AuE 8150 Electric and Hybrid Powertrains

Final Report – Battery Pack Design

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Problem Statement

In this project, a battery pack will be designed using prismatic battery cells. Each battery cell is 2.4 volts and 20 Ah. The goal is to design four 12-volt modules that can be connected in series to produce a 48-volt battery pack. Each module can also provide voltage and can be charged and discharged independently. Specifically, the project will:

1. Provide a design configuration topology for each module with measured readings confirming the target voltage of 12 volts per module.

2. Ensure safety with a temperature sensor to actuate a cooling fan and protection unit to prevent overcharging and over-discharging.

3. Achieve the target 48 volts with the final battery pack.

4. Test an individual 12-volt pack in the Arbin.

Design of 12V Battery Pack

The approach behind this project is to produce four identical modules from prismatic cells of 2.4 volts and 20 Ah. Each module will contain ten prismatic cells with two cells connected in parallel, providing a total capacity of 40 Ah. The five pairings are connected in series to provide a target voltage of 12 V per module. Each module will have a temperature control switch to actuate a fan if the temperature increases beyond a certain limit and a protection unit to prevent overcharging and over-discharging.

Table 1: List of components, quantity, and source

Component Name	Quantity	Source
W1209 Temperature Control Switch	4	Amazon
12 V DC Fans	4	McMaster
Heat Wrap	2	Amazon
Battery Protection Unit	4	Amazon
Box	4	Provided
Wire	-	Provided

Figure 1: Final battery pack with four modules connected in series. The blue wires are connected to each individual module.

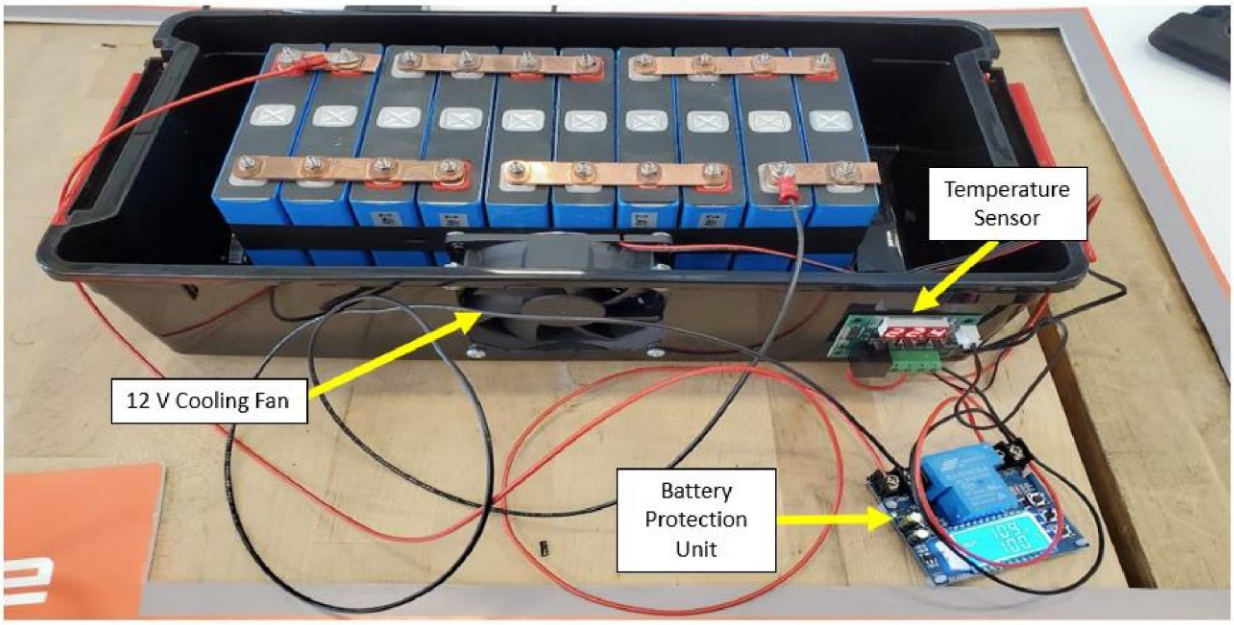

Figure 2: Module design with battery, cooling fan, battery protection unit, and temperature sensor.

The battery protection unit acts as a switch to protect the battery under charging and discharging scenarios.

Figure 3: Battery protection unit display screen.

The final set of testing involved charging and discharging using the Arbin. The schedule was set to discharge for 15 minutes, rest for 10 minutes, and charge for 15 minutes. The discharge and charge current was set to 20 A.

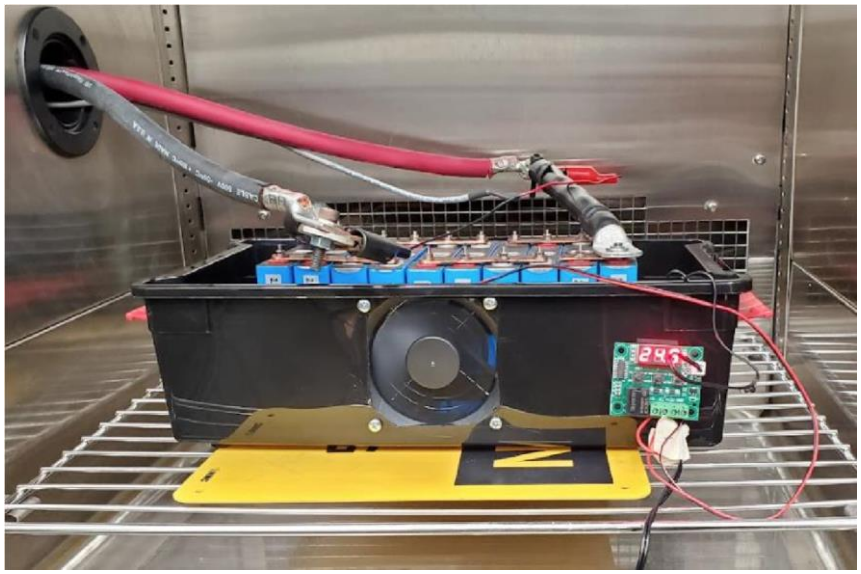

Figure 4: Arbin test set up with battery module, temperature sensor, and cooling fan.

Figure 5: Voltage and current of battery module during Arbin test.

Conclusions

In this project, a battery module was design and fabricated such that multiple modules could be connected in series to achieve a higher voltage output. The final outputs of the project are as follows:

1. Four 11.2 V 40 Ah battery modules were fabricated using prismatic cells, a container, a temperature sensor, and a battery protection unit. The measured voltage of 11.2 V was slightly

lower than the desired voltage of 12 V, likely due to a mismatch of specification from the labelled cells. In the future, this can be remedied by adding two additional cells in series to each module to achieve ~13 V.

2. The temperature sensor was tested in the individual battery module. During Arbin testing, the cooling fan was sufficient at maintaining the module temperature below 23°C.

3. The four battery modules were connected in series and produced a voltage of 44.9 V. Again, this was slightly less than the desired voltage of 48 V.

4. An individual module was tested in the Arbin at a charge and discharge current of 20 A.