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Design & Development Of a Dc Charging Unit For Various Engineering Applications

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Abstract
In this paper, the design & development of a DC charging unit for various engineering applications is presented. The DC Charger project is the creation of a charging system that converts AC power from the mains into a steady DC output for charging batteries and devices. The process involves using a transformer to step down the mains voltage, followed by a bridge rectifier that converts AC to pulsating DC. Smoothing capacitors then refine the DC waveform, which is further stabilized by voltage regulators to provide a consistent 12V output. A relay that manages the charging process. When the battery is fully charged, the relay disconnects the charging current. LED indicators provide visual cues for charging status. Protection mechanisms prevent issues such as overcurrent and overvoltage, ensuring safety. The project teaches about the basics of DC power electronics and how to design, build, components, and test a DC charger. It will also give you the opportunity to apply your skills in electronics and problem-solving. The work carried out is the second semester mini-project by the students of Electronics & Communication Engineering under the guidance of the faculties.
Keywords : Step down transformer, 7812 Voltage regulator, Voltage relay, Charging Unit

Introduction
DC chargers also known as Direct Current chargers, are essential devices used to charge electronic devices and batteries that require direct current power [1]. DC chargers to convert AC input into a constant flow of electrical energy in a single direction, catering to the specific voltage requirements of various devices [2]. The evolution of DC chargers is driven by the growing demand for portable electronics and electric vehicles, leading to advancements in technology, efficiency, and power delivery capabilities [3]. As technology continues to progress, DC chargers will remain indispensable components in our daily lives, empowering the seamless operation of electronic devices and promoting the adoption of cleaner and sustainable energy solutions [4].
DC chargers operate on the principle of converting alternating current (AC) from the grid into Direct current (DC) suitable for charging batteries [5]. The conversion process involves several stages, including rectification, inversion, and regulation [6]. In simpler terms, AC power is first rectified into a pulsating DC waveform, which is then smoothed into a more constant voltage level. This DC power is then delivered to the vehicle's battery at the appropriate voltage and current levels for efficient charging [7]. High-Speed Charging is One of the most significant advantages of DC chargers is their ability to deliver high power levels, enabling rapid charging [8]. This is particularly crucial for long journeys, where a quick top-up can significantly reduce travel time [9].
DC chargers is driven by the growing demand for portable electronics [10]. The conversion process involves several stages, including rectification, inversion, and regulation. In simpler terms, AC

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power is first rectified into a pulsating DC waveform, which is then smoothed into a more constant voltage level [11]. DC chargers are versatile devices used in a wide range of applications, from everyday consumer electronics to critical infrastructure and specialized industries [12]. They play a crucial role in providing reliable and efficient power sources for various devices and systems that depend on direct current electricity [13].
Solid-state switch-mode rectification converters have reached a matured level for improving power quality in terms of power-factor correction (PFC), reduced total harmonic distortion at input AC mains and precisely regulated DC output in buck, boost, buck-boost and multilevel modes with unidirectional and bidirectional power flow [14]. This paper deals with a comprehensive review of improved power quality converters (IPQCs) configurations, control approaches, design features, selection of components, other related considerations, and their suitability and selection for specific applications [15].

Scope of the project work

Device Charging: DC chargers are primarily used to charge various electronic devices, such as smartphones, tablets, laptops, etc. They provide a convenient and efficient way to power these devices, enabling seamless usage [16].

Problem statement

Energy Efficiency: As the demand for energy-efficient solutions increases, optimizing the efficiency of DC chargers becomes essential to minimize power wastage during charging process [17].
Safety: Overheating, over-current, over-voltage, and short-circuiting are potential safety hazards associated with DC chargers. Ensuring robust safety mechanisms and protection features is critical to prevent accidents and device damage [18].

Objectives of the project work

- The objectives of the mini-project are:
- To design and construct a functional DC charger prototype.
- To understand the principles of DC charging, selecting appropriate electronic components.
- To Build a charger circuit capable of supplying the required voltage and current to charge specific devices or batteries

Methodology

- A DC (Direct Current) charger is a device used to charge batteries or electronic devices that require direct current power.
- Step-by-step working principles of a basic DC charger are given in the next 4 steps as follows.
- Power Input: The DC charger is connected to a power source AC (Alternating Current). The charger needs to convert this AC input into DC power suitable for charging the target device's battery.
- AC to DC Conversion: The charger contains an internal component called a Bridge wave rectifier, which converts the AC input into pulsating DC.
- Filtering: The rectified DC output contains ripples due to the pulsating nature of the rectified waveform. A filter, usually in the form of capacitors and inductors, is used to smooth out these ripples and provide a more stable DC voltage.
- Voltage Regulation: Voltage produced after filtering needs to be maintained at a constant voltage so that the appliances do not get damaged.

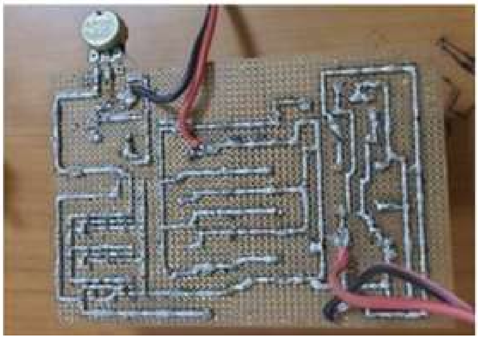

Fig. 1 : Design of the PCB layout – back track with soldering

Fig. 2 : Design of the PCB layout – front track with component layout

Conclusions

The DC Charger Mini Project aimed to design, develop, and evaluate a functional DC charger capable of converting alternating current (AC) into direct current (DC) which helps in charging electronic devices and batteries requiring direct current power [19]. DC charger technology, design, and safety were explored, leading to the successful creation of a working prototype [21]. We need to work to develop a charger with high efficiency and power loss [22]. As technology continues to evolve, the knowledge gained from this mini project will serve as a stepping stone to contribute to the ongoing development of DC chargers and their pivotal role in our daily lives [20].

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