HERIOT-WATT
ROBOTICS SOCIETY

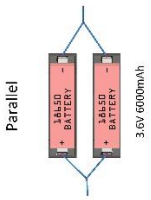
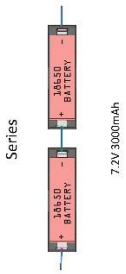
Robotics Society – Kart Workshop

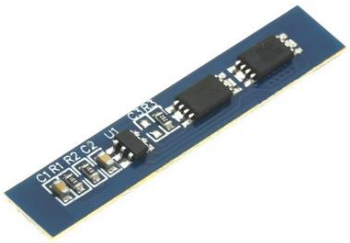
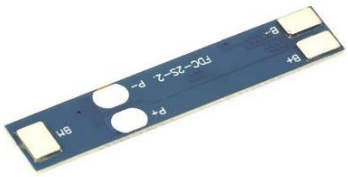
Session 4 – Power pack

Last week, we wired up and programmed the Pico for control from the Android app. This week, we will build and solder the power system, which works using a 2S Li-ion battery, with an attached BMS and step-down voltage converter. Both kart designs use the same power pack.

Note: Lithium-Ion cells have very high power and energy density. Exercise common sense precautions when handling or testing.

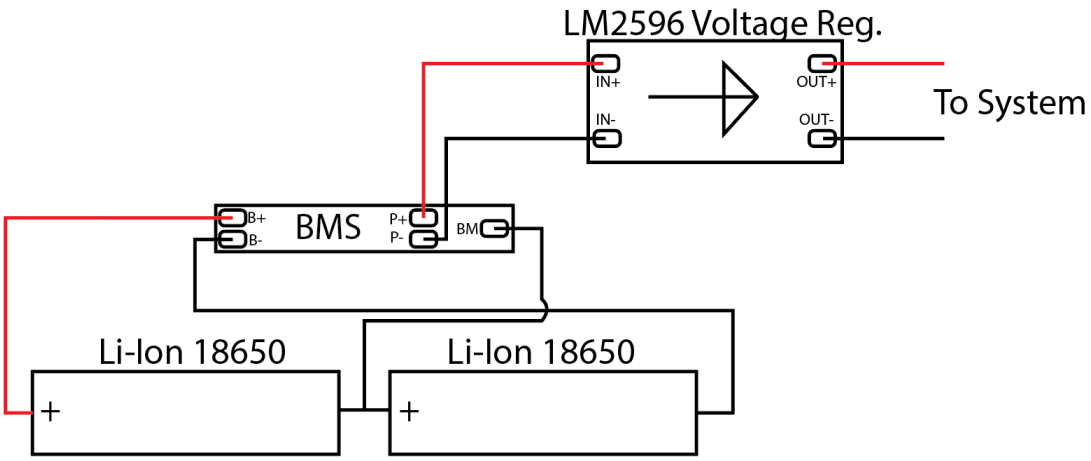
Part list

Part name	Description/use	Picture
Li-ion Battery Cell 18650 - 3.6V 2500mAh - 20A **Information about Li-ion charging/safety:**	We use these 2500mAh lithium ion cells to provide power to the system. Each cell nominally provides 3.6V, however, they can vary from 4.2V to 2.5V depending on their charge level. It is incredibly **important to monitor their charge level**, as keeping the voltage near either end of the range for a period of time **can cause irreversible damage**. Realistically, the voltage should never be allowed to drop below 3V. Even more dangerous is going past the end of this maximum/minimum, which can cause a fire or worse. Due to the variability of the voltage, firstly, a regulator is important to supply a constant voltage across the system. Secondly, a monitoring system is needed to keep within the range, as the batteries themselves do not monitor any of these factors. We will use two of these cells in series, and when batteries are placed in series, their voltage is added. Thus, we will have a nominal voltage of 7.2V, maximum of 8.4V, and minimum of 5V.	  

LM2596 DC to DC Buck Converter **More about buck converters:**	As our nominal, minimum, and maximum vary significantly, we need to use a voltage regulator. If you remember from Session 2, the maximum voltage the RPi Pico can handle is around 5.5V. We can use a step down buck converter to keep this voltage constant, around 5.2V. There are four solder pads on this board, two input, and two output, labelled by IN and OUT, and marked with a direction arrow on the back of the board. We can adjust the voltage output by taking a screwdriver and turning the brass screw in the blue variable resistor. Test the output by attaching a voltmeter to the OUT pins, and vary the position of the brass screw to see its output.	
2S 3A Li-ion Battery Charger Protection BMS	As mentioned above, ensuring that the li-ion battery is not over-discharged, over-charged, or too much current is drawn from the battery, we use a BMS, which stands for Battery Management System. This small chip takes three input, B+, B-, and BM. B+ and B- are simply the positive and negative input from the battery itself. BM however connects to the midpoint between the two batteries, which ensures that both batteries are charged at the same rate, and individual cells can have their voltage measured. P+ and P- are then multiuse pins, acting both as charging pads and discharging pads. For our basic use, we will connect the P+ and P- pads to just discharge, and charge the batteries using a Li-ion charger. However, USB-C connectors are available to solder on if desired.	 

Wiring Diagram and Description

Ideally, the cells would be contained within a small housing, with the BMS and voltage regulator attached to the outside, however, as we are placing the cells into a cell holder anyway, the outside of this can be used to attach the components to.



The diagram above demonstrates the principles covered in the part list in action. The BMS can be mounted to the side of the battery holder, where as the voltage regulator can be mounted atop the batteries themselves with a piece of tape.

Key to this part of the project will be soldering. **DO NOT** solder directly to a li-ion battery, it is highly dangerous, and even the prolonged high temperature can damage the cells. In this workshop, we are using a 2x18650 plastic holder, however in practice, many cells are joined together using spot welding and nickel plating.

A few notes to take into account, the pads on the BMS like to move about when the solder flows, so a steady hand is needed to keep them in place, and leave them to cool once in position. Additionally, soldering the connector piece for the BM lead is tricky, and has to be soldered onto a connector on the battery pack itself.

In the session, we will take small groups over to solder these together, but outside these sessions, please do let us know if any help is required.

Please note, we require the cells back at the end of the session, or for them to be stored securely between sessions. Leaving exposed cells around can be dangerous, especially if someone without the knowledge of the cells starts handling them.