Chapter 15
Li-Ion-Based DC UPS for Remote Application

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ABSTRACT

A DC UPS has been widely used over the years as backup power for devices that need uninterruptable power. Especially in rural regions or areas that are prone to have power outages, a DC UPS has become an essential device to power up important IoT systems such as data servers, workstations, or any system heavily reliant on uninterruptable power whenever a power from the grid is missing. Typically, this device is heavy and takes a lot of space. Furthermore, the battery needs to be replaced once every two years, making it very costly for maintenance. This chapter will discuss the method of replacing the highly inefficient battery in a traditional UPS with highly efficient and low maintenance cost Li-ion batteries. This method could potentially increase the performance of a conventional ongoing IoT market device in terms of efficiency, size, weight, and backup power capacity.

INTRODUCTION

In this project, the objective is to replace the SLA (Sealed Lead Acid) batteries in the traditional UPS system. Since SLA is high maintenance and high-cost battery cell that will soon be replaced by Li-ion batteries, which is lower in maintenance, lower in cost, and smaller form factor contributing to a higher power density than SLA batteries.

Building a DC UPS with Li-ion batteries has several significant challenges, such as a single Li-ion cell voltage is only up to $4.2V$. Multiple cells in series can raise the voltages to encounter this issue. Still, the other problem is charging the battery cells since charging batteries in series is not as simple as charging batteries in parallel. Charging multiple batteries in series could overcharge one of the battery

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cells in the series configuration. This is where the battery monitor in each cell is implemented into the charging algorithm.

When charging multiple battery cells in series, the battery cells will not be fully charged at the same rate; there will always be a cell with a different capacity than the other cells. This is the issue with SLA batteries since it is made up of 6 or more cells in series, and it is impossible to open SLA batteries and monitor each cell's voltage. With lithium-ion batteries, fewer cells are needed since it has a higher power density, and each cell monitoring is still applicable. But to fully charge every single cell, a battery cell balancing is needed to eliminate the difference of voltage in each cell to avoid overcharging and fully charge every single cell in series.

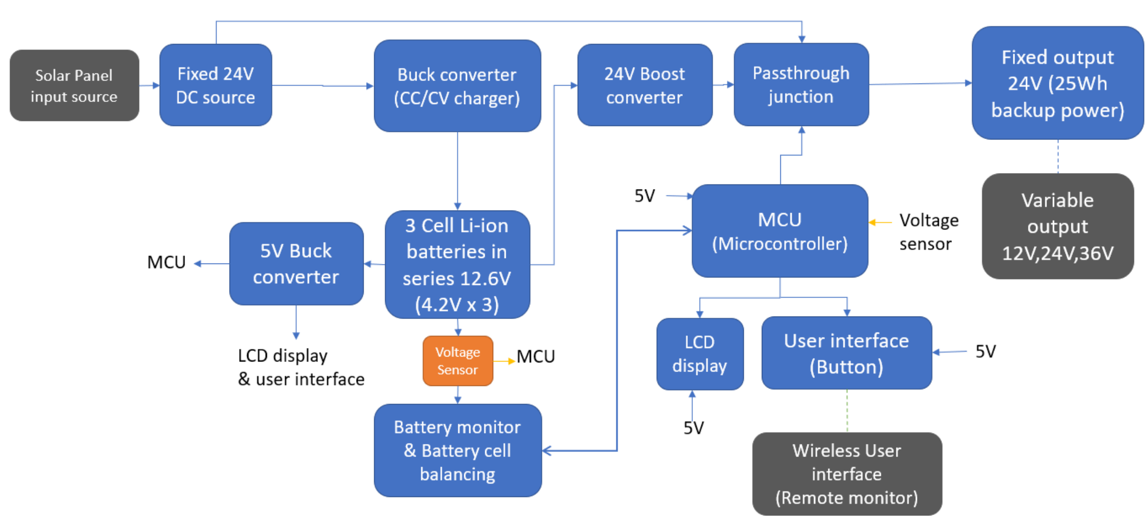
A microcontroller will be used to control the charger according to the information received from the battery monitor. The battery monitor information will also be displayed to the LCD display that is also connected to the MCU.

A user interfaces such as an alarm buzzer to notify the user, such as a "fully charged" indicator or the absence of input supply. This will be connected to the MCU. The wireless user interface is to send a notification to the user's phone or PC.

For remote application, a solar panel input source is another option to power the UPS as another alternative input. The UPS will have feature pass-through charging, meaning the input voltage will charge the battery cell for the backup power and be the primary power source for the output. If the main power source is cut off, the pass-through junction will relay the battery's power source to the output. The output will produce a fixed 24*V* power; a variable output will be included using multiple boost converters for other purposes

As seen in Figure 1, a general block diagram of the proposed design is provided. There ones in blue are the minimum modules required to make this system, and the ones in grey are the extra modules that can be added for additional feature and are not limited to this block diagram.

Figure 1.



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