Using Arduino to Regulate Current from Rechargeable Batteries for Portable Charging of an Electric Vehicle

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# Pre-Game Questions

* Why is charging an electric vehicle difficult?
* How would a rechargeable power source be better?
* What could the Arduino do to benefit this addition?
* How would I get the Arduino to read current?
* How do I safely monitor the charge exchange between battery and device?
* What are the limits of rechargeable batteries?
* How will the Arduino know what current to supply to the device?

# Abstract

The Arduino-based microcontroller board is a sufficient and cheap alternative to monitoring charge of electrical equipment as it has the required capability to restrict, allow, and monitor current exchange via appropriate circuit configuration and code implementation. This is a particularly useful venture for electric vehicle users who often find charging a nuisance due to the time required, lack or portable chargers, and location of charging stations to fully charge their car. To demonstrate feasibility, the system will be created using all required electrical components and tested on its ability to charge a smaller and more reasonable component or device. If feasibility is demonstrated, this Arduino system could be an effective and inexpensive method of achieving accessibility for charging one’s electric vehicle.

# Background

Electric vehicles are appealing because of their minimum or non-existent emissions, however, the range of such vehicles between charges is what deters most drivers. Though charging stations are growing rapidly in number, they are not yet as abundant as gas stations and they take much longer to charge. This can take up to 30 minutes for a DC fast charge, 3 hours for a Level 2/ J1772 charge (the most common type), and 24 hours for a standard outlet via a J1772 cable like you would get from charging from home at night. The electric vehicle on average has less mileage per full charge than a gas car giving it a 100 to 200 mile difference in mileage. The increased time and frequency to refuel leaves many drivers walking away from the zero-emission option due to either suspected inconvenience or inaccessibility. Currently, the only portable charging options are not only highly priced but reliant on access to electrical outlets which may not always be available. The most convenient way to charge a vehicle is when the car is parked at home, work, or any other long term stop so that the car has time to charge without inconveniencing the driver.

Since most vehicles come with an adaptable charging cable for the vehicle to charge from a standard outlet at home, the remaining issue for this portable transportation is a portable power source. Gas generators defeat the purpose of zero emissions, and battery-powered generators with the necessary amperage output for charging a vehicle are too high in cost for most consumers.

A technical barrier of implementing this new power source is being able to produce the right current and not disrupting the EVSE compliant component of the charger. EVSE stands for ‘electric vehicle supply equipment’ and is a protocol used to regulate safe EV charging. So the current into the charging cord needs to positively respond to this device. This means being able to change and monitor the current so that it is supplying enough current but not an unsafe amount. Finally, obtaining cheap, light, and sufficient rechargeable power for the system will be a challenge. Currently, 9v batteries seem to be the cheapest and lightest option but other avenues may need to be explored to find the most efficient for this cause.

# Significance

The benefit of a cheap and truly portable option to recharge a vehicle is that it would alleviate the stress of electric car consumers. Long term success of such a venture is that fuel efficient and zero emission vehicles more accessible while electric motor battery advancements are made to increase mileage. Will also ultimately allow for increased ease of use making the electric motor a more user-friendly buy than it currently is.

# Technical Objectives

* How will the Arduino be able to measure current in and out of the system? Possible option is to wire circuit as ammeter and attempt to use analogRead() to read in current value. Being able to measure current is the main function of the Arduino so it needs to be able to do this.
* How can I ensure the power supply sufficiently supplies the system and has an output sufficient for charge in a reasonable amount of time? The code will need to limit current in and out of the system. It may benefit from the capability to read in charge progress, which will also need to be explored as it may branch off easily from this.
* What component or device is best to use for the feasibility study? Is it a capacitor? If needing to implement the GFCI is it better to charge something like an iPhone or another smaller standard-outlet-charged device? Probably.
* How will the Arduino dictate how much current should be allowed into the system? Does it read in certain values? Or should it manually be inputed?
* How does using a rechargeable battery instead of a power outlet affect charging capabilities? How often would the battery need to be recharged? How often would the battery need replacing?
* What is the best rechargeable power source to use? Is it the 9v battery?

# How to Measure Success

Feasibility will be demonstrated if the device or component being charged is indeed charged, and that the Arduino is limiting power in/out of the circuit as current changes. To ensure serial plotter is reading in proper values, a regulated power source such as those in lab can be used to ensure the Arduino can differentiate various current sources. Then, by increasing and decreasing current, ensure the Arduino is regulating the current that is going out of the system to the device by noting if it is appropriately restricting and allowing current within the specified intervals.

# Working BOM (Bill of Materials)

* Arduino (already acquired)
* LCD Display (Amazon has it from Adafruit for pretty cheap)
* Circuit wires (already acquired)
* Breadboard (already acquired)
* Resistors (lab available)
* GFCI outlet (found one at Home Depot)
* Outlet wires (also ^)
* Testing power source (lab available)
* rechargeable batteries (9v, how many necessary? Is this the lightest/ cheapest option?)
* Case (waterproof? necessary? cheap?)