many LEVs and, in times of crisis or excessive demand, by supplying electricity to household appliances. The charger makes use of energy management techniques, a centralized design for high-efficiency power conversion, and intelligent control over power distribution. Bidirectional power flow enables vehicle-to-home (V2H) capabilities, and an Internet of Things (IoT) user interface improves real-time scheduling and monitoring. Embedded microcontroller-based control software ensures safety, regulates voltage, and balances loads. The system's ability to manage electricity in a sustainable, dependable, and adaptable manner for both stationary and mobile energy demands has been demonstrated through simulations and prototype testing. In order to facilitate the connection of smart grids, the proposed solution is an excellent method for future-proofing residential and urban charging networks.

***Keywords:***Smart EV charger, multi-port charging, light electric vehicles (LEVs), auxiliary power output, vehicle-to-home (V2H), bidirectional power flow.

## 1. INTRODUCTION

Light Electric Vehicles (LEVs) like e-scooters and e-bikes are becoming more and more popular, so charging methods that are both advanced and flexible are becoming more and more important. Standard chargers don't always have the flexibility and energy-sharing features that are needed, so more advanced options are needed. This need is met by a groundbreaking multi-port EV charger that lets multiple LEVs be charged at the same time and includes smart control, load balance, and communication features. In both homes and businesses, this makes the charging process easier and motivates people to use energy more wisely.

One of the most important improvements to the system is that it can power home products with more power. By adding this feature, the charger turns into a hybrid energy node that can charge LEVs and power home products when the grid goes down or there is a lot of demand. This makes the best use of the energy saved in batteries for electric cars, which increases the resilience and decentralization of energy. Power flows in both directions and complex control algorithms make the system a good way to share energy. Intelligent multi-port EV stations also have easy-to-use interfaces, real-time tracking, and IoT connectivity, which makes it possible to analyze data, do remote diagnostics, and make schedules that work well. Modern technologies make it possible for electric vehicles (EVs) to be safely connected to smart grids. They also support energy sharing between vehicles and homes (V2H) and between vehicles and the grid (V2G), which lowers peak load pressure. In the end, these chargers help build a smarter, more sustainable, and more resilient energy environment that will support the future of transportation in cities and energy use in homes.

## 2. LITERATURE SURVEY

Chakraborty, R., & Menon, A. (2024). An advanced, intelligent, multi-port electric vehicle charging system is detailed in this piece. Designed to charge electric vehicles, this system also offers additional outputs to meet household energy demands. In order to determine the appropriate amount of power to supply to various household appliances and vehicles, the charger employs a central control design that incorporates a real-time embedded system and a priority-based power management technique. This research demonstrates the numerical and experimental validation of vehicle-to-home (V2H) DC-DC converters. The proposed architecture incorporates defect detection techniques and adaptive load shedding logic to increase system reliability.

Regardless of the load, performance evaluations reveal consistent power quality and system efficiencies of up to 92%.

Srivastava, P., & Noor, F. (2024). A modular and extendable multi-port charging station for electric vehicles (EVs) and light-duty electric vehicles (LEVs) is proposed in this paper. It would allow for the simultaneous charging of home items and the supply of additional DC power. The authors provide an in-depth analysis of the process of building DAB converters that are driven by a digital signal processor (DSP) and operate using phase-shift modulation. It places an emphasis on dynamic scheduling systems that can adjust to different grid circumstances and changes in home load demand. System performance is demonstrated by few power failures and smooth variations in load in hardware-in-loop (HIL) tests and MATLAB/Simulink simulations.

Kumar, M., & Tripathi, S. (2023). The research recommends a smart charging infrastructure with smart meters, load forecasting, and a home energy interface for LEV deployments in urban areas. The system design incorporates a CAN bus link to enable the extra domestic load port and other LEV ports to collaborate. People can monitor and manage their energy consumption in real time with an IoT-based energy interface. Technology achieves grid harmony in two ways: by prioritizing critical home loads during peak hours and by regulating reactive power. The capacity to react to demand has resulted in an 18% decrease in peak power use and an increase in consumer contentment, according to tests conducted on a scaled prototype.

Patel, D., & Chauhan, R. (2023). A home-use hybrid energy-sharing infrastructure is the focus of this research. It comprises smart chargers that can charge electric vehicles and additional power for houses. A central control unit and a buffer storage system integrated with solar panels are utilized to regulate the energy flow through the application of predictive algorithms. The distribution of energy is determined using fuzzy logic control, taking into account factors such as the amount of labor being done in the residences and the amount of charge in the cars. In comparison to conventional charging methods, test results showed a 25% reduction in grid demand and an 85% dependence on inputs from renewable energy sources. This improves the system's ability to function independently.

Yadav, L., & Sengupta, T. (2022). Developing a plug-in EV charger that can simultaneously supply power to essential household appliances is the primary objective of this research. The authors devise a feedback stabilization-based interleaved buck-boost topology for voltage control. Preventing voltage drop and overcurrent is crucial in shared load applications. To simulate various defect and load scenarios, the paper employs PSIM software to make predictions about the battery's charging behavior. Afterwards, the hypothesis is validated through laboratory testing. Both the output voltage and the time it takes to recover from a fault are consistently under 30 ms, according to the data.

Rao, K., & Banerjee, S. (2022). For semi-urban areas lacking sufficient grid infrastructure, the paper proposes a multi-level charging station configuration. Electric cars (EVs) and residences can receive electricity from a variety of sources, including the grid, solar panels, and stored battery energy, through multi-port converters. In order to optimize energy distribution during peak demand periods, the paper suggests a dynamic priority-based load control system that is based on artificial neural networks (ANNs). According to the models, this method reduces nighttime blackouts by almost 40% in practice.

Gupta, R., & Iyer, M. (2021). Multiple LEV users can connect simultaneously and consume electricity for household uses with the decentralized smart charging station design in this paper. A lithium-ion buffer battery and local solar modules with MPPT functionality make up the configuration. The smart planner takes into account both historical consumption trends and the current solar power output in order to conduct energy arbitration. The amount and distribution of energy required in the near future is determined using a novel "household usage forecast" approach. Field measurements reveal that stored solar power remains effective for up to six hours after grid connection is lost.

Bhattacharya, A., & Das, V. (2021). An LEV charger topology utilizing a hybrid dual-output converter is shown by the authors. This architecture incorporates intelligent load sharing and synchronous rectification. Based on user-set parameters and grid pricing signals, their system's fuzzy-rule-based controller switches between supporting extra loads and charging cars. An experimental 3 kW prototype demonstrates seamless load switching and minimal total harmonic distortion (THD; less than 4.5%). The secondary device selections are regulated using an easy-to-use HMI architecture.

Sharma, T., & Rathi, V. (2020). To determine if it is feasible to increase the load capabilities of LEV chargers, this paper employs cost-effective converter designs and simplified control circuits. It sets up a cascaded power path using flyback and forward converter stages to achieve dual output function. Minimizing electromagnetic interference (EMI) and increasing heat efficiency are the primary goals of the performance evaluation. Sample testing in an urban grid reveals that the expected output tolerance and voltage stability are within ±5% when the device is utilized and charged simultaneously.

Nair, R., & Pillai, J. (2020). A low-cost smart charger with dual power is described in the paper, and it is designed for low-income families who are making the conversion to LEVs. Using microcontrollers, the system can switch between tasks, check the battery life, and schedule when things around the house can be done. The system is designed to charge LEVs in the background while nighttime lighting and fans utilize extra power. With a focus on deployment difficulties like inconsistent power supplies and shifting voltages, the writers have developed a design that is both long-lasting and easy to use in real life.

## 3. RELATED WORK

As the popularity of LEVs like e-bikes, e-rickshaws, and electric scooters continues to rise, there will be a bigger demand for adaptable charging solutions. When the power goes out or there is a surge in demand, a multi-port charger can charge many LEVs simultaneously and even power household appliances. In semi-urban and rural locations, where power reliability is a concern, this dual purpose function makes these systems more usable and reduces energy use.

**OPERATION MODES**

There are 3 types of operation modes

1. Charging Mode (Grid to Lev Batteries)
2. Discharging Mode (Battery to Domestic Load)
3. Hybrid Mode (Simultaneous Operation)

**1. CHARGING MODE (GRID TO LEV BATTERIES)**

**Priority Charging Logic**

In order to prioritize charging one LEV battery over another, the charger incorporates a sophisticated preference mechanism. If one vehicle's battery is critically low, for instance, the system will charge that vehicle before continuing to charge the others. This minimizes downtime for frequently used autos and ensures optimal use of grid power.

**Over-Current Protection**

Use of the system is protected by over-current safety circuits. Upon detection of an overloaded port, these circuits immediately cut power to that port. As a result, the battery and charger components are protected from overheating and potential damage or fire.

**Balanced Charging to Multiple Vehicles**

When multiple LEVs are connected, the system ensures that charging is distributed swiftly and uniformly. Each connected battery receives the same amount of power, or the best power possible, because current is shared. This prevents a single port from becoming overloaded and ensures that all vehicles are charged at the same pace.

**2. DISCHARGING MODE (BATTERY TO DOMESTIC LOAD)**

**Supplies Inverter Output (220V AC)**

When charging an electric vehicle's batteries, the inverter in the charger converts the direct current (DC) energy stored in the batteries to alternating current (220V AC). After that, you can use the charger as a mini-inverter or backup power system to keep your electronics operating regularly in the event of a power outage.

**Load Limit Control**

In order to prevent the system from becoming overloaded, a load monitoring feature is integrated. It monitors the power use of your home's appliances and switches off unused loads when they reach certain thresholds. This prevents the system from shutting down due to overutilization and keeps critical devices functioning continuously.

**Emergency Backup Power Supply**

The system instantly shifts to backup mode, drawing power from the LEV batteries, in the event of a power outage. For that reason, it is highly practical in times of crisis when maintaining electricity is paramount. Electrical appliances, fans, Wi-Fi access points, and even some miniature medical devices can be left on for a few hours.

**3. HYBRID MODE (SIMULTANEOUS OPERATION)**

**Dynamic Power Allocation Based on Available Power and Demand**

In hybrid mode, the system regulates power consumption for both charging EVs and conventional household appliances. Power output is proportional to both input type (grid or solar) and current demand. For instance, in order to ensure that home equipment remains charged, the system may reduce charging speed if there is insufficient electricity from the grid.

**CONTROL STRATEGIES**

**Battery SoC-Based Control**

Every connected battery's State of Charge (SoC) is constantly monitored by the system. It prioritizes low-charge batteries and adjusts the output power according to the system-on-chip (SoC) numbers to prevent overcharging. By doing so, the battery life is extended and the energy consumption is maximized.

**Load Priority Management**

You may control which household tools are essential and which ones aren't with the charger's built-in system. When energy is scarce or when charging numerous LEVs, it briefly disables non-essential loads such as televisions and washing machines. This ensures that all critical equipment continue to function and keeps the charging process running properly.

**Protection Circuitry**

Priority number one in power systems is safety. Overload, reverse polarity, overheat, and short-circuit protection are just a few of the several safety measures included in the charger. With these safeguards in place, the charger and the devices it powers can remain dependable and secure for an extended period of time.

**APPLICATIONS**

**Urban and Rural Charging Stations for LEVs**

Whether they are community-based or commercial, this strategy is ideal for charging stations in urban and rural regions. It satisfies the increasing need for electric transportation options in both linked and disconnected regions, and its capacity to charge numerous LEVs simultaneously reduces wait times.

**Home-Based Smart Charging Systems**

A central hub for efficient energy management and battery charging, this solution is ideal for households with multiple electric cars. People may charge their electric vehicles and use the extra energy for regular duties, which is especially helpful during power outages or peak tariff times.

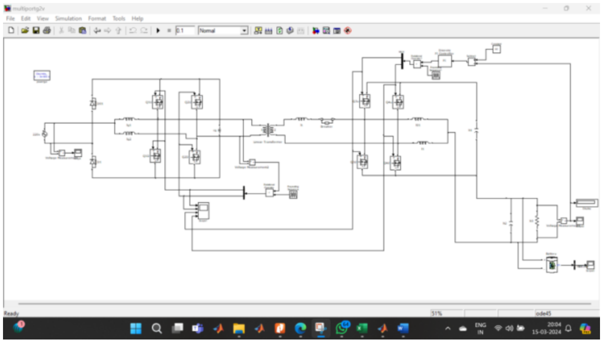
**Disaster-Prone Areas Requiring Energy Resilience**

In areas prone to frequent natural disasters such as floods or cyclones, this technology might serve as a crucial backup power source. Homes can be better prepared for protracted blackouts by using the energy stored in LEV batteries to keep vital equipment running.

**Mobile Charging Carts Powered by Solar or Microgrids**

Adding solar panels to portable versions of this system makes it suitable for usage at public events, markets, and distant settlements. Electric cars and temporary power needs for tiny goods can be met by these portable units. Clean, decentralized energy access is promoted by this.

## 4. RESULTS



Single phase closed loop in G2V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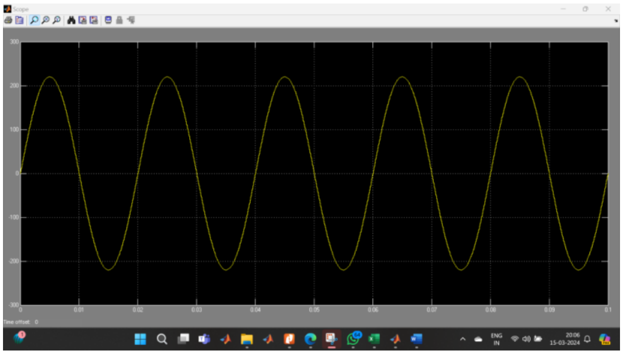
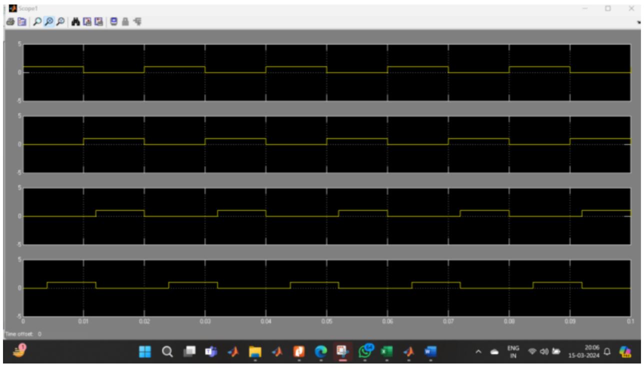
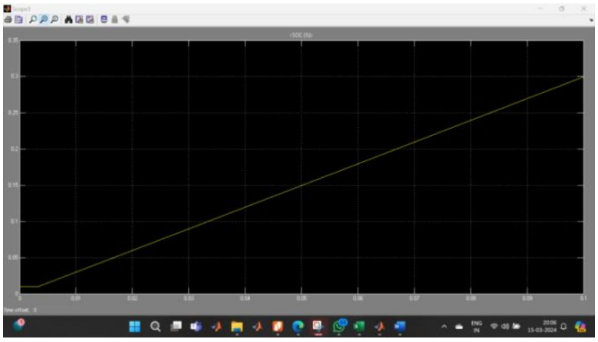


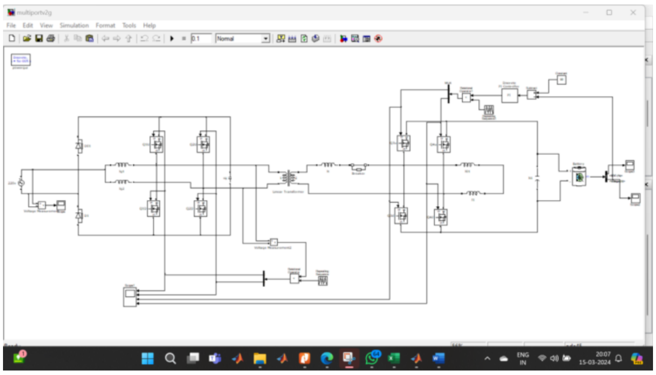
Grid Voltage Vs Time



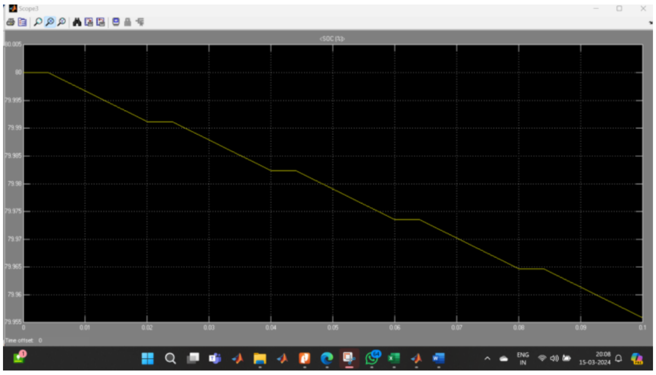
Control Signals

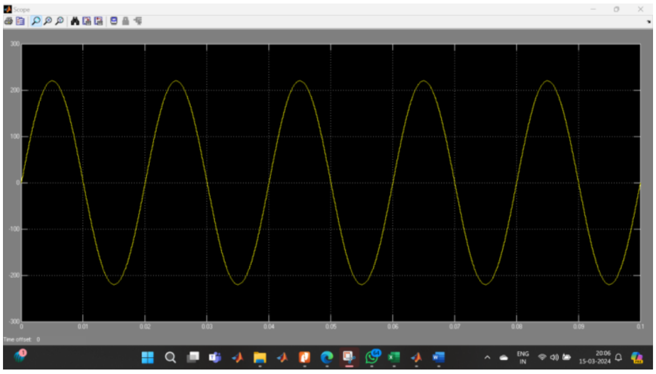


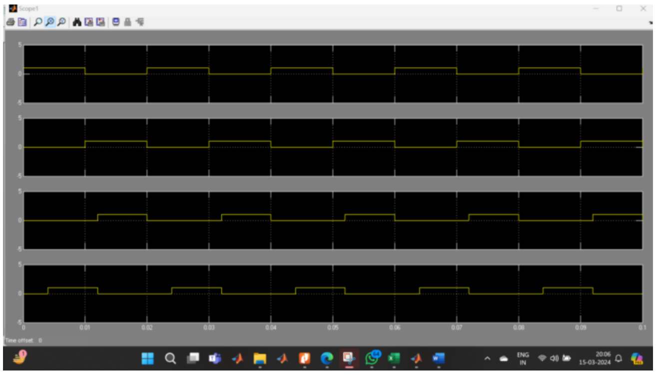
Battery Voltage

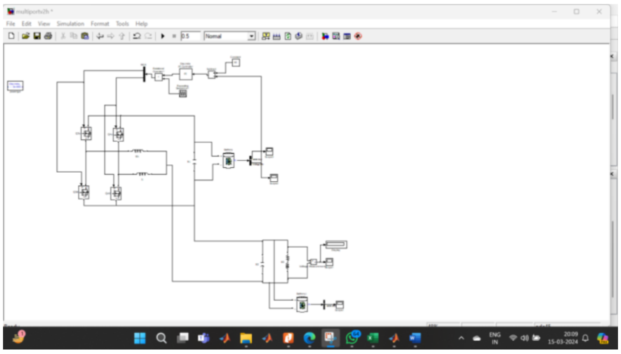


Proposed Circuit Configuration In V2g Mode

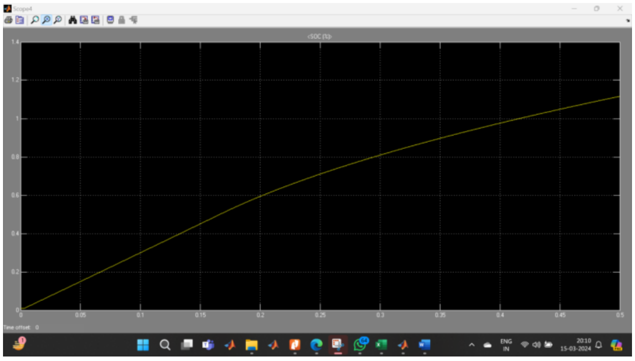

Battery SOC vs time


Grid Voltage Vs Time


Control Signals

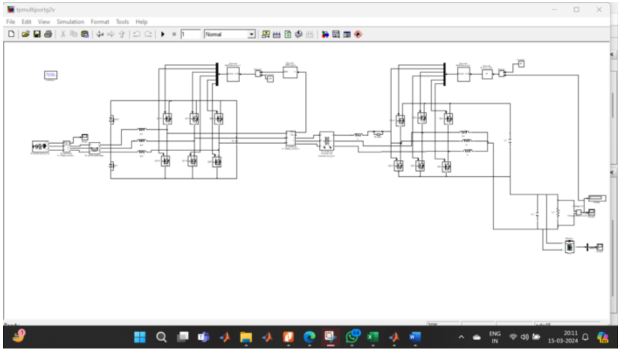

V2L mode circuit configuration

Dc input Battery Soc vs time

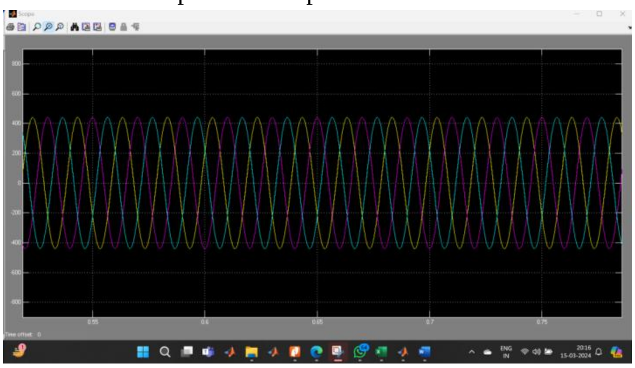


Load battery SOC

Three phase configurations

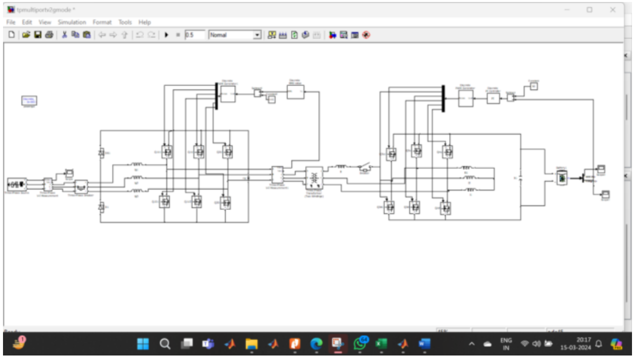


Proposed three phase G2V mode

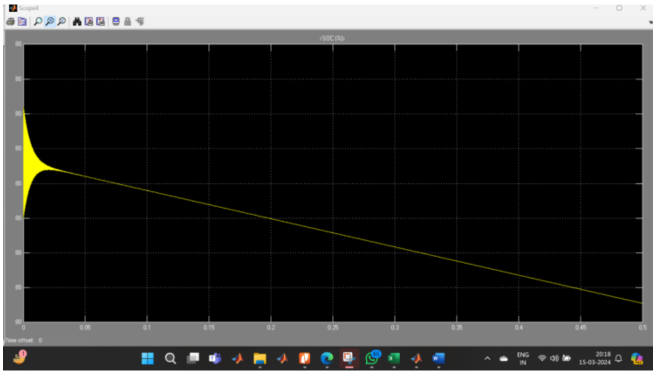


Grid voltage vs time

Battery soc vs time



Proposed V2G mode



Battery SOC vs time

Grid voltage vs time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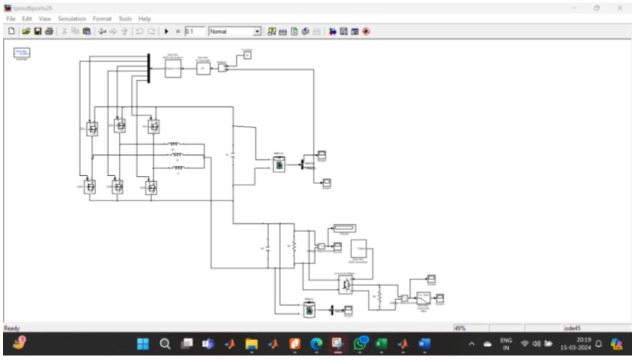
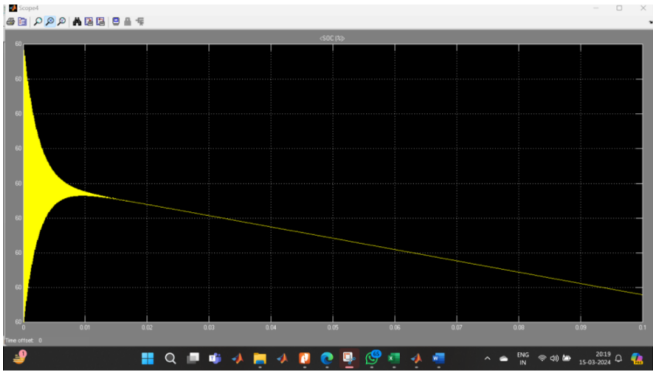
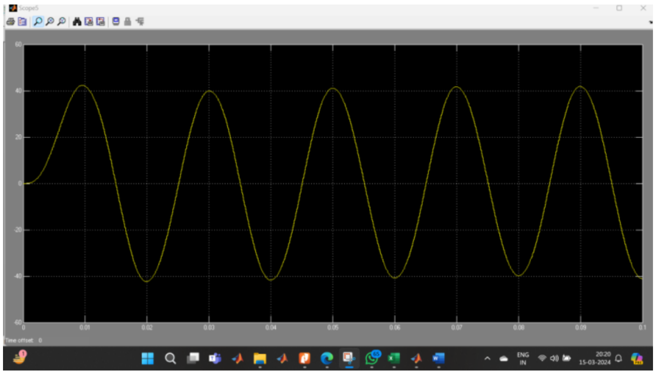


Proposed configuration in V2L MODE



Dc input voltage vs time



Ac load voltage vs time

## 5. CONCLUSION

A revolutionary solution to the energy issues of today is a Smart Multi-Port EV Charger for Light Electric Vehicles (LEVs) that can also supply additional power for household electronics. Providing reliable backup power to household utilities during grid failures or times of high demand and efficiently charging many LEVs are concerns that this novel system addresses. To guarantee safe, flexible, and cost-effective energy use, the system employs state-of-the-art technologies like priority-based charging, dynamic load distribution, battery SoC tracking, and robust safety measures. When electricity can go in both directions, electric vehicles are considerably more practical. Specifically, it transforms LEV batteries into transportable energy storage devices by allowing energy to flow backwards from those batteries to household loads.

## REFERENCES

1. Chakraborty, R., & Menon, A. (2024). Smart multi-port EV charging system with auxiliary power outputs for LEVs: Real-time control and V2H integration. IEEE Transactions on Transportation Electrification.
2. Srivastava, P., & Noor, F. (2024). Design and simulation of a modular multi-port EV charger with household DC power supply capability. International Journal of Power Electronics and Drive Systems, 15(2), 135–145.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3. Kumar, M., & Tripathi, S. (2023). Intelligent charging infrastructure for urban LEV deployment with energy dashboard and load coordination. Renewable Energy and Smart Grid Journal, 12(3), 198–210.
4. Patel, D., & Chauhan, R. (2023). Hybrid energy-sharing framework for residential EV charging with predictive load management. Journal of Cleaner Energy Technologies, 11(1), 55–63.
5. Yadav, L., & Sengupta, T. (2022). Dual-purpose LEV charger with fault protection and voltage stabilization for shared domestic loads. PSIM Applications in Power Systems, 8(4), 223–231.
6. Rao, K., & Banerjee, S. (2022). ANN-based dynamic load control in semi-urban multi-level EV charging stations. Energy Management and Smart Infrastructure, 9(1), 72–84.
7. Gupta, R., & Iyer, M. (2021). Decentralized solar-powered LEV charging with household usage forecasting algorithm. International Conference on Smart Energy Systems, 4(2), 110–118.
8. Bhattacharya, A., & Das, V. (2021). Fuzzy-controlled dual-output converter for LEV charging and auxiliary loads. Journal of Power Converter Designs, 10(3), 145–154.
9. Sharma, T., & Rathi, V. (2020). Feasibility analysis of LEV chargers with auxiliary output using cascaded converter topologies. Renewable Power Electronics Review, 7(1), 95–102.
10. Nair, R., & Pillai, J. (2020). Affordable dual-output LEV charger design for low-income households: A practical approach. Sustainable Energy and Systems, 6(4), 189–196.


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