International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

A Noval Ultra Wide Output Range DC-DC Converter for EV Fast Charging

Mary Sumitha M[1], Afzal A[2], Arumuga Gopal M[3], John Robin J[4], Joshua I [5]
[1,2,3,4,5]Department of Electrical and Electronics, Francis Xavier Engineering College, Tirunelveli, India
***EmailID:** marysumitha@francisxavier.ac.in[1], afzala.ug22.ee@francisxavier.ac.in[2], arumugagopalm.ug22.ee@francisxavier.ac.in[3],johnrobinj.ug22.ee@francisxavier.ac.in[4], joshuai.ug22.ee@francisxavier.ac.in[5]*

Abstract
High-performance and dependable fast charging systems are becoming more and more necessary as electric vehicles (EVs) proliferate. Conventional charging converters frequently have issues with power density, efficiency, and their capacity to function over the broad output voltage ranges needed by various battery chemistries. This work suggests a novel resonant DC–DC converter topology made especially for EV fast-charging applications in order to overcome these difficulties. For next-generation charging infrastructure, the suggested system seeks to offer high efficiency, adaptable voltage control, and enhanced thermal performance. Compatibility with various battery configurations and charging protocols is made possible by the proposed converter's ultra-wide output voltage range of 6 V to 18 V. Soft switching methods like Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS), which drastically lower switching losses and electromagnetic interference, are made possible by the incorporation of a resonant tank network. The converter increases overall energy conversion efficiency and boosts system reliability by reducing switching stress on power semiconductor devices. The converter uses a variable frequency control strategy, which dynamically modifies the switching frequency to maintain ideal resonance conditions across a range of load and voltage levels, in order to further enhance performance. Throughout the whole operating range, this strategy guarantees effective energy transfer. Furthermore, a dual-phase interleaved structure is used to spread the power flow over several channels, which lowers current ripple, enhances thermal control, and raises the converter's overall power density.

***Keywords:** Electric Vehicle Fast Charging, Resonant DC–DC Converter, Soft Switching (ZVS/ZCS), Variable Frequency Control, Interleaved Converter, High-Efficiency Power Conversion.*

1. Introduction

The need for fast-charging systems that are effective, dependable, and flexible enough to accommodate large battery voltage fluctuations has increased due to the quick growth of electric vehicles (EVs). EV batteries have a wide operating voltage range during charging because of differences in their chemistry, capacity, and state of charge. Under these fluctuating circumstances, conventional power converters struggle to maintain high efficiency and steady performance. Overall charger performance is lowered by high switching losses, poor voltage adaptability, and a slow transient response. The softswitching capability of resonant DC–DC converters reduces losses and electromagnetic interference. Power density and thermal management are also important design factors in contemporary EV charging systems. Fast charging generates a lot of heat because it transfers a lot of energy in a short amount of time. System dependability and component longevity are jeopardized in the absence of effective conversion and optimized thermal performance. Therefore, to meet the demands of future EV infrastructure, novel power converter architectures are needed. For high-efficiency power conversion applications, resonant DC-DC converters have shown great promise. Resonant converters use soft-switching methods like Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS), in contrast to traditional pulse-width modulated (PWM) converters. By guaranteeing that semiconductor devices switch under ideal voltage or current conditions, these methods drastically lower switching losses. As a

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

result, switching stress, electromagnetic interference, and heat production are reduced, improving the system's overall efficiency. Maintaining high efficiency over a broad output voltage range is crucial for EV fast charging applications. During charging cycles, battery voltage can fluctuate greatly, particularly in lithium-ion and emerging battery chemistries. When there are light loads or high voltage conditions, traditional converters frequently lose efficiency. The system can dynamically adjust to shifting load and voltage conditions while maintaining softswitching operation thanks to a resonant topology and variable frequency control. Additionally, resonant converters allow for the use of smaller passive components like capacitors and inductors by supporting higher switching frequencies. This helps to improve dynamic response, decrease system size, and increase power density. These features are especially helpful for EV charging stations, where thermal control, efficiency standards, and space limitations are important considerations. A unique resonant DC-DC converter topology created especially for EV fast charging applications is presented in this project. The suggested system maintains high efficiency under a variety of load conditions while achieving an ultra-wide output voltage range of 6V–18V. In order to minimize switching losses and increase reliability, the converter incorporates a meticulously optimized resonant tank network to guarantee soft switching (ZVS/ZCS) over the whole operating range. To improve thermal distribution and power handling capacity, a dual-phase interleaved configuration is used. Input and output current ripple is greatly decreased by operating two converter phases interleaved. This increases electromagnetic compatibility, lowers stress on passive components, and increases efficiency. Interleaving also increases the thermal balance between power switches, which extends the life of the system. Variable frequency modulation is used in the control strategy to efficiently control output voltage and current. In contrast to fixed-frequency methods, this technique ensures continuous soft switching and optimal energy transfer by adjusting switching frequency based on load conditions. To enable smooth transitions between constant voltage (CV) and constant current (CC) charging modes, a novel output regulation technique is also used. This is especially crucial for modern charging protocols and compatibility with various battery chemistries. Validation of hardware prototypes verifies the efficacy of the suggested design. High peak efficiency and stable operation under dynamic load conditions are shown by the experimental results. The converter can be integrated into future high-power EV charging infrastructure, such as fast and ultra-fast charging stations, thanks to its scalable architecture. Variable frequency modulation is used in the control strategy to efficiently control output voltage and current. In contrast to fixed-frequency methods, this technique ensures continuous soft switching and optimal energy transfer by adjusting switching frequency based on load conditions. To enable smooth transitions between constant voltage (CV) and constant current (CC) charging modes, a novel output regulation technique is also used. This is especially crucial for modern charging protocols and compatibility with various battery chemistries. Validation of hardware prototypes verifies the efficacy of the suggested design. High peak efficiency and stable operation under dynamic load conditions are shown by the experimental results. The converter can be integrated into future high-power EV charging infrastructure, such as fast and ultra-fast charging stations. Power signals have experienced undesired variations as a result of this tendency. Power Quality Disturbance Events (PQDEs) are the collective term for these variations from typical voltage, current, or frequency values. Transients, harmonics, voltage sag/swell, imbalanced voltage/current, and interruptions are examples of common PQDEs. Serious repercussions from these disruptions may include sympathetic tripping, malfunctioning protection and control devices, harm to delicate electronic devices, memory failures in monitoring systems, decreased productivity, more. Consumers, utilities, and industries are all impacted by these effects, with end users ultimately suffering. [1-5]

2. Literature Review

To lessen air pollution in densely populated urban areas, electric vehicles (EVs) are required. The DC

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

voltage required to charge the high-energy battery parks found in EVs is provided by battery chargers. The on-board battery charger setup discussed in this paper is entirely dependent on the EV motor drive's power components. The suggested solution fully satisfies the desired characteristics for EV battery chargers, including minimal volume, low cost, high efficiency, and high reliability. A prototype electric scooter being developed for the Far East markets has the suggested on-board charger arrangement installed. The on-board charger prototype's design analysis and experimental findings are shown. In the coming decades, electric vehicles (EVs) are probably going to remain a part of the light vehicle market. EV charging will therefore increase the strain on the distribution grid, and in certain situations, changes must be made. However, EVs may also be able to help the grid. In order to reduce production costs, this paper proposes a single-phase bidirectional charger topology that combines an EV charger with a photovoltaic (PV) source. Vehicle-to-grid (V2G) services are then implemented using the topology that has been presented. This paper primarily focuses on power quality services that only slightly deplete the battery. In order to compensate for voltage drops brought on by motor startup or inductive loads, it investigates the potential for local reactive injection of EVs connected to the grid via a single-phase charger. In order to maintain system stability during PV transients in cloudy weather, it also investigates the possibility of active power injection of EVs for brief periods of time. Additionally, it investigates how EVs might support PV sources during low voltage ride-through. Simulink simulations and a real-time implementation in Real Time Digital Simulator (RTDS) are used in the research. The outcomes show how well power-quality V2G services work with minimal EV battery wear. IEC 61000-3-2 Ed.2.2000 [1] is the fundamental test procedure for harmonic current emissions into the mains supply. This has been adopted with some common modifications because, when using the self-declaration to standards route to conformance, the harmonized European standard EN 61000-3-2 is now required (for all equipment within its scope) for conformity with the electromagnetic compatibility (EMC) Directive [3]. Solid-state switch-mode rectification converters have advanced to a high degree of maturity, especially in terms of minimizing total harmonic distortion at the AC input, achieving effective power factor correction (PFC), and providing precisely regulated DC output in a variety of configurations, including buck, boost, buck–boost, and multilevel modes. Additionally, unidirectional and bidirectional power flow are supported by these converters. A thorough analysis of improved power quality converter (IPQC) topologies, including control strategies, design considerations, component selection, and other important aspects, is presented in this work. The appropriateness of various setups for particular purposes is also covered. The goal is to give researchers, designers, and application engineers a thorough understanding of the most recent developments in IPQC technology for switched-mode AC–DC conversion. We introduce a bridgeless buck power factor correction rectifier that significantly increases efficiency at the low line of the universalline range. The efficiency of the suggested rectifier is further increased by removing input bridge diodes. Additionally, following a dropout of the line voltage, the rectifier doubles its output voltage, extending the bulk capacitor's usable energy. A 700-W, universal-line experimental prototype running at 65 kHz was used to confirm the suggested circuit's functionality and performance. The observed efficiencies of the 115 and 230 V lines at 50% load are both close to 96.4%. The efficiency gap between the high and low lines is less than 0.5% at maximum load. To show that the combined power stages easily meet the Climate Saver Computing Initiative Gold Standard, a secondstage half-bridge converter was also implemented. This paper presents a systematic review of dual boost PFC rectifiers, also known as bridgeless PFC boost rectifiers. A representative member of the bridgeless PFC boost rectifier family and the traditional PFC boost rectifier are compared in terms of performance. For both CCM and DCM/CCM boundary operations, loss analysis and an assessment of experimental efficiency are given. Common-mode noise, continuousconduction mode (CCM), discontinuous-conduction mode (DCM)/CCM boundary, dual-boost PFC rectifier,

e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

single-phase rectifier, and bridgeless power factor correction (PFC) are index terms. The active power factor correction (PFC) converter lowers the line current harmonics to the suggested IEC 61000-3-2 power quality (PQ) standard for the electric vehicle (EV) battery charger and reshapes the line current proportionate to the input voltage. However, because a rectification diode is used at the charger's input end, modern car chargers with integrated PFC experience additional high conduction loss. This study describes a simplified bridgeless (BL) topology for EV battery chargers that rely on the buckboost configuration. Because fewer semiconductor components conduct over a single switching cycle during charging operation, the conduction loss is significantly reduced. The built-in PFC capability at the mains side is inherited, and the suggested bridgeless converter comes before a flyback converter to control the charging of a 48V/100Ah battery throughout the constant current (CC)/constant voltage (CV) profile. By reconstructing the line current waveform and drastically lowering the input harmonic distortion to the suggested IEC 61000-3-2 standard, an 850W prototype is created to support the improved battery charger performance. New bridgeless single-phase ac–dc power factor correction (PFC) rectifiers based on Sepic and Cuk topologies are proposed. The absence of an input diode bridge and the presence of only two semiconductor switches in the current flowing path during each switching cycle result in less conduction losses and improved thermal management compared to the conventional Sepic and Cuk PFC converters. The proposed topologies are designed to work in discontinuous conduction mode (DCM) to achieve almost unity power factor in a simple and effective manner. Additional benefits of DCM operation include zerocurrent turn-on in power switches and zero-current turn-off in output diodes, as well as a reduction in control circuitry complexity. Theoretical research is done on the suggested rectifiers. The suggested and traditional Sepic PFC rectifiers are compared in terms of performance. To assess the performance of the suggested PFC rectifier, simulation and experimental results are given for a design example of a 65-W/48-V at 100-Vrms line voltage. This paper uses a bridgeless (BL) ZETA to address power factor correction (PFC) in low voltage high current (LVHC) multistring light emitting diodes (LED). Large-scale LED lighting with illumination control is the intended use for this application. Lighting control is achieved through a multi-mode LED dimming technique. The isolated flyback DC-DC converter receives power from the BL-ZETA PFC converter. The synchronous buck converters for the multi-string LED driver and the forced cooling system for the LED junction are powered by the controlled low voltage from the flyback converter. Discontinuous inductor current modes (DICM), which offer good PFC at a low cost, are the foundation of the BL-ZETA PFC converter inductor design. Hardware test results are used in the design and development of the suggested LED driver. With dimming control capability for universal input AC (90-265 V), the critical parameter of the LED driver is tested and measured at full load. The total harmonic distortion (THD) exceeds the IEC 61000-3-2 Class C harmonic limits. One well-liked technique that is frequently used in electronic circuit design is the voltage lift technique. The voltage lift technique can improve circuit characteristics because parasitic elements limit the output voltage and power transfer efficiency of DC-DC converters. This method has been successfully used for DC-DC converters after extensive research. Similar to positive output Luo converters, negative output Luo converters are a new class of DC-DC step-up (boost) converters that were created from voltage lift prototypes. These converters have a straightforward structure, high power density, high efficiency, and inexpensive topology while converting positive to negative DC-DC voltage. They differ from other DC-DC step-up converters currently in use and have a number of benefits, such as a high output voltage with minimal ripples. As a result, these converters will be extensively utilized in industrial and computer peripheral applications, particularly for high output voltage projects. [6-10]

3. Existing System

The majority of current EV fast-charging systems use traditional hard-switched DC–DC converter topologies, such as buck, boost, and buck–boost converters. LLC resonant converters are also employed in some sophisticated designs to increase efficiency. Because of their straightforward design, wellestablished control techniques, and simplicity of use, these converters are widely used. Nevertheless, the majority of these converter structures are only intended to function effectively within a restricted output voltage range, making them less appropriate for accommodating the various EV battery chemistries and fluctuating battery voltage levels needed in contemporary charging systems. When there is non-zero voltage or current, hard-switching converters work by turning the switching devices on and off. When operating at the high switching frequencies and power levels usually needed for fast charging applications, this leads to high switching losses. Power losses in semiconductor devices rise with switching frequency, which lowers conversion efficiency and raises heat production. As a result, the system's overall size and cost rise as more thermal management solutions, like heat sinks and cooling systems, are required. Additionally, a lot of current EV charging systems use singlephase converter architectures, which limit the system's overall power density. Reduced reliability and uneven thermal distribution can result from high current stress on individual components. Additionally, when these systems are operating under dynamic load conditions, like when battery charging states change quickly, they frequently exhibit slow transient response. This may result in transient instability in the regulation of voltage or current, which would impact the charging performance as a whole. While resonant converters, like the LLC converter, can achieve higher efficiency than conventional hard-switched converters, their performance is usually optimized around a particular operating point. The efficiency of the converter significantly decreases when the load condition or output voltage deviates from this nominal point. Because of this, the system finds it difficult to sustain peak performance over a broad operating range, which is crucial for contemporary EV fast-charging applications.

3.1.Result & Discussion

Hard-switched DC-DC converters suffer significant switching losses, particularly at high frequencies and power levels, according to a performance analysis of current EV fast-charging systems. As a result, power semiconductor devices become less efficient and produce more heat. The system displays unstable voltage regulation and slower transient response as the load fluctuates during various charging stages. When operating outside of the intended voltage and load range, LLC resonant converters perform worse even though their efficiency increases close to their resonant operating point. Furthermore, the charging system's overall dependability and scalability are impacted by single-phase architectures, which restrict power density and result in uneven thermal distribution. [11-15]

3.2.Drawbacks of Existing System:

The efficiency and performance of current EV fast-charging systems are hampered by a number of issues. When operating at high frequencies, hard-switched DC-DC converters generate large switching losses, which result in decreased efficiency and increased heat generation. These systems are less compatible with various EV battery types and charging requirements because they usually only support a small output voltage range. Complex cooling mechanisms are required due to high thermal stress on semiconductor devices, which increases the size and cost of the system. Single-phase converter architectures also limit power density and produce unequal component thermal distribution. The converters frequently exhibit unstable voltage regulation and slow transient response during dynamic load variations. [16-20]

4. Proposed System

A unique resonant DC–DC converter topology designed for EV fast-charging applications is introduced in the suggested system. It is compatible with a variety of battery chemistries thanks to its ultrawide output voltage range of 6 V to 18 V. Under all operating conditions, an optimized resonant tank guarantees zero voltage and zero current switching. This increases efficiency and drastically lowers switching losses. Resonant operation is maintained while the output is dynamically regulated by a variable-frequency control scheme. Power density is increased and current ripple is decreased with a dual-phase interleaved structure. Additionally, it enhances dependability and thermal management. The smooth

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

transition between voltage and current modes is made possible by an innovative output regulation technique. Rapid changes in load don't affect the system's stability. Figure 1 shows Block Diagram

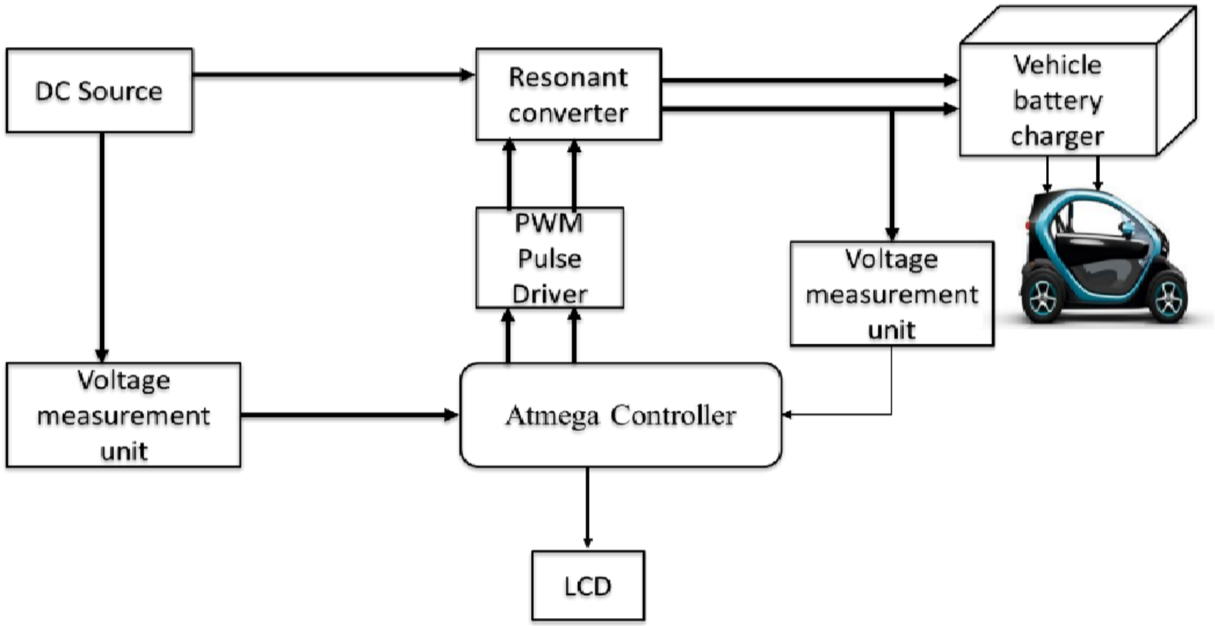

Figure 1 **Block Diagram**

Fast charging systems that are dependable and efficient are in high demand due to the explosive growth of electric vehicles (EVs). EV fast chargers must provide high power levels while upholding high efficiency, safety, and dependability, in contrast to traditional charging systems. The DC–DC converter, which controls and transforms electrical power to match the battery requirements of the electric vehicle, is one of the most important parts of a fast charging station. A broad range of EV battery voltages, usually from 200V to 800V or higher, can be supported by the suggested Ultra-Wide Output Range DC–DC Converter. The charger must be able to adjust its output voltage while retaining stable operation and high efficiency because different electric vehicles run at different battery voltage levels. The system makes use of wide bandgap semiconductor devices, sophisticated power electronics topologies, and clever digital control strategies to accomplish this. The suggested system's block diagram shows a structured architecture with multiple stages of electrical power flow. Power conditioning, voltage conversion, filtering, control, and protection are just a few of the specific tasks that each stage completes. Before regulated DC power is supplied to the EV battery, the system starts with the AC grid input and moves through several power conversion and control blocks.

4.1.AC Grid Input and Power Conditioning Stage:

The AC grid input is the first step in the EV fast charging system. The electrical power grid, which normally provides alternating current (AC) at voltages like 230V single phase or 415V three phase depending on the infrastructure, is connected to the charging station at this stage.

Nevertheless, direct current (DC) is needed to charge EV batteries. Consequently, the AC power needs to be converted into DC power before it can be utilized to charge batteries. To do this, a rectification and power factor correction stage is employed.

4.2.Power Factor Correction (PFC) Rectifier:

Because it guarantees that the charger draws current from the power grid effectively without producing needless power losses or distortion, a high power factor is crucial. The charger would draw non-

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

sinusoidal current from the grid in the absence of PFC, which might result in decreased efficiency and more strain on the electrical infrastructure.

Active PFC circuits are utilized in place of passive ones in contemporary EV chargers. In order to mold the input current waveform to match the grid's sinusoidal voltage waveform, active PFC circuits use controlled semiconductor switches like MOSFETs or IGBTs. As a result, the power factor approaches unity. [21]

4.3.High-Frequency DC–DC Converter Stage:

The high-frequency DC–DC converter stage receives the regulated DC voltage after the PFC stage has transformed the AC power into DC. Because it modifies the voltage level to meet the needs of the EV battery, this stage is the essential part of the EV fast charging system. Since different EVs run at different battery voltage levels, the DC–DC converter needs to support a broad output voltage range. While more recent high-performance EVs might use 800V architectures, some EVs use 400V battery systems. As a result, the converter needs to be able to step voltage up or down without sacrificing efficiency.

4.4.Constant Current (CC) Mode:

The battery is charged with a steady current during the first stage of charging. This enables quick energy transfer to the battery.

4.5.Constant Voltage (CV) Mode:

The charging system enters constant voltage mode when the battery voltage reaches its maximum permitted level. Until the battery is fully charged, the voltage stays constant while the current progressively drops. To guarantee safe and effective charging, the battery management interface continuously checks battery parameters like voltage, current, temperature, and state of charge.

4.6.Digital Control Unit:

The controller continuously analyzes feedback information from voltage and current sensors. To maintain the intended output conditions, the controller modifies the duty cycle or phase shift of the switching devices based on these signals. Stable performance across a broad voltage range is ensured by this closed-loop control. Figure 2 shows Circuit Diagram

4.7.Circuit Diagram

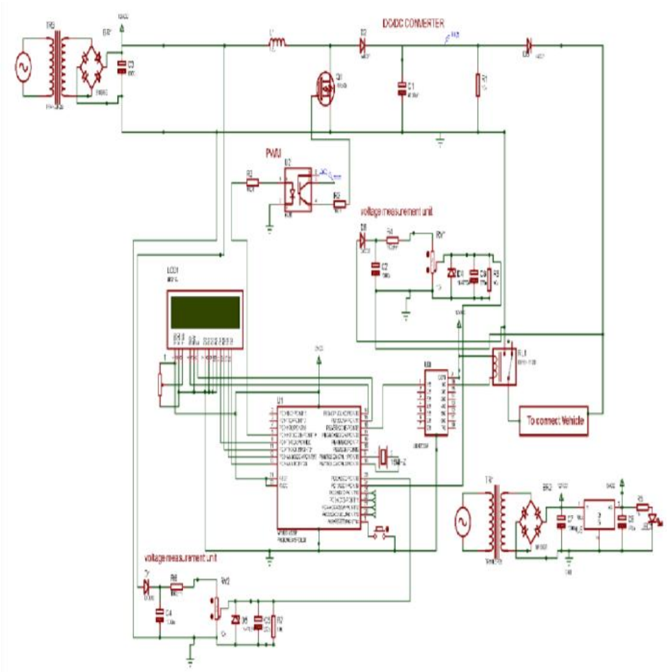

Figure 2 **Circuit Diagram**

The circuit shown here is a comprehensive microcontrollerbased DC charging and monitoring system intended to safely control the delivery of energy to a car battery, monitor charging parameters, and regulate electrical power. AC-to-DC power conversion, a switching DC-DC converter stage, voltage sensing circuits, microcontroller-based control logic, relay protection, and LCD display interfacing are just a few of the functional components that the system combines. The AC power input from the electrical mains starts the system's operation. The incoming AC supply is first stepped down using a transformer designated TR3 because electronic circuits cannot function directly from high AC mains voltage. In addition to offering basic electrical isolation from the grid, the transformer lowers the high mains voltage to a lower AC voltage level appropriate for power conversion and charging. A full bridge rectifier stage, denoted by BR1, receives the reduced AC voltage from the transformer secondary winding. The four diodes that make up the bridge rectifier are positioned so that both halves of the AC waveform are transformed into pulsating DC. Because the output waveform is not entirely smooth,

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

ripple components are still present even after this process transforms alternating current into direct current. To reduce this ripple and provide a more stable DC voltage, a large electrolytic capacitor C3 is connected across the rectifier output. This capacitor acts as a smoothing filter by storing charge during voltage peaks and releasing it when the voltage drops, thereby reducing fluctuations and producing an unregulated but relatively smooth DC supply that feeds the next stage of the system.

5. Hardware Implementation

5.1.ATMEGA 328 Controller:

Microchip produces the ATmega328, an 8-bit, 28-pin AVR microcontroller with a flash-type program memory of 32KB and a RISC architecture. It has 2KB of SRAM memory and 1KB of EEPROM memory. For ADC operations, it has eight pins, which add up to Port A (PA0–PA7). Additionally, it has three built-in timers, two of which are 8-bit timers and one of which is a 16-bit timer. The Arduino UNO, which is based on the Atmega328 microcontroller, is probably familiar to you. It is the heart of UNO. Although we typically use 5V as a standard, it can operate between 3.3V and 5.5V. Its cost-effectiveness, low power dissipation, security-related programming lock, and real timer counter.

5.2.Atmega328 pin out:

If you are working on an engineering project, you must first read the pinout of the components since pinout diagrams allow us to comprehend the pin arrangements of any electrical equipment. Figure 3.

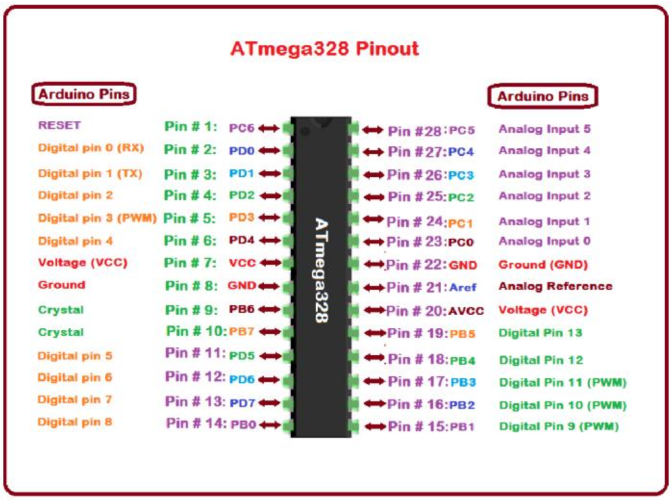

Figure 3 AT mega328 Pinout

5.3.ATmega-328 architecture:

The capacity of flash memory is 32 KB. It has an address of 15 bits. It is a Read Only Memory (ROM) that can be programmed. It is memory that is not volatile.Static Random Access Memory is referred to as SRAM. Since it is a volatile memory, data will be deleted once the power source is cut off.Electrically Erasable Programmable Read Only Memory is referred to as EEPROM. It contains long-term data. The ATmega 328 and Arduino can be utilized in a variety of practical applications.It can be applied to projects involving embedded systems.Robotics is another application for it. It can also be used to design miniature airplanes and quadcopters. • This device can also be used to prepare power management and monitoring systems. Figure 4 shows AT mega328 Architecture

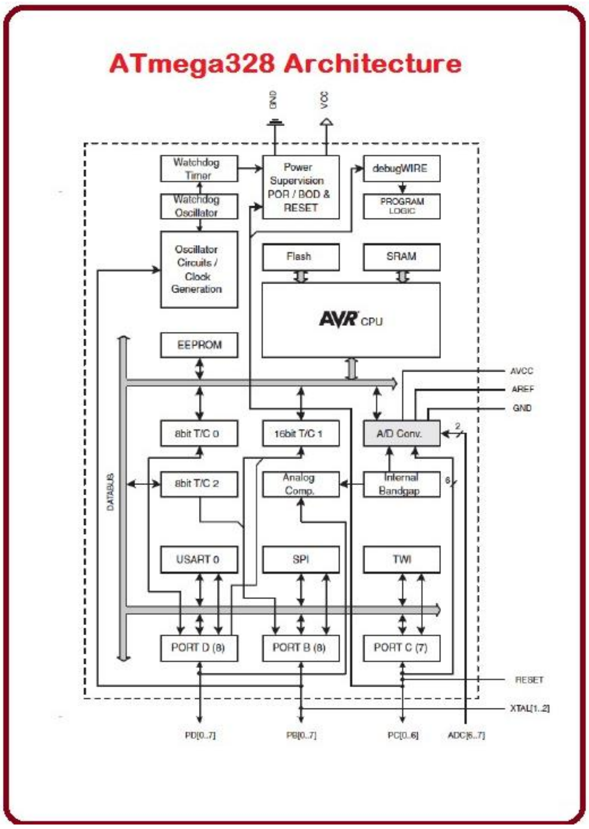

Figure 4 AT mega328 Architecture

5.4.LCD – Liquid Crystal Display:

Instead of having a melting point, they have a range of temperatures where the molecules are nearly as mobile as they would be in a liquid but are arranged

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

in a crystal-like order. Sand, a liquid crystal material, is sandwiched between two glass panels to form an LCD. Transparent electrodes that define the character, symbols, or patterns to be displayed are applied to the inner surface of the glass plates. Polymeric layers are present between the electrodes and the liquid crystal, causing the liquid crystal molecules to maintain a specific orientation angle. Figure 5 shows LCD-Liquid Crystal Display

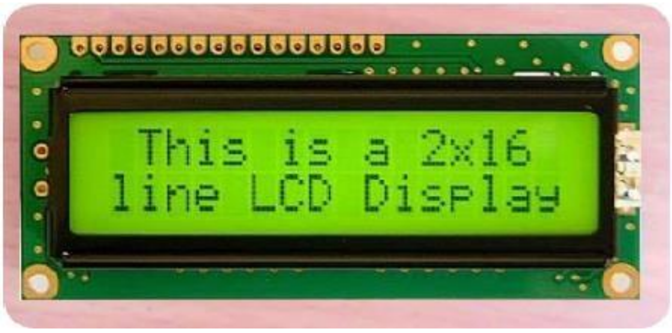

Figure 5 LCD-Liquid Crystal Display

Outside of the two glass panels, one polarizer is adhered. The light beams going through them would be rotated to a specific angle and direction by this polarizer. The two polarizers and the liquid crystal rotate light rays when the LCD is in the off state, causing the light rays to exit the LCD without any orientation and giving the impression that the LCD is transparent. The liquid crystal molecules will align in a particular direction when the electrodes receive enough voltage. The polarizer would rotate the light rays going through the LCD, activating or highlighting the desired characters. Figure 6 shows Block Diagram for Power Supply

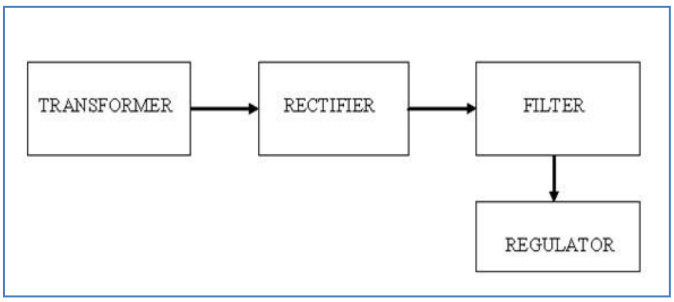

Figure 6 Block Diagram for Power Supply

The AC to DC power supply block diagram includes Transformer: Adjusts the voltage of the home line as needed.

Rectifier: This device transforms ac voltage into dc voltage. Filter: Create a fluctuating DC voltage by smoothing the pulsating DC voltage. Regulator: Set the output voltage to a steady level. Figure 7 shows Pin Diagram 4N35: IC 7805

5.5.Pin Details:

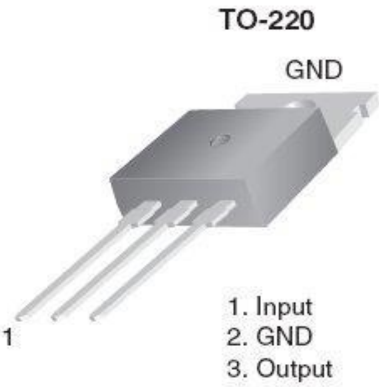

Figure 7 Pin Diagram 4N35: IC 7805

A photo transistor is a light-sensitive device, while an LED emits light. Despite the physical separation of the two devices, the conduction current of the LED can be used to control the conduction current of the phototransistor. Because the input (LED) and output (phototransistor) devices are optically coupled, such a package is called an opto coupler. A circuit connected to the opto coupler device can be electrically completely isolated from the output circuit, and a potential difference of hundreds or thousands of volts can safely exist between these two circuits without negatively affecting the opto coupler action. This is the most significant feature of the device. Figure 8 shows PIN Diagram 4N35

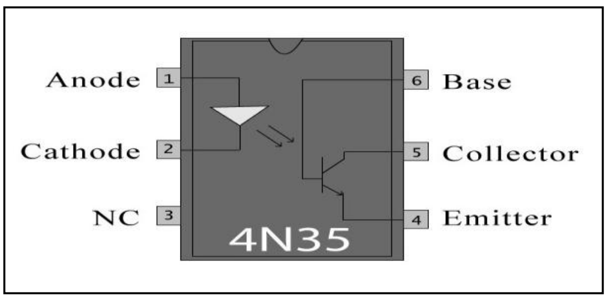

Figure 8 PIN Diagram 4N35

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

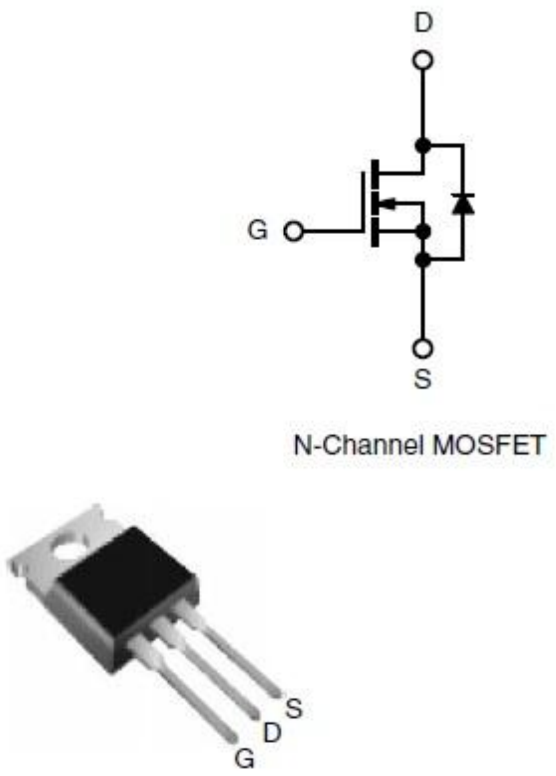

Figure 9 **MOSFET IRF840**

The best combination of quick switching, ruggedized device design, low on-resistance, and affordability is offered to designers by Vishay's third generation Power MOSFETs. For all commercial-industrial applications up to about 50 W of power dissipation, the TO-220AB package is the standard. The TO220AB is widely accepted in the industry due to its low package cost and low thermal resistance.

6. Software Implementation

6.1.ARDUINO IDE

Microcontrollers and embedded systems are frequently programmed using the open-source Arduino IDE (Integrated Development Environment). It offers an easy-to-use interface for creating, assembling, and uploading code to Arduino boards and other compatible hardware. Developing embedded applications is made simple for novices and researchers by the software's support for programming in C and C++-based languages. The control algorithm and hardware interface for the EV fastcharging system are developed in this project using the Arduino IDE. Through serial communication and libraries, it enables effective communication between the microcontroller and the linked sensors or converters. The development process is made much simpler and system reliability is increased by the availability of built-in libraries, debugging tools, and example programs. The Arduino IDE's cross-platform compatibility—it can operate on Windows, Linux, and macOS—is a significant benefit. Researchers and developers can simply design and test embedded systems without complicated software requirements thanks to this flexibility. Code editing, error detection, compilation, and direct program uploading to the microcontroller via a USB interface are among the features of the IDE. The Arduino IDE is frequently used to implement monitoring and control features for voltage, current, and system protection in power electronics and energy-based projects. The Arduino IDE helps manage system parameters, control switching operations, and effectively test the hardware prototype in the suggested EV fast-charging system. Customization and integration with other libraries and hardware modules are also made possible by its open-source nature.

Conclusion

A high-efficiency, wide-output voltage power conversion solution appropriate for contemporary electric vehicle infrastructure is demonstrated by the suggested resonant DC– DC converter for EV fast charging applications. Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS), which greatly lower switching losses and improve overall system efficiency, are used in the converter's design to achieve soft switching operation. The converter is compatible with different EV battery chemistries and charging needs because it uses a variable frequency control strategy to maintain stable operation over a broad output voltage range of 6V–18V. Furthermore, the dual-phase interleaved architecture evenly distributes thermal stress among switching components, lowers current ripple, and increases power density. This design strategy guarantees effective operation under high-power charging conditions, increases system dependability, and enhances thermal management. Additionally, the optimized resonant tank circuit facilitates seamless

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

transitions between constant current and constant voltage charging modes and guarantees effective energy transfer under various load conditions. Stable voltage regulation, less switching stress, and high peak efficiency under dynamic load variations are confirmed by hardware implementation and experimental validation. Additionally, the system exhibits quick transient response, which is necessary for dependable EV fast-charging operations. Compact design and enhanced system safety are further benefits of decreased heat production and electromagnetic interference. The converter architecture's scalability makes it simple to incorporate into upcoming high-power EV charging stations. All things considered, the suggested converter offers a versatile, effective, and dependable solution that can meet the expanding need for cutting-edge EV fast-charging technologies.

References

[1]. S. B. Althurthi, "A Novel Ultra-Wide Output Range DC-toDC Converter for EV Fast Charging," Int. J. Emerging Innov. Electr. (IJEIE), vol. 5, pp. 586–597, 2024.

[2]. I. Kim and J. W. Park, "New Integrated DC-DC Conversion System for Electric Vehicles," IEEE Trans. Ind. Electron., vol. 71, no. 7, pp. 7126–7135, Jul. 2024.

[3]. S. Liu, G. Dong, T. Mishima, and C.-M. Lai, "Over 98% Efficiency SiC-MOSFET based Four-Phase Interleaved Bidirectional DC-DC Converter Featuring Wide-Range Voltage Ratio," IEEE Trans. Power Electron., 2024, DOI: 10.1109/TPEL.2024.3389052.

[4]. R. Ponnambalam, "GaN-Based DC-DC Converters for EV Fast Charging," Renew. Electr. Power Syst. Rev., 2025.

[5]. M. Vesali, "A New High Step-Down Zero Voltage Switching DC–DC Converter," IET Power Electron., 2025.

[6]. N. Bagheri, H. Alipour, L. Mohammadian, and J. Beiza, "A New High Step-Down Soft-Switched DC–DC Converter Based on Coupled Inductor," Int. J. Electron., vol. 112, no. 7, pp. 1396–1416, Jul. 2024.

[7]. R. Rostami et al., "High Gain Non-isolated Step-up DC-DC Converter Optimized for DC Microgrids," Sci. Rep., 2025.

[8]. A. C. Sunny, "A Multi-Output DC–DC Converter for Solid-State Transformer-Based Fast EV Charging Stations," Energy Convers. Syst. J., 2025.

[9]. W. Christopher, "A Bidirectional DC/DC Converter for Renewable-Fed Charging Stations," Renew. Energy Power Syst., 2024.

[10]. K. Velmajala, "A High Step-up Dual-Switch Luo NonIsolated DC-DC Converter," IEEE Trans. Power Electron., 2025.

[11]. V. T. K. Nhi, "Model Order Reduction of High-Gain DCDC Converters for Control Design," Eurasian Trans. Automat. & Syst. Res., 2025.

[12]. Y. Zhang, H. Fang, and L. Chen, "Multilevel, Multimodule DC-DC Converter Architecture for Universal EV Battery Charging," Proc. IEEE Int. Conf. Power Electron., 2025.

[13]. S. Habibi and R. Rahimi, "Interleaved High Step-Up Converter with Coupled Inductor and Built-In Transformer," Proc. Int. Conf. Power Electron. Appl., 2024.

[14]. T. Sakthiram and colleagues, "Single-Switch Ultra-High

[15]. Step-Up DC-DC Converter for PV and Charging Applications," Energy Proc., 2025.

[16]. H. Hasanpour, "A New Step-Up DC-DC Converter Topology Using Switched Inductor and Switched Capacitor Networks," IET Power Electron., 2025.

[17]. M. Lingamaiah, "A Vehicle-to-Grid Enabled Bidirectional

[18]. Multilevel Converter for arging and V2G," Chin. J. Electr. 2025. [17] S. Chaurasiya et al., "A Bidirectional Fast EV Charger for Wide Voltage Range Using Three-Level DAB," IEEE Trans. Ind. Appl., 2024.

[19]. V. Mahadeva-Iyer, "Parallel Operation of Partial Power DC-DC Converters for Ultra-Fast Charging of Electric

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0251
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1705 - 1716

Vehicles," Proc. IEEE APEC, 2026 (conference paper; accepted/presented).

[20]. X. Li, J. Zhou, and P. Wang, "Non-Isolated DC–DC Converters with Wide Conversion Range for High-Power Applications," Power Electron. J., 2026.

[21]. A. Lim and H. Lee, "Multi-Level DC–DC Converter for E- Mobility Charging with Low Ripple," Proc. IEEE Vehicle Power and Propulsion Conf., 2024.