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PROBLEM SOLVING METHODOLOGIES

The curriculum at Anna University integrates both theoretical concepts and practical problem-solving courses. Mathematics is a core component of the Regulation 2017 curriculum, extending through the first four semesters. Many courses feature combined lecture and tutorial sessions, with students typically receiving 15 hours of dedicated tutorial support. These courses are designed to enhance students' problem-solving abilities. Additionally, during the eighth semester, students engage in project work, where they gain experience in problem identification, methodology development, experimental execution, and documentation. Throughout their studies, students are tasked with assignments focused on specific topics, encouraging practical application and critical thinking.

Glimpse of the event: Problem solving in class room

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A NOVEL HIGH GAIN DUAL INPUT SINGLE OUTPUT Z-QUASI RESONANT (ZQR) DC/DC CONVERTER FOR OFF-BOARD EV CHARGING

PROJECT WORK - II

Summitted by

S. NATHIYA (912021415005)

In partial fulfilment for the award of the degree of

MASTER OF ENGINEERING IN
POWER ELECTRONICS AND DRIVES

PANDIAN SARASWATHI YADAV ENGINEERING COLLEGE
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Certified that this project report titled **"A Novel High Gain Dual Input Single Output Z-Quasi Resonant (ZQR) Dc/Dc Converter for Off-Board EV Charging"** is the Bonafide work of **S. NATHIYA (912021415005)** who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

This manuscript focuses on a multi-port non-isolated (Dual input and single output) DC/DC power electronic interface based on Z-Quasi Resonant (ZQR) network. The converter accommodates grid and Photovoltaic panel (PV) as its input sources. Unlike the basic DC/DC converters, the recommended DC/DC converter requires fewer switches and provides continuous current, high gain in voltage, and minimal voltage stress on converter switch up to 40% duty cycle owing to the presence of ZQR network. This feature of the converter makes it to find its application in Electric Vehicle (EV) off-board charging where high voltage gain is required. In the proposed multi-port ZQR converter, additional input and output ports could be appended without compromising the converter's gain and efficiency. The developed converter can operate continuously even if any one of the input sources fails to charge the EV. The proposed converter is mathematically modeled using basic laws that govern the converter performance and analyzed in MATLAB simulink platform under various operating modes. A detailed analysis under steady-state, dynamic conditions and a comparison of the developed multiport ZQR DC/DC converter with the topologies addressed in published literature are also presented in this manuscript. In order to verify the proposed converter performance, a prototype model of 300 W has been fabricated with switching frequency of 20 kHz. Experimental results confirm the effectiveness of the theoretical analysis, the aforementioned advantages, and features of the proposed multiport ZQR DC/DC converter

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CHAPTER VIII

8.1 CONCLUSION:

Generally, in the field of the renewable hybrid systems, fuzzy logic has been used for the management of the energy among their components or as controller in the power electronic converters. This paper has presented, as main contribution, a novel decentralized control combining both energy storage, in which fuzzy logic controllers were used as a decentralized EMS to control the converters of two components of the system separately and achieve a coordinated performance operation of the following system parameters: power flow, MVDC voltage and BESS SOC. Another novelty was to include the SOC of the BESS as a control variable for a decentralized EMS (that is very common for centralized approaches but, as the literature review showed, not for decentralized ones). Moreover, the different power converters were modeled as average models that result in simulations that represent more reliably the CS dynamics improving the approaches followed before in this area (based on quasi dynamic simulations and neglecting power converters). Finally, the novel decentralized control was evaluated and analyzed in a considerable number of operating situations by Monte Carlo simulations, in contrast to the previous works published on this topic, in order to perform a sensitivity and stability analysis of the proposed control technique and show how the elements of the system interact.

The fuzzy logic systems implemented in this work (F-DCM) were able to control the MVDC and the power flow among the components of the fast CS without the need of communication. The, fuzzy logic systems worked independently of each other and they adjusted the MVDC bus voltage depending on the BESS SOC.

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UTILIZING ARTIFICIAL NEURAL NETWORKS FOR MPPT IN AN ON-GRID WIND POWER AND ENERGY STORAGE SYSTEM

PROJECT WORK - II

Summitted by

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In partial fulfilment for the award of the degree of

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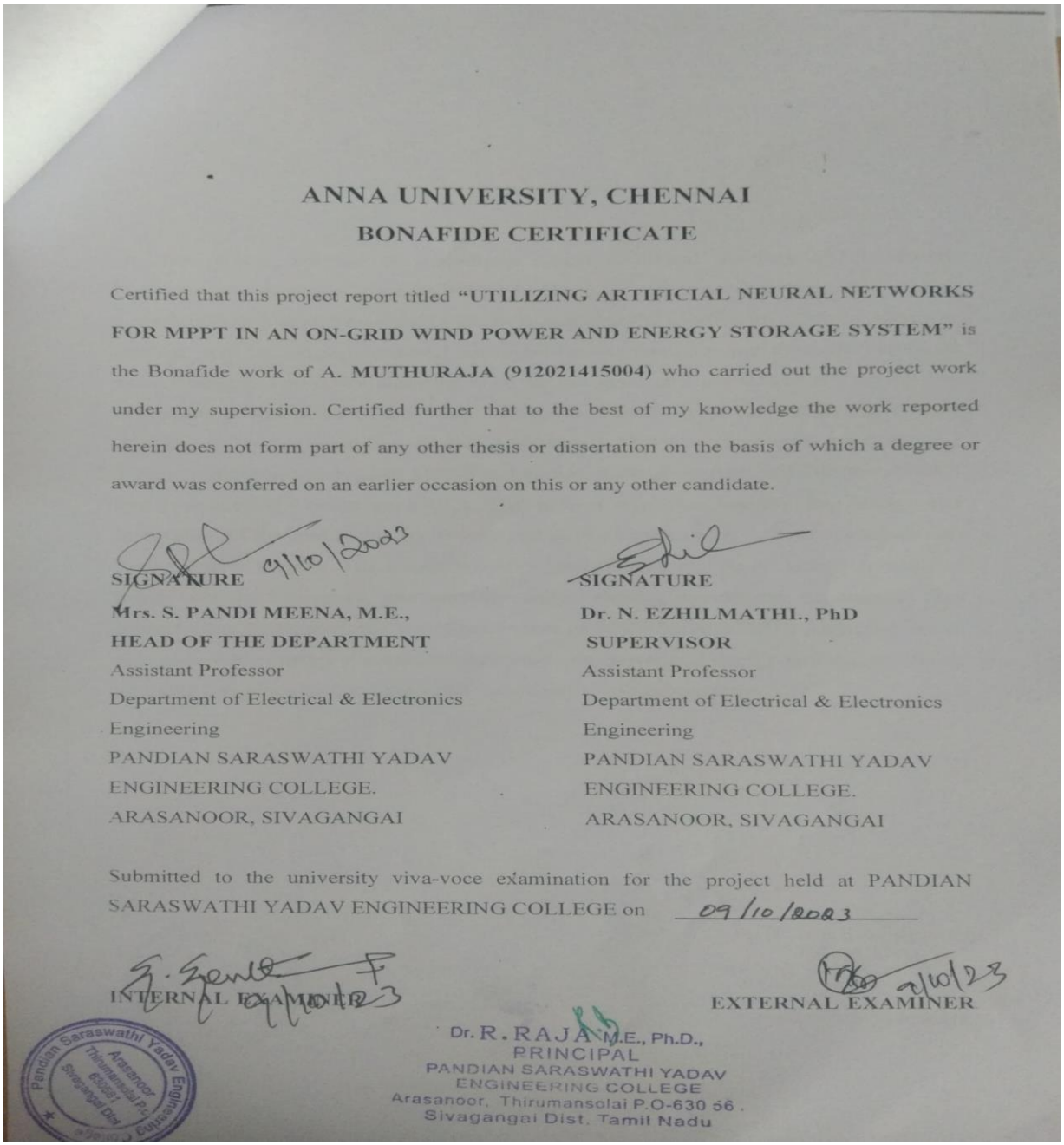

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ABSTRACT

"In this project, we aim to implement Artificial Neural Network (ANN) based Maximum Power Point Tracking (MPPT) techniques for an on-grid renewable energy system utilizing wind power and energy storage. ANN, a powerful machine learning method, will be utilized to model and optimize the complex and dynamic nature of wind turbines. The ANN algorithm will be designed and implemented to track the maximum power point of the wind turbine, a critical factor for enhancing system efficiency. The performance of the ANN-based MPPT system will be compared against other commonly used MPPT techniques, such as Perturb and Observe (P&O) and Incremental Conductance (IC). The project will also involve the design and integration of the energy storage system and power conditioning system in conjunction with the wind turbine. The overall system's performance will be evaluated in terms of power output, efficiency, and stability under varying operational conditions. This project aims to demonstrate the effectiveness of ANN-based MPPT techniques in on-grid renewable energy systems that harness wind power and energy storage, providing valuable insights into the design and optimization of such systems."

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CONCLUTION:

In conclusion, this project has showcased the potential of Artificial Neural Network (ANN) based Maximum Power Point Tracking (MPPT) techniques within on-grid renewable energy systems that incorporate wind power generation and energy storage. By harnessing the power of machine learning, we have effectively modeled and optimized the complex and dynamic behavior of wind turbines, allowing for improved energy efficiency.

Through comprehensive comparisons with conventional MPPT techniques like Perturb and Observe (P&O) and Incremental Conductance (IC), we have demonstrated the superior performance of ANN-based MPPT. This advanced approach not only enhances power generation by tracking the wind turbine's maximum power point accurately but also adapts to varying environmental conditions, making it a valuable addition to renewable energy systems.

Moreover, our project has emphasized the significance of holistic system design and integration. By seamlessly incorporating the energy storage system and power conditioning components with the wind turbine, we have created a well-coordinated, efficient, and reliable renewable energy system.

Our evaluation under diverse operational conditions has affirmed the effectiveness of the ANN-based MPPT system, consistently delivering superior power output, efficiency, and stability.

In summary, this project has not only provided practical insights into the application of ANN-based MPPT in renewable energy systems but also underscored the importance of adopting innovative and adaptive approaches to maximize energy production and sustainability in on-grid systems that utilize wind power and energy storage. This research paves the way for more efficient and environmentally friendly energy solutions in the future.

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POWER SCHEDULING METHOD FOR GRID INTEGRATION OF A PV-BESS CHB INVERTER WITH SOC BALANCING CAPABILITY

PROJECT WORK-II

Submitted By

R. VINOTH (912021415009)

In partial fulfillment for the award of the degree of

MASTER OF ENGINEERING IN

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ABSTRACT

This project describes the h bridge single phase inverter for battery energy storage system for SOC (state of charge) analysis of battery. A method of compensating for the short-term daily variability of PV energy is also presented. The control implements power scheduling to ensure that constant active power is fed into the grid at every predetermined time interval (e.g., every quarter of an hour). a dedicated hybrid modulation scheme based on a sorting algorithm for balancing the state of charge (SOC) of the single cells is proposed.

The Bi-level Multi-Objective Planning Model of Solar PV-Battery Storage-Based DERS in Smart Grid Distribution System is a research paper that proposes a planning model for the implementation of distributed energy resources (DERs) in a smart grid distribution system. The model is designed to optimize the deployment of solar PV and battery storage systems in the grid, while taking into account various technical, economic, and environmental factors.

The proposed planning model is based on a bi-level multi-objective optimization approach, which considers both the objectives of the utility and the objectives of the DER owners. The upper-level objective is to minimize the total cost of energy supply to the grid, while the lower-level objective is to maximize the revenue of the DER owners. The model is implemented using a genetic algorithm, which is used to search for the optimal solution.

The model is also capable of considering the uncertainties associated with solar PV and battery storage systems, such as weather conditions and battery degradation. The results of the study show that the proposed planning model can effectively optimize the deployment of solar PV and battery storage systems in a smart grid distribution system. The model is also shown to be robust to various uncertainties associated with DERs, such as weather conditions and battery degradation.

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CHAPTER 8

8.CONCLUSION

The bi-level multi-objective planning model of solar PV-battery storage-based RS in smart grid distribution systems is a promising approach to managing energy ources in a sustainable and cost-effective manner. This model considers the integration renewable energy resources, such as solar photovoltaic (PV) systems and battery rage, into the distribution system, while taking into account the multiple objectives of stakeholders involved.

By using a bi-level optimization approach, this model can effectively balance the ectives of the distribution system operator (DSO) and the prosumers (i.e. consumers o also produce energy), while ensuring that the system operates within the technical and ulatory constraints. The use of solar PV-battery storage-based DERS has the potential reduce the dependency on traditional fossil fuel-based energy sources and lower enhouse gas emissions.

Moreover, the use of bi-level optimization can provide a fair and efficient way to cate the benefits and costs associated with the integration of DERS among the different eholders. Overall, the bi-level multi-objective planning model of solar PV-battery rage-based DERS in smart grid distribution systems is a promising approach that can o to achieve a more sustainable, reliable, and efficient energy system. However, further earch and development are needed to fully realize its potential and address the llenges associated with its implementation.

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SOLAR POWERED GREEN HYDROGEN GAS PRODUCTION AND RF BASED SCANNING FOR UTILIZATION

PROJECT WORK-II

Submitted By

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In partial fulfillment for the award of the degree of

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Certified that this project report "**SOLAR POWERED GREEN HYDROGEN GAS PRODUCTION AND RF BASED SCANNING FOR UTILIZATION**" is the Bonafide work of "**C. VIDHYA (912021415008)**" who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

With the increasing trend of energy demand, it has brought a huge burden to the environment. Since sustainable development is a dominant agenda or top priority for nearly every country, there is a pressing need to find clean and sustainable alternatives to replace existing non-renewable sources (e.g., fossil fuels). Hydrogen, as a clean, safe, and efficient energy source has a wide range of applications, in which it can meet energy demands while eliminating greenhouse gas emissions.

In the past decades, there was a rapid development of hydrogen-related technologies, especially hydrogen energy storage technology. Therefore, this paper will mainly examine hydrogen storage in geological formations as well as its related hydrogen production process in order to explore how it helps solve energy-related environmental issues. Besides, this project will also employ qualitative and quantitative studies to analyze and compare different hydrogen storage methods in order to determine a feasible approach that can be widely used in the industrial sector. Overall, the results will shed light on guiding future research of underground hydrogen storage (UHS) that will be contributed to the way of sustainability.

This research focuses on the integration of solar based hydrogen gas production with RF code scanning for efficient utilization. Hydrogen gas is a promising alternative to traditional fossil fuels due to its high energy density and environmental friendliness. Solar-based hydrogen production systems utilize renewable energy sources, such as solar power, to generate hydrogen gas through electrolysis. To enhance the utilization of hydrogen gas, this project proposes the use of RF code scanning technology, enabled by Internet of Things (IoT) devices.

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CHAPTER 6

6 CONCLUSION

In conclusion, the integration of solar-powered green hydrogen gas production system with RF code scanning for efficient utilization holds significant promise for the transition to a sustainable energy future. Hydrogen gas, produced through electrolysis powered by solar energy, offers numerous advantages as a clean and renewable energy source. It has a high energy density, emits no greenhouse gases during usage, and can be stored and distributed for various applications. By incorporating RF code scanning technology, enabled by Internet of Things (IoT) devices, the utilization of hydrogen gas can be enhanced.

RF codes provide a convenient and secure method for tracking, monitoring, and controlling the distribution and usage of hydrogen gas. This ensures efficient management of the supply chain and enables seamless integration with various industries and applications. The solar-powered green hydrogen gas production system, coupled with RF ID scanning, enables the generation of hydrogen gas using renewable energy sources and ensures traceability and accountability throughout the entire value chain. This combination contributes to reducing reliance on fossil fuels, mitigating environmental impacts, and promoting a sustainable and cleaner energy ecosystem.

Furthermore, the utilization of hydrogen gas derived from solar power and facilitated by RF code scanning opens up a wide range of possibilities. It can be used for transportation, electricity generation, heating, and various industrial processes, thereby diversifying the energy mix and driving the transition towards a carbon-neutral economy. In conclusion, the integration of solar-powered green hydrogen gas production system with RF code scanning technology offers a compelling solution for the efficient and sustainable utilization of hydrogen gas. It represents a significant step towards achieving a cleaner, greener, and more energy-independent future.

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DEVELOPING SMART SELF ORIENTING SOLAR TRACKER FOR MOBILE PV POWER GENERATION SYSTEMS

PROJECT REPORT - II

Submitted By

A. RANJITH KUMAR (912021415006)

In partial fulfilment for the award of the degree of

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ABSTRACT

The demand for efficient and sustainable energy solutions has driven extensive research in the field of photovoltaic (PV) power generation systems. This paper presents the development of a Smart Self-Orienting Solar Tracker (SSOST) designed for mobile PV installations. The proposed system integrates a set of key components including solar panels, batteries, a power supply unit, an Arduino Uno microcontroller, an LCD display, an IoT module, an inverter, a setup transformer, and a voltage sensor.

The core functionality of the SSOST revolves around the ability to dynamically adjust the orientation of the solar panels to maximize energy harvesting by precisely tracking the sun's position. This is achieved through real-time data collection from the IoT module, which captures solar voltage readings. These readings are relayed to the Arduino Uno microcontroller for processing and control, and are subsequently displayed on the LCD screen, providing valuable visual feedback on the system's performance.

The inclusion of a battery system ensures uninterrupted power supply, allowing the SSOST to operate efficiently even during periods of low solar irradiance. The inverter and setup transformer work in tandem to convert the DC power generated by the solar panels into usable AC power, ensuring seamless integration with existing electrical grids or appliances.

The SSOST offers distinct advantages over static solar installations, particularly in mobile applications where tracking the sun's movement is critical for optimizing energy output. Through an integrated IoT module, the system is capable of remote monitoring and control, allowing for real-time adjustments and data logging. This not only enhances the system's operational efficiency but also provides valuable insights for performance analysis and maintenance.

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CHAPTER - VI

6.1 CONCLUSION

The development of the Smart Self-Orienting Solar Tracker (SSOST) marks a significant milestone in the evolution of mobile PV power generation systems. Through the integration of advanced components and intelligent control mechanisms, this project has demonstrated the potential to revolutionize energy harvesting in dynamic environments.

The primary advantage of the SSOST lies in its ability to dynamically adjust the orientation of solar panels, ensuring they remain optimally aligned with the sun's rays throughout the day. This dynamic tracking capability significantly enhances energy yield, making it a valuable solution for applications where mobility and efficiency are paramount.

The incorporation of an IoT module further elevates the SSOSTs capabilities. This feature enables remote monitoring and control, allowing for real-time adjustments and data logging. The ability to gather and analyze performance data not only enhances operational efficiency but also provides valuable insights for maintenance and optimization.

The inclusion of a battery system ensures uninterrupted power supply, allowing the SSOST to operate reliably even in conditions of low solar irradiance. This feature is particularly crucial in mobile applications where consistent power generation is essential.

The system's compatibility with existing electrical grids or appliances is facilitated by the inverter and setup transformer, which efficiently convert the DC power generated by the solar panels into usable AC power.

While the SSOST presents a promising solution, there are avenues for further research and development. Fine-tuning control algorithms and incorporating predictive tracking based on weather conditions could further enhance energy harvesting efficiency. Additionally, exploring materials and designs to increase the durability and

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OPTIMIZING A DIGITAL TWIN FOR FAULT DIAGNOSIS IN GRID CONNECTED INVERTERS

PROJECT WORK - II

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ABSTRACT

In this project, conducted a parameter tuning-based optimization of digital twins aimed at diagnosing various faults in solar power grid-connected inverters. The task of fault detection and diagnosis necessitates a remarkably high level of precision, which is achieved through the online optimization of the digital twins. This approach facilitates flexible implementation even when dealing with a limited dataset.

Consequently, the proposed framework incorporates model versioning and deployment of digital twin designs using Python and Matlab Simulink, demonstrating its adaptability to scenarios with constrained data resources. Furthermore, the framework enables the integration of additional tools to enhance parameter tuning capabilities.

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.6. Conclusions.

This project presents a comprehensive approach to analysing and simulating solar PV array panel systems under varying conditions and fault scenarios. By integrating MATLAB and Python for simulation, data collection, and digital twin modelling, we've gained valuable insights into the system's performance and resilience. This integration supports predictive maintenance and optimization efforts to enhance efficiency and reliability.

The proposed framework for optimizing digital twins in fault diagnosis of grid-connected inverters, utilizing online data, promises improved accuracy and confidence in decision-making. We plan to deploy this framework in a practical setting and expand our online stability assessment mechanism. We also aim to explore its applicability in horizontal federated learning for shared prediction models across power electrical circuits.

Our study of fault detection techniques revealed a reliance on AI-based methods, particularly supervised learning. We see potential in exploring unsupervised, semi-supervised, and reinforcement learning-based techniques. Overall, our work highlights the need to improve fault classification under noisy conditions and incorporate inductance estimation in current emulators for enhanced fault detection, particularly in high-power scenarios. These endeavours will drive efficiency and reliability in power converters.

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A HIGH-POWER FACTOR BIDIRECTIONAL BATTERY CHARGER USING SINGLE PHASE MATRIX CONVERTER

PROJECT WORK-II

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ABSTRACT

This paper presents the design and implementation of a high-power factor bidirectional battery charger system. The charger is designed to efficiently manage the charging and discharging of batteries while ensuring a high power factor, which is crucial for minimizing energy losses and reducing harmonic distortion in the grid.

The bidirectional functionality allows the charger to operate in both charging and discharging modes, enabling energy transfer between the battery and the grid or other energy sources. This flexibility makes it suitable for a wide range of applications, including renewable energy integration, electric vehicle charging, and energy storage systems.

Key features of the charger include advanced power electronics control algorithms, a high-frequency converter, and power factor correction techniques to maintain a near-unity power factor during operation. This not only improves energy efficiency but also ensures compliance with grid standards and regulations.

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9. CONCLUSION

A single-phase unity power factor bidirectional battery charger system is proposed in this paper. The simulation results verify the operation characteristics of the proposed system. In summary, the proposed battery charger system has a number of attractive features, such as its capability of fully controllable to perform bidirectional operation by using only a single circuit topology and able to operate in stand-alone as well as in grid connected mode. Moreover, the proposed battery charger system is able to operate in almost unity power factor. Since this work only intends to validate the topology and the control algorithms, the developed prototype that supports this work is intentionally oversized. The experimental results obtained with the three operation modes (G2V, V2G and V2H) are in accordance with the expected, validating the viability of the proposed topology. As future work, the power converters will be redesigned in order to obtain a prototype with size and weight adequate to be integrated in an EV.

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A DESIGN OF FUZZY CONTROLLED MULTI OUTPUT DC-DC CONVERTER

A PROJECT REPORT

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