

# Design of EV Charger Protection Box

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**Abstract-** In this system, a current sensor and voltage sensor are used to measure the power delivered to EV charger. Also, a temperature sensor is used to measure the charger temperature. All 3 sensors will send a signal to the microcontroller which will calculate and measure the power delivered and display it. With the keypad and display user can set charging time. In case of any fluctuation in input supply, or when the set charging time completes, the microcontroller will switch off the input supply using cut-off device to protect the charger and battery. The microcontroller will also send values and alert to the webpage through wifi module. User can turn on or off the charging through the webpage. Buzzer is used to provide audio signal. The power supply will provide the required power to every circuit element. The proposed system will provide safe 230V AC output for EV chargers which will help to avoid any damage to the charger and battery. The proposed system compatible with every vehicle charger so that every vehicle can be charged

**Index Terms:** Charger Protection, EV chargers, Automation, IOT, Electrical protection

## I. INTRODUCTION

Nowadays, the world is shifting towards electrified mobility to reduce the pollutant emissions caused by nonrenewable fossil fueled vehicles and provide the alternative to pricey fuel for transportation. Since EV batteries are most high-cost component, charging EVs safely is the most important. Currently, most of the EVs are charged on 230V AC mains supply. Here due to fluctuations in AC supply there is lot of chance to damage the EV charger as well as batteries. To overcome this issue, EV charging protection box is the best solution. The proposed system will monitor the current and voltage provided to the EV charger input and cutoff the supply in case of any fluctuations or temperature rise. User can also set the charging time so that charging process can stop automatically after the set time. Since it monitors and controls 230V AC, it will be compatible with any EV charger with AC input.

## II. LITERATURE SURVEY

[1] "IoT Remote Control of Plug-in Electric Vehicle Charging Loads for Smart Energy Management of Virtual Power Plants"

The paper states that the grid integration of plug-in electric vehicles (PEVs) requires a comprehensive analysis and effective control strategies to prevent any violation of the electrical constraints of the power systems. When renewable energy sources (RESs) are available, they can be used to supply the energy demand of the PEVs. In this study, a photovoltaic (PV) power plant and IoT based remote control of PEV charging are proposed as a virtual power plant (VPP). Particularly, the concept for the use of LoRaWAN to remotely monitor and control the PEV charging loads is presented. Moreover, a hierarchical VPP control (VPPC) system based on the model predictive control (MPC) method is proposed for the optimal energy management (EM) of the VPP. The EM of the VPP is scheduled based on the predicted information initially and based on the optimal values for the EM and the intermittency of PV generation, the charging rate of the PEVs is modified during the real-time process. The results of the case studies show that the proposed VPPC can minimize the energy costs to the VPP and satisfy the energy balancing for the VPP entities while fulfilling the charging demand of the PEVs under system uncertainties.

[2] "Development of an IoT System with Smart Charging Current Control for Electric Vehicles"

This paper presents the development and test of an Internet of Things (IoT) system for monitoring and control of electric vehicles. The IoT architecture, which was developed using the Firebase platform, allows the synchronization of the vehicles' data to the online server, as well as the access to the data outside of the vehicle, through the Internet. The smart charging system proposed in this paper allows the control of the electric vehicle's battery charging current in real-time, based on the demand at the residence (home current), which is measured using a residential wireless sensor network (WSN). An Android mobile app was developed to access the vehicle's data. This app communicates with the wireless sensor nodes of an intra-vehicular wireless sensor network (IVWSN), which was developed using the Bluetooth Low Energy (BLE) protocol. A real-time notification system was also implemented to alert users about certain events, such

as low battery and full battery charge. The main features of the proposed IoT system are validated through experimental results.

[3] “Impact of EV home charger on distribution transformer overloading in an urban area”

The concentration of electric vehicles (EV) in an urban area can cause distribution transformer overloading because of their charging behaviors and the resulting power demand. This paper assesses the impact of EV home charging on transformer overloading considering two critical factors, which are penetration level and driving performance. Test scenarios are confined by a low-voltage distribution system with household load profiles. Test results show that the transformer overloading indexes are unacceptable when EV penetration level reaches 75 percent. The overloading indexes become significantly poorer when the EV driving performance is lower. Additionally, there are unsuccessful charge events in all tested cases. The assessment can provide guidelines for a power utility to devise necessary monitoring and control schemes to accommodate the EV penetration, and to plan for upsizing the distribution transformer in an appropriate time.

[4] “Electrical protection in a smart dc node that feeds electric vehicles charging stations”

This research provides a detailed overview of the design and functionalities specified in electrical protection requirements for the grid-interconnection systems of a smart dc node used to feed electric vehicle (EV) charging stations. The survey focuses on protection relays. The multi-terminal dc node connects a 0.4-kV ac secondary distribution network (SDN), a 25-kV ac railway traction system (RTS), a 3-kV dc RTS, and a local distributed generation (DG) system. The DG includes both a photovoltaic (PV) system as well as backup storage systems (battery and supercapacitor). For this purpose, a wide revision was made of all the codes and standards for the networks, DG of the smart node, and the EV charging stations.

### III. PROBLEM STATEMENT

There are multiple research done on EV battery management system and battery charging methods to improve the safety and performance of EVs. However some researchers also noted the ignored point of effect of EV charging infrastructure on electricity supply network and other devices connected to the grid. However in the race of cost cutting, many EVs and chargers do not have sufficient protection features and smart access to the charging process. In this research, an innovative device is proposed that will be suitable for all EV chargers and that will protect the EV chargers ultimately EVs from any fluctuation in charging supply. It also provides IOT-based connectivity and control for charging status and charging time.

### IV. OBJECTIVES

In this project, an cost effective and compact system will be design which will make the EV charging process safe, convenient and will help to increase the life of the charger and battery. The major design objectives of the project are as follows:

- Measure and detect the fluctuation in input voltage and current.
- Measure and detect the high temperature.
- Cut off the supply automatically when any value crosses the set limit
- System must be compatible with any vehicle and also with any EV charger.
- Able to set the charging time as required.
- Set limit values must be adjustable.
- IOT-based connectivity with monitoring, control and alert.

### V. CONNECTION DIAGRAM

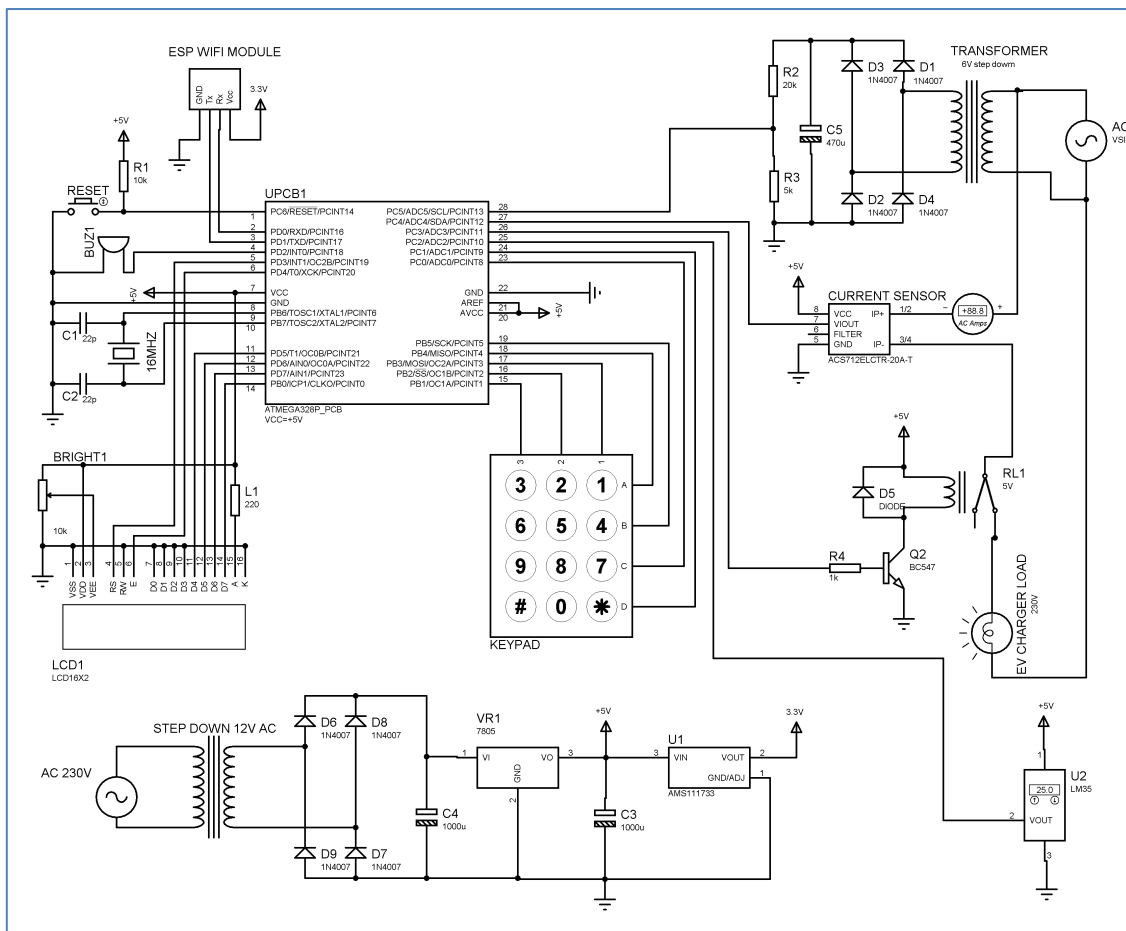


Figure 1: Connection Diagram of System

In this project, AC power from the source will be delivered to the output plug to charge any vehicle using the vehicle charger. The proposed system will measure the voltage and current and protect the charger from any fault and fluctuation from input supply. Control the charging power from webpage. A microcontroller-based system is designed to control and measure the output power given to vehicle charger. The keypad is used to accept input from a user. User can set delay on or delay off time using keypad. This input entered is sensed by the microcontroller and shown on LCD. Buzzer is used to provide a sound indication on key press. To monitor the power delivered, a voltage measurement block and current sensor are used. These blocks sense the corresponding parameters and send a signal to the microcontroller. Microcontroller calculates the parameter and check for any fluctuation in supply. In case of any fault, it gives signal to the cutoff device to disconnect or connect the power at output. Temperature sensor measures the charger temperature and gives signal to microcontroller. So that, microcontroller can cutoff supply in case of overcharging. Simultaneously, the microcontroller gives a signal to wifi module to upload readings on a webpage. The power supply block converts AC power in 5V DC to power up the complete system.

## VI. SOFTWARE IMPLEMENTATION

Algorithm of system is:

Step 1: Initialize LCD

Step 2: Wait for user input for charging time

Step 3: If the value is entered and cancel is pressed, go to step 2.

Step 4: If the value is entered and the ok is pressed, display: press 1 for delay On timer, 2 for Delay off timer

Step 5: if 2 is pressed, Upload parameters to webserver & turn on the relay to supply power & start timer.

Step 6: Calculate V, I & T. if any fault occurs, turn off relay. Upload status to webpage.

Step 7: wait for timer ends. When timer ends, turn off charging and upload status to webpage.

Step 8: if 1 is pressed, Upload parameters to webserver & turn on timer.

Step 9: When timer ends, turn on relay.

Step 10: Calculate V, I & T. if any fault occurs, turn off relay. Upload status to webpage.

Simulation results of system are shown in bellow figure 2. Simulation is designed in protius 8 software. The same software is also used to design the PCB layout for system.



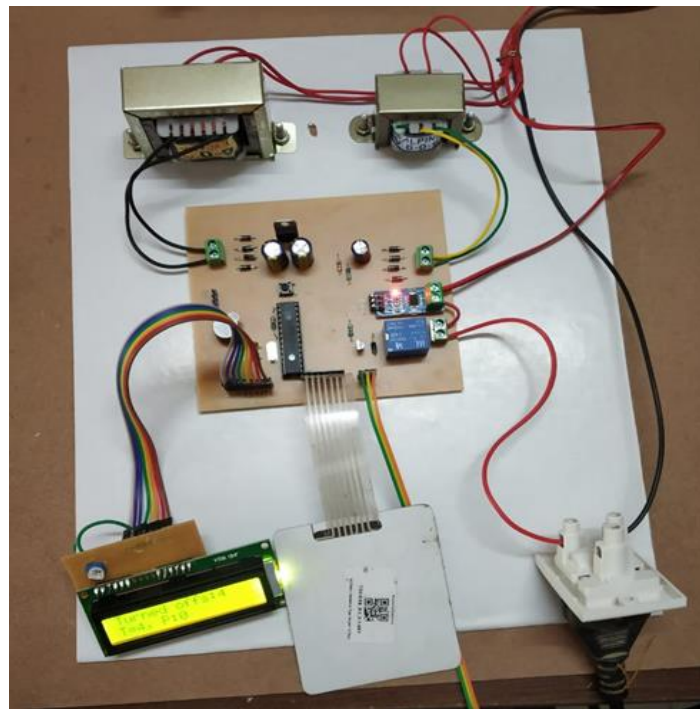


Figure 3: testing of Hardware



Figure 4: Complete Prototype Setup

### VIII. RESULTS & DISCUSSION

This project presents, an cost effective and compact system which will protect EV chargers from faults in supply and also from overheating. The system will make the charging process safe and able to control any conventional simple charger into a smart charger with IOT connectivity.

The final system specifications are:

- Output supply available at charging plug: 230V, AC
- Features: Delay on & delay off timer

- Monitor for faults related to voltage and current.
- Monitors over heating using LM35 temperature sensor.
- Current sensor used: ACS712, Hall Effect type, 5Amp capacity
- Supply control switch: Relay with capacity of 230V, 7Amp
- Maximum Allowed Load Current: 7Amp
- Controller Used: ATmega328
- Output on 16x2 LCD display
- Audio alert type: Single tone pizo buzzer
- Communication Features: Adafruit IO Server
- Working temperature range: 0 to 70 °C

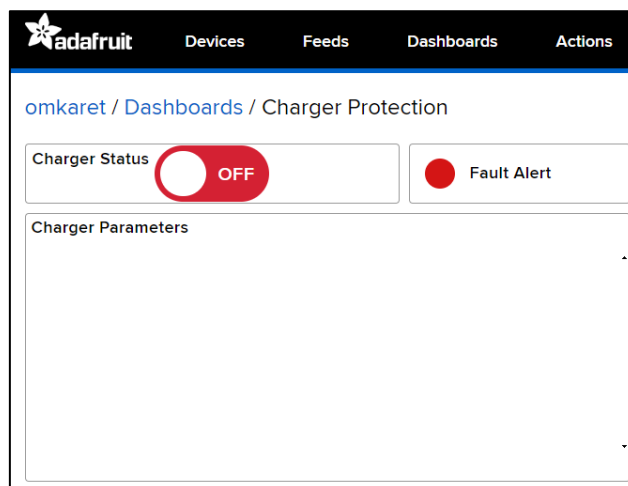


Figure 5: Screenshot of Webpage Result

The above image shows the webpage screenshot used to show the charging status and other information. In this project, a cost-effective and compact system will be designed which will make the EV charging process safe and convenient and will help to increase the life of the charger and battery. The major outcomes of the project are as follows:

- It measures and detects the fluctuation in input voltage and current.
- Cut off the supply automatically when any value crosses the set time limit
- Measure and detect the high temperature.
- System is compatible with any vehicle and also with any EV charger.
- System provides feature to set charging time as required.
- It provides IOT based connectivity with monitoring, control and alert.

## IX. ADVANTAGES

- System will protect the charger and battery against any fluctuation or fault in supply.
- System will protect charger from overheating in case of long use or damage.
- Interactive HMI system will provide option to user to adjust the cutoff values
- System will enable users to set the charging time as per flexibility and convenience.
- System will provide online monitoring and control of charging status and power.
- IOT based system will automatically save the log of readings for future reference.
- Since the system output is set to 230V AC, it can be compatible with any vehicle charger.

## X. LIMITATION

Though system monitors voltage and current faults and also temperature fault, it is unable to remove them. So in case of faults, system directly turn off the charging

## XI. APPLICATION

- For EV charging
- For other industrial machine protection and control
- For other domestic appliances protection and control

## XII. CONCLUSION

In the race of sustainability and cost-cutting, many EVs and chargers do not have sufficient protection features and smart access to the charging process. In this research, an innovative device is presented that will be suitable for all EV chargers and that will protect the EV chargers ultimately EVs from any fluctuation in charging supply. It also provides IOT-based connectivity and control for charging status and adjustable charging time.

The presented system will convert any regular chargers in smart chargers with IOT connectivity and provide features like fault protection, delay on timer, and delay off timer.

## XIII. FUTURE SCOPE

Since improvement is endless process, there is always scope to advancement in future. As shown in limitations, system is able to detect faults but unable to remove it. In future, researchers can work on to remove the fault and provide uninterrupted continuous charging supply.

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