

## MAIN FEATURES

- High Energy Density, 120Wh/kg to 150Wh/kg
- Suitable for hard vacuum conditions.
- Compatible with operation of 1 Year or more in LEO.
- Integrated battery heater with thermostat to maintain battery temperature above 0°C.
- Battery over-current protection.
- Battery temperature, voltage, and current telemetry.
- Available in 8.2V, 12.3V and 32.8V versions.
- Required battery capacity achieved using parallel connected strings.
- Low magnetic signature due to aluminium foil casing.

## APPLICATIONS

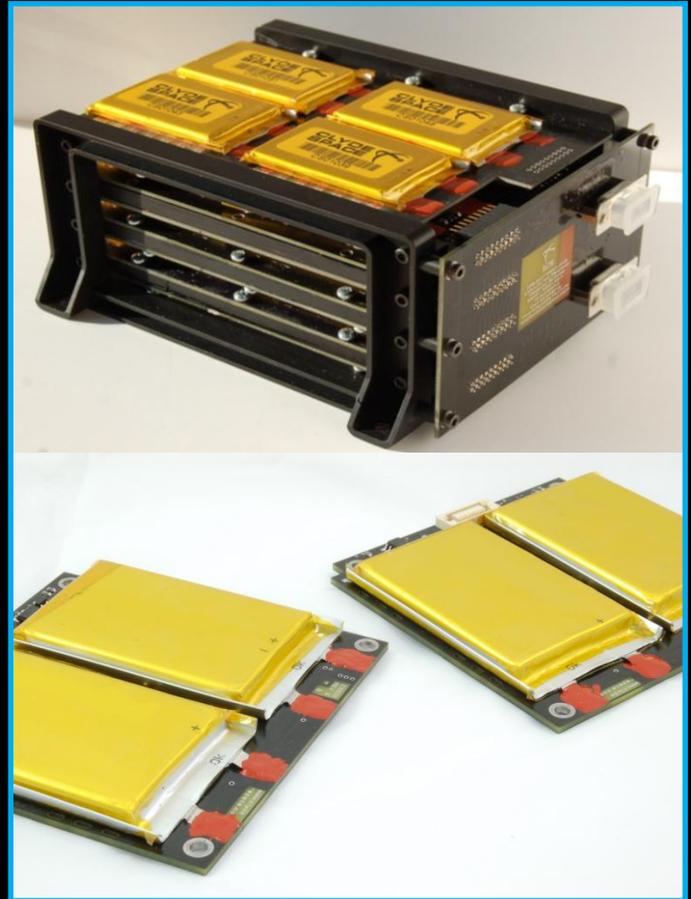
- CubeSats and other small satellites.

## TECHNICAL DESCRIPTION

A commercial Lithium Polymer cell has been selected by Clyde Space for use with our CubeSat EPS in a space application. Prior to selecting this cell it has undergone a number of tests to verify its performance in a space environment. These tests were as follows:

- Capacity at C/10 under vacuum.
- Radiation up to 500krad.
- DPA
- Capacity at -10°C, 0°C, 20°C and 40°C
- Resistance
- Self Discharge
- Missions Scenario Tests
- EMF vs SOC
- Cycling Tests at reduced pressure (15-20mbars) - 30% DoD, C/2 Charge/Discharge >5000 cycles.

Satisfied with the performance of the cell under these conditions, we are happy to recommend to our customers that they use this cell on their spacecraft.



## CELL ACCEPTANCE TESTING

Lot Acceptance tests are performed on flight cells to verify integrity for space use.

Once the batch has passed this test, the cells are matched for capacity and voltage characteristics over temperature. This helps verify the individual cell integrity and also enables selection of cells with matched characteristics for flight batteries.

## CONTINUOUS DEVELOPMENT

We are continuing to characterise our cells and are conducting further life tests in order to build up data for battery sizing for different mission scenarios. This will provide confidence in the technology for long duration LEO, GEO and interplanetary missions.

Higher voltage batteries are also being developed with up to 8 cells in series (32.8V) and multiple strings in parallel to achieve the required capacity.



## 32.8V BATTERY

Our 32.8V battery has a modular design and can easily be adapted to sizes from 1.25Ah up to 10Ah by selecting the appropriate mounting frame. Similar to our CubeSat batteries, the 32.8V battery has integrated functionality and protection, including a thermostatically controlled heater. In addition, the front face PCB provides the further option to have a telemetry and telecommand node on the battery in order to measure and access all battery telemetry information on the spacecraft serial data-bus.

## 1U CUBESAT BATTERY

The 1U Battery integrates with our power system and is scalable to increase the total capacity. Each battery has an integrated battery heater with thermostat, battery cell voltage, terminal voltage, as well as current and temperature monitoring.

The bottom picture on the previous page shows a prototype of the battery board design with two lithium polymer cells. The cells are coated in Kapton® for insulation, although the foil bag is not connected to battery negative or positive. The cells are held onto the PCB using thermally conductive adhesive. The capacity of each battery is 1.25Ah at a maximum voltage of 8.2V.

The figure middle right shows the battery and EPS fully integrated with 2 lithium polymer batteries in parallel, providing approximately 20Whrs of capacity.

With one battery integrated onto the EPS, the total height of the unit is 14mm from the EPS board surface; with two batteries this is 21mm. The mass of the EPS is 80g and the mass of one, two cell, 10Whr battery is 62g.

## 3U CUBESAT BATTERY

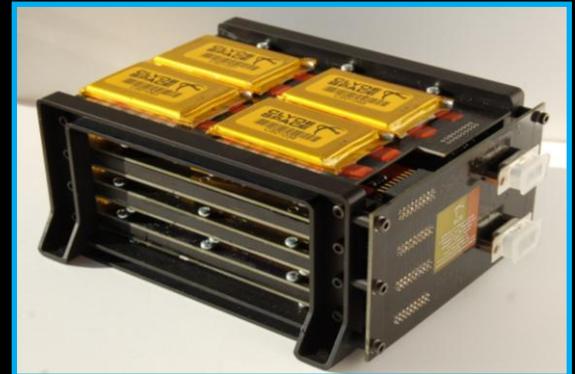
The 3U battery has a main battery board with two series cells which are mounted flat, side-by-side on a PC104 sized, CubeSat kit compatible PCB. Two additional, two cell battery daughter boards can then be integrated with this main PCB to increase the capacity (in the same way that the daughter boards integrate with the 1U EPS). The main battery board has its own I2C microcontroller for telemetry and telecommand. It can also provide a further two voltages as an option: 12V at 300mA and 50V at 1mA. These voltages are accessed via spare pins on the main header connector.

This configuration results in a 2s3p battery (2 series cells per string and 6 strings in parallel). The capacity of each 2s3p is 3.75Ah at a maximum voltage of 8.2V. The main battery PCB (PC104) weighs approximately 80g and each daughter battery unit weighs 62g.

## CUBESAT REMOTE BATTERY BOARD

The remote battery board interfaces with our standard CubeSat batteries. It has all of the functionality of our battery daughter boards, plus its own I<sup>2</sup>C node, and can be fitted into very small spaces in your satellite (dimensions with cells are 8.2 x 4.1 x 1.2cm).

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32.8V 5Ah Battery for Small Satellites



CubeSat Power board with integrated 20Whr battery



12.3V 15Whr Battery Cell String for Nanosatellites



CubeSat Remote Battery Board