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AEROPAK

Fuel Cell Power System

TECHNICAL DATA SHEET
VERSION AUGUST 2010

Horizon Energy Systems

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1. AEROPAK Physical Features

The AEROPAK consists of a 200W fuel cell and a 900Wh chemical hydride based fuel cartridge. With a system specific energy of more than 3 times that of advanced lithium-polymer batteries, the AEROPAK increases flight endurance of small and stealthy electric Unmanned Aerial Systems (UAS), creating new mission possibilities.

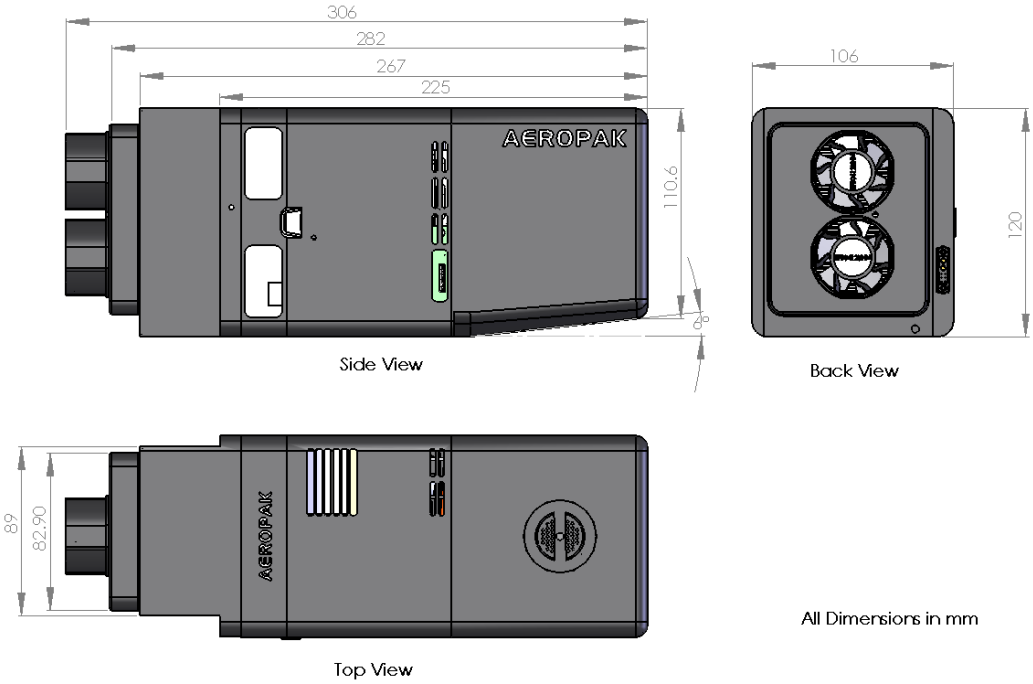

Figure 1. Views and dimensions of AEROPAK

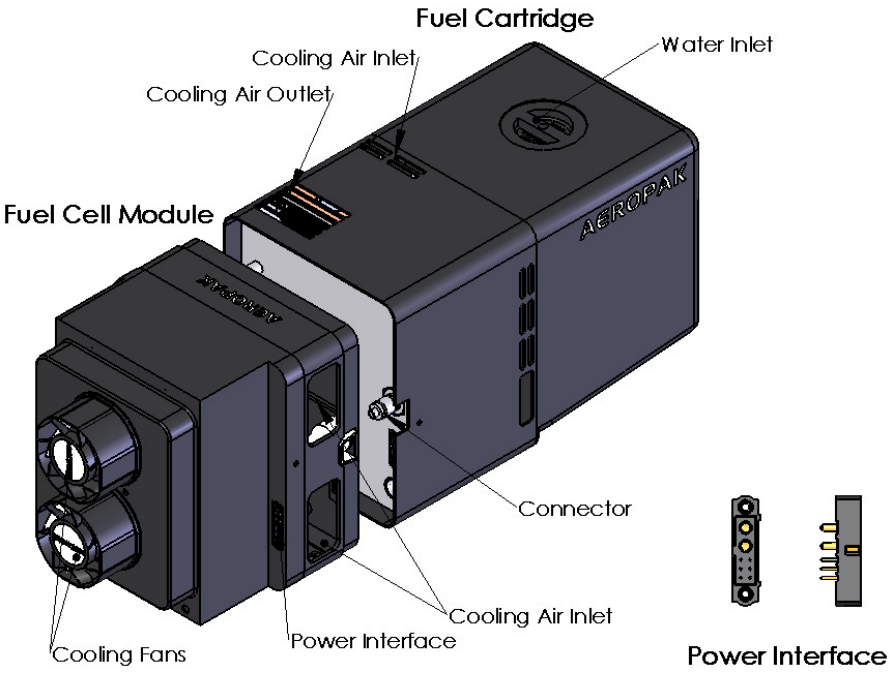

Figure 2. Main parts of the AEROPAK

2. AEROPAK Performance Specifications

The AEROPAK can deliver up to 10A of current. Its operating voltage ranges from 32V (no load) to 21V (full load). The rated operating point of 10A@21V is recommended.

2.1 Power output

2.1.1 Power output characteristics

Figure 3 below presents the voltage-current characteristic and system-to-system variability bands of the fuel cell operating at normal room temperature. On average the system is capable of delivering around 10% more than the rated power of 200W.

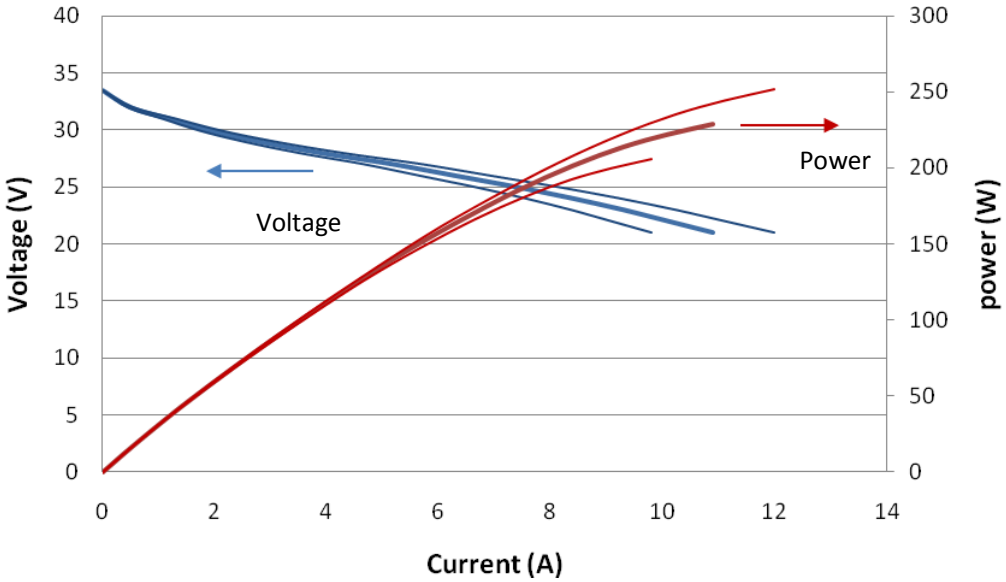

Figure 3. Power output characteristics of the AEROPAK

2.1.2 Peak power output

The AEROPAK can deliver a peak power output of 600W* to meet the high power requirements during UAS take-off or climbs. This is realized by connecting a lithium-polymer battery in parallel hybrid configuration. A power management card combines the total power output from fuel cell and hybrid battery before delivering to the load. It also recharges the battery when excess power is available from the fuel cell during cruise.

*Peak power value and duration depend on the capacity of the hybrid battery module. Table 1 presents typical options. For any other requirements please contact us.

Capacity	Net Power Output	Duration	Estimated battery weight
6S 730mAh	600W (400W from Battery)	2 mins	134g
6S 910mAh	600W (400W from Battery)	3 mins	164g
6S 1350mAh	600W (400W from Battery)	4.5 mins	208g

Table 1. Lithium polymer battery options for peak power output

2.2 Fuel consumption rate

Figure 4 presents the fuel consumption rate of the AEROPAK system at different power outputs under various ambient temperatures.

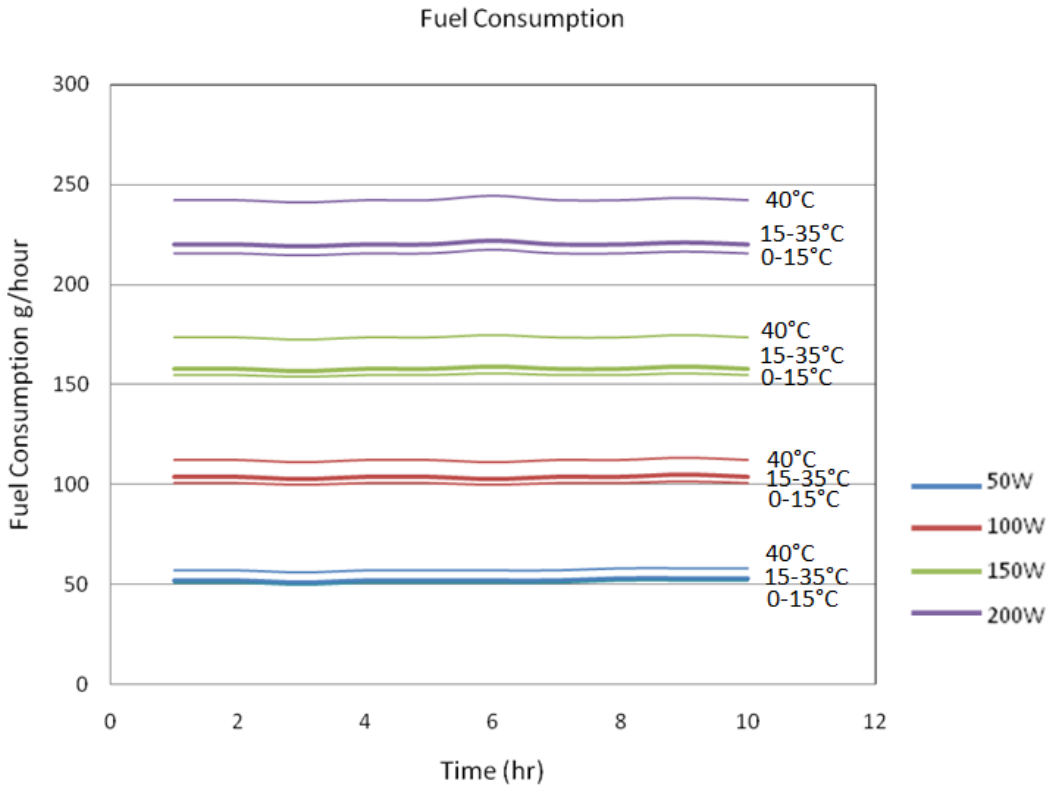

Figure 4. Fuel consumption

2.3 Control and communication

Communication channel: RS232 serial byte format, 9600 bps, 8 data bits, no parity, 1 stop bit; Little-endian format.

Message frequency: 1 Hz.

Reportable parameters:

Name	Data Range	Resolution	Baud rate	Frequency(Hz)
Fuel Cell Stack Voltage	18-35	0.1V	19200	1
Fuel Cell Stack Current	0-12	0.1A	19200	1
Fuel Cell Power	0-650	1W	19200	1
Total Energy	0-1000	1Wh	19200	1
Fuel Cell Stack Temperature	0-70	0.1C	19200	1
Battery Voltage	18-30	0.1V	19200	1
Hydrogen Pressure	0-10	0.1bar	19200	1

Table 2. RS232 data and format

3. AEROPAK Operating Environment Specifications

3.1 Airflow requirements

Fuel cell system requires airflow for reaction oxidant as well as cooling. Figure 5 below shows the estimated airflow requirements of the AEROPAK at different power outputs.

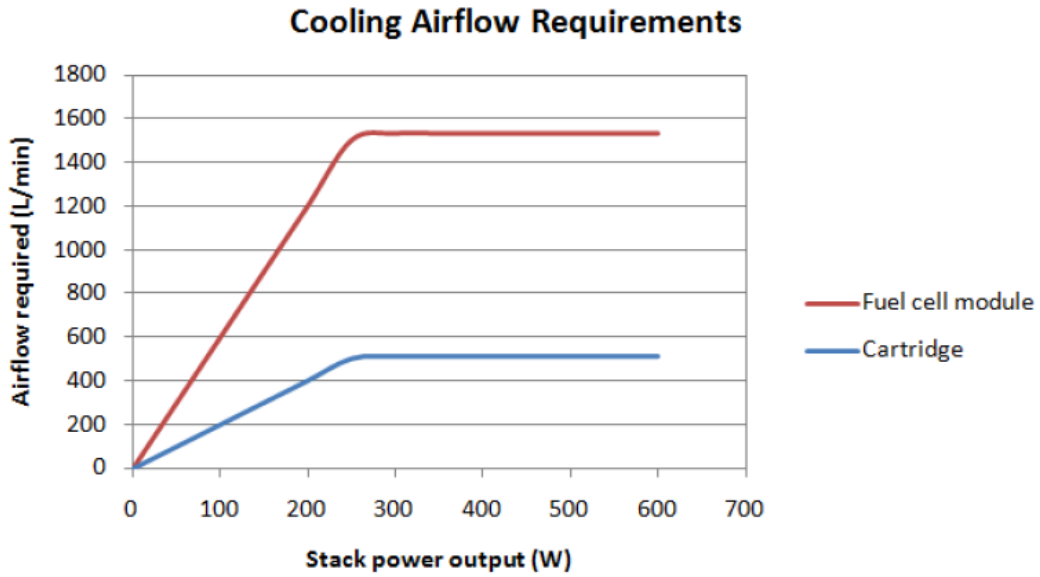

Figure 5. Airflow requirement

Slight contaminant level in the operating environment has insignificant effect on the AEROPAK performance over the full product lifetime. Exposure to high level of contamination in the operating environment will lead to a drop in performance drop, which may or may not be recoverable.

If the operating environment is expected to be very dusty, filter for the oxidant and cooling air may be required.

3.2 Altitude & temperature

Operating altitude affects the AEROPAK performance. At higher altitude, there is a reduced level of oxidant for reaction, leading to lower single cell voltages within the fuel cell stack. A slight drop in performance (power output level) can be expected typically at altitude 1000m above sea level.

Another factor that affects the AEROPAK performance is ambient temperature. Higher temperature leads to the drying up of the proton exchange membranes inside the fuel cell stack, reducing proton conductivity and consequently the power output of the fuel cell.

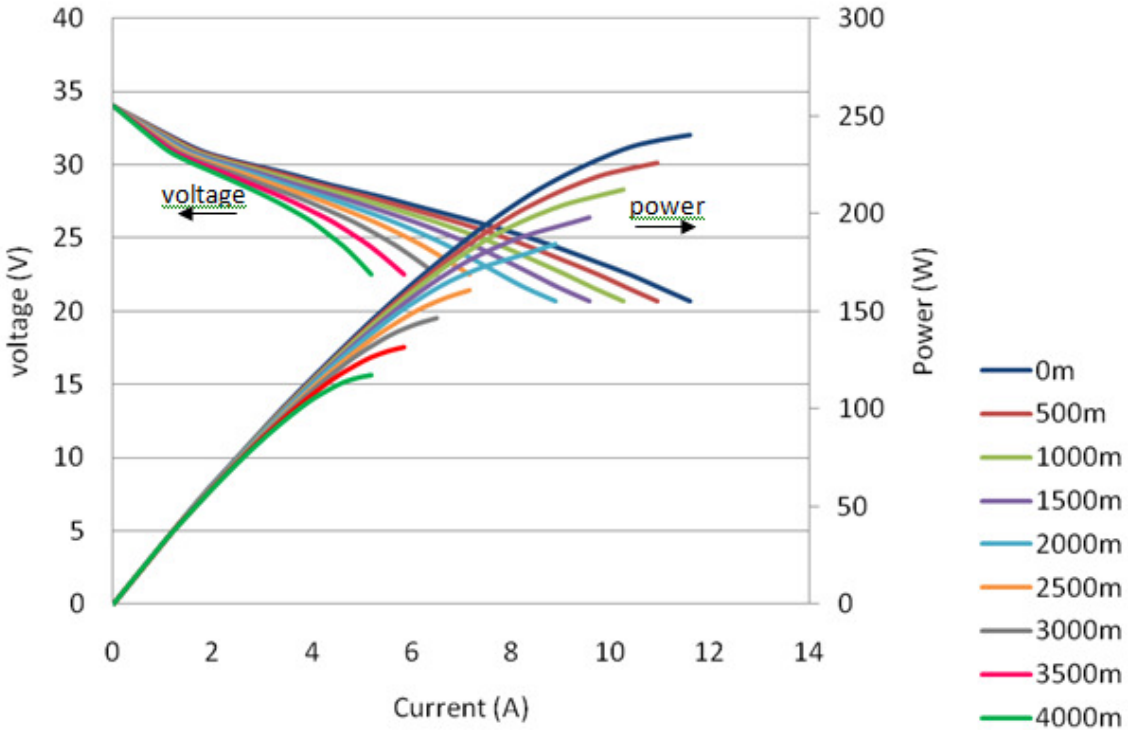

Figure 6. AEROPAK performance at various altitudes

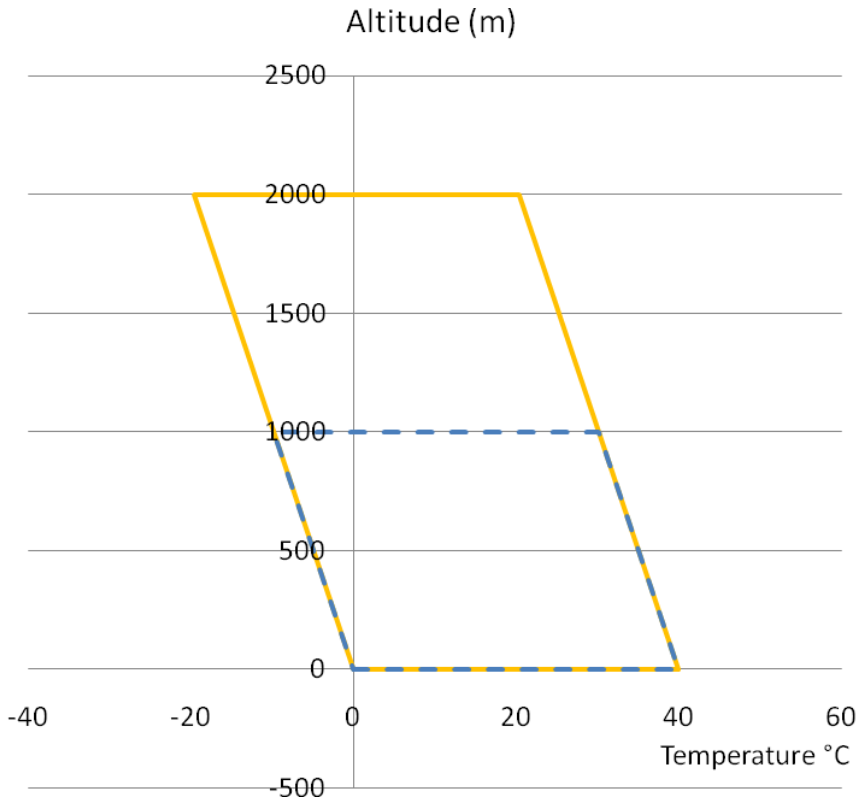

Figure 7. Applicable altitude range for the fuel cell system; the blue inner envelope represents operating conditions for fuel cell rated performance while the yellow outer envelope represents operating conditions for limited fuel cell performance.

3.3 Environment temperature and humidity

The AEROPAK can deliver its rated performance when operating at ambient temperature ranging 0-40°C* and a relative humidity range of 10-90%. At a given environment temperature, the AEROPAK performance increases with a higher level of relative humidity. Figure 8 shows the correlation between environment temperature/humidity and the AEROPAK performance.

*Up to -20°C possible with optional Winter Add-On Kit.

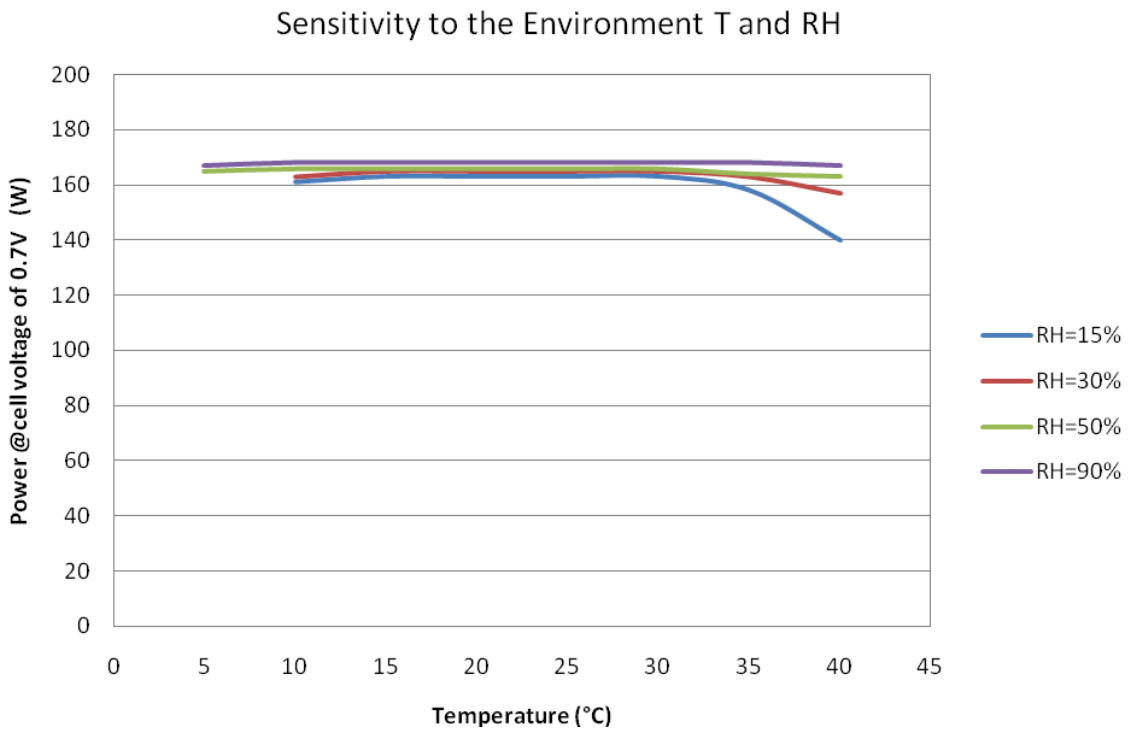

Figure 8. Effects of environment temperature & humidity on the AEROPAK performance

3.4 Radiation and neutron radiation effects on the AEROPAK

Impacts of radiation and neutron radiation on the AEROPAK have yet to be tested. Strong radiation and neutron radiation might cause damage to the AEROPAK.

3.5 Shock and vibration

The AEROPAK undergoes vibration and shock tests according to UL2267 standards (for vibration tests), and IEC-68227Ea and IEC68229Eb (for shock tests).

4. Lifetime and Performance Degradation

The AEROPAK standard warranty is 500 operating hours at its rated performance. After 500 hours operation, power degradation rate will be approximately 5% per 100 hour operation.

Fuel cartridge is meant for one-time use. Cartridges are disposable or returnable to Horizon Energy Systems for refills.

The fuel cell system will undergo reversible performance degradation after long term storage, up to a maximum power loss of 10%. System performance can be recovered after some conditioning. It is recommended that the AEROPAK is used at least once a month.