### ELECTRICAL CHARACTERISTICS / @ 23°C / 77°F

- **Nominal capacity (single cells):** 20Ah
- **Nominal voltage:** 24V (25.60V)
- **Charge voltage:** 29.20V
- **Charge cut-off:** 30.80V
- **Charge mode:** CC / CV (29,20V) (constant current / constant voltage)
- **Standard charge current:** 6.67 (C/3) A
- **Max. cont. current in CC state:** ≤ 20 (1C) A @ 0~90% SOC
- **Peak charge current:** ≤ 40 (2C) A @ 15 sec. @ 0~80% SOC
- **Balancing time in CV state:** 1 ~ 2h
- **Floating charge voltage:** 27.20V
- **Discharge voltage:** 25.60V @ C/2 discharge
- **Cut-off discharge voltage:** 19V
- **Standard discharge current:** 6.67 (C/3) A
- **Max. cont. discharge current:** 60 (3C) A
- **Peak current / 5 sec.:** ≤ 200 (10C) A
- **Peak current / 15 sec.:** ≤ 100 (5C) A
- **Peak current / 60 sec.:** ≤ 100 (5C) A
- **Self discharge rate:** 3% / month
- **Dimensions (cell), L*W*H mm.:** 103x41x168 mm
- **Weight, cell / 24V battery:** 0.83kg / 6,64kg
- **Poles:** M12
- **Poles distance:** 54 mm
- **Available capacity:** ≥98% @ 1C discharge
- **Energy density (C/3):** 90,20Wh/L
- **Specific energy (C/3):** 77,10 WH/Kg
- **Specific power:** 386 W/Kg. @ 15 sec. Continuously: 231 W/Kg
- **Inner resistance / cell:** ≤ 2mΩ
- **Cycle life:** 2000 times @ 80% DOD
- **Working temp. / charging:** 0~45°C
- **Working temp. / discharging:** -20~+60°C
- **Storage temp.:** 1 month: -20°C~+60°C
- **3 month:** -20°C~+45°C
- **6 month:** -20°C~+25°C
- **Protection class / cell:** IP67
- **Atmospheric pressure:** 86~106 KPa
- **Operation humidity:** 25~85%, non-condensing

These batteries are widely used in electric vehicles, energy storage, marine applications, industry, telecommunications, electric tools, etc.. The single Lithium Ion cells are completely sealed, and the cells can be assembled in serial and parallel connections for a complete battery pack that match customers battery box designs.

For LiFePO4 molecular structure is reliable and has a high degree of electrical conductance. The battery offer high continuously / peak power even when nearing the end of discharge, and the battery do also accept large charging current such as regeneration of power when the EV's are braking or reducing speed. Those features gives electrical vehicles above average performance when starting or accelerating or climbing.

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**LiFePO4 Lithium Iron Phosphate Battery**

**Type: HP-PW-20AH**

**Power Type ”24V” 20Ah**

- **LiFePO4 single cell**

ZEPIA Energy ApS • Niels Jernes Vej 10 • 9220 (NOVI Science Park) Aalborg • Denmark • Phone +45-96310199 • info@zeapiaenergy.dk • www.zeapiaenergy.dk
LiFePO4 Lithium Ion

Common advantages

1. LiFePO4 is environmentally friendly without any heavy metal, rare metal and toxics.
2. Completely sealed (IP67) and no gassing. Therefore the batteries can be recharged in same room as living.
3. Low weight = 1/3 of lead acid.
4. Small dimensions = ~50% of lead acid.
5. Long cycle life = ~2,000. Lead acid = ~350 cycles.
6. No memory effect.
7. Good performance at high & low temperatures.
8. Intrinsically safe.
9. High C-rate discharge.
10. High peak power available under high DOD.
11. Can be fast re-charged.

Remarks:

1. C-rate can be used to distribute current, ”C” means capacity rating (Amp-hour), easy for calculating. For example, 50Ah cell, 3C means 3*50=150A, C/5 means 1/5*50=10A, also be called 0,2C
2. Test is according to QC/T743-2006
TECHNICAL REQUIREMENTS TO BATTERY CELLS

Testing Conditions

Standard charge: Under temperature 20±5 °C, charge with 1I₃ constant current till it reaches (to) charge cut off voltage(3.85V), then starts to Charge with constant voltage, Till charge current<0.01C.

Standard discharge: Under temperature 20±5 °C, discharge with 1I₃ constant current till(to) discharge cut-off voltage(2.0V).

Standard testing environment:

- Temperature: 15-35°C
- Relative Humidity: 25% ~ 85%RH
- Atmospheric Pressure: 86kPa ~ 106kPa

Electrical cell performance:

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Testing Instructions</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nominal Capacity</td>
<td>Temperature 20±5°C, Measure discharge capacity to 2.0V cut-off within 1h after standard charge. (One time for the first 5 times, meeting the requirements can do)</td>
<td>20.0Ah</td>
</tr>
</tbody>
</table>
| 2   | high-current discharge performance | Temperature 20±5°C, discharge with 1.5C constant current to discharge cut-off voltage within 1hrs after standard charge. | Discharge time≥ 36 min.  
The battery shall not be metamorphose, rupture. |
| 3   | Low-temperature discharge performance | Keep the battery in the case at -20±2°C for 20hrs after standard charge. Measure the discharge time with constant discharge current 1I₃ to cut-off voltage. Then, Temperature 20±5°C lay the battery for 2hrs, observe the appearance of the battery. | Discharge time≥ 126 min  
The battery shall not be metamorphose, rupture. |
| 4   | High-temperature discharge performance | Keep the battery in the case at 55±2°C for 5hrs after standard charge. Measure the discharge time with constant discharge current 1I₃ to cut-off voltage. Then, Temperature 20±5°C lay the battery for 2hrs, Observe the appearance of the battery. | Discharge time≥ 171 min.  
The battery shall not be metamorphose, rupture. |
| 5   | Charge Retention                  | Temperature 20±5°C after standard charge, keep the battery open circuit for 28 days. Then, Measure the discharge time with constant discharge current 1I₃ to cut-off voltage. | Discharge time≥ 144 min |
| 6   | Cycle Life                        | Temperature 20±2°C, Charge with constant charge current 1I₃ to charge cut-off voltage, Then charge with constant voltage to the current ≤ 0.01C, Then, stop charge. 10 min later, discharge with discharge current 0.5C to 100% of the capacity DOD. 10 min later, repeat the cycle, till the capacity of lasting 24 times ≤ 80% of the Nominal Capacity, Then consider the life of battery end. | Cycle Life ≥1000 times |
### Misuse testing:

<table>
<thead>
<tr>
<th>No</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
<td>Falling off testing</td>
<td>After standard charge, drop the battery from the height of 1.5m to the hardwood floor 20mm thin, 2 times one direction, 6 times altogether. During the testing, make note of the changes of voltage and the temperature.</td>
<td>No explosion, no leakage, no fire.</td>
</tr>
<tr>
<td>2</td>
<td>Extrusion testing</td>
<td>After standard charge, lay the battery at 20±5°C for 1 hour.  1. Extrusion direction: press in the vertical direction of the battery polar board.  2. Extrusion area: ≥20cm²  3. Extrusion extent: till the rupture of the battery rind and till to be short-circuited inside (voltage be 0V).</td>
<td>No explosion, no fire (distortion and leakage allowed).</td>
</tr>
<tr>
<td>3</td>
<td>Puncture testing</td>
<td>After standard charge, put the battery at 20±5°C for 1 hour. Then puncture the battery in the direction of electrode board with the high temperature-proof steel pin with 3mm diameter. The test must be conducted in the protective condition. During the test, make note of the changes of the voltage and the temperature.</td>
<td>No explosion, no fire (distortion and leakage allowed).</td>
</tr>
<tr>
<td>4</td>
<td>Calefaction testing</td>
<td>Put the battery in the case at constant temperature of 70±2°C for 120min and observe the appearance of the battery. Meanwhile, make note of the changes of the battery voltage.</td>
<td>No explosion, no fire (distortion and leakage allowed).</td>
</tr>
</tbody>
</table>

### Safety cell performance:

<table>
<thead>
<tr>
<th>NO</th>
<th>Item</th>
<th>Testing Instructions</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Short Circuit performance</td>
<td>After charging the battery standardly put it under the temperature of 20±5°C for 1 hour and then short-circuit the battery for 10min, connecting the positive and negative terminals of it (The resistance of the circuitry ≤5 mΩ). Notice the change of the temperature, battery current and the voltage during the experiment.</td>
<td>No fire, no explosion</td>
</tr>
<tr>
<td>2</td>
<td>Over charge performance</td>
<td>After charging the battery standardly, put it under the temperature of 20±5°C for 1 hour. The battery with thermocouple is to be put into the fume cupboard. Charge it with constant current 0.3C to 4.1 voltage. Observe the appearance of the battery. Notice the change of the temperature, battery current and the voltage during the experiment.</td>
<td>No fire, no explosion</td>
</tr>
</tbody>
</table>
**Storage**
The place of preserving the battery must accord with the following requirements: Indoor, The temperature of environment is between 5°C~35°C, The relative humidity is ≤75%, The place must be clean dry and ventilative;

Avoid contacting to the corrosives;
Keep far away from fire and heat;
Keep the battery 50%~60% charge state;
Avoid being over-charged, the battery should be charged once per 3~6 months when preserved.

**Battery maintenance**
Be sure to charge the new battery fully before using for the first time .The battery will reach its max capacity after 3-5 times of full charging and discharging .

The battery should be used in a ventilated and dry environment. Avoid being near to fire .

The best working temperature range for the battery is 15°C-40°C .Beyond that , there will be effect on the battery's normal working .

Don’t short circuit the battery by connecting the cathode and anode, in case of any danger.

Don’t wash the outer shell of the battery with impregnate .In case of fire, please use Carbon Chlorin to put out fire instead of CO2.

If the battery goes wrong, please deliver that to the factory service centre or relevant organization for proper disposal.

**Notice when using the battery**
In case of leakage, heat, fire, performance decrease etc , please use the battery according to the following regulations Factory won’t take any responsibility for any mis-operation not according to this specification.

Handle with care.

Don't immerge the battery in the water or other liquid , in case of damp .Especially on rainy days , take care to prevent the water from going into the controller and motor ,in case of short- circuit.

Avoid being short-circuited, connecting the anode and cathode.

Please charge the battery with the special Lith.Ion charger provided by your Lith. Ion battery supplier.

Don't dismantle the battery, as that may cause inner short-circuit and then decomposition of the inner material, fire and even explosion accordingly. In addition , dismantling the battery may cause the leakage of the electrolyte ,which will do bad to the human body. If the electrolyte is spattered onto skin , eye and other part of the body , please wash with clean water immediately and go to the doctor at once.

Don't dispose the battery with fire ,in case of any danger.

If the battery is damaged, distorted or there is leakage of the electrolyte or the taste of electrolyte and some similar
abnormal phenomena, don't use the battery any more. Please deliver that to the factory service centre or relevant organization for proper disposal. In addition, battery with electrolyte leakage should be far away from fire, in case of explosion.

**Battery replacement:**
The battery provider should be responsible for replacing and installing the battery. The consumer may not make any service/dismantle or replace cells or complete battery unit.

**Notice during the transportation:**
The battery is suitable for being transported by truck, train, plane. During transportation, please avoid direct solar irradiation, drench and serious shake.

The battery pack must be packed with insulated material and marked with logo of frangibility in case of any damage caused by bumping in transit.

Don't upside down the battery. A sticker indicating 'Don't upside down' is needed.

Handle with care in transit. Can't throw or impact the battery.

Don't place any heavy objects on battery pack.

Don't mix-transport with flammable or explosive consignment, or metal objects with sharp end.

Outer packing should be marked 'Away from moisture, water, and fire'.
Fig. 1 shows a typical schematic diagram for a battery implemented into an electric wheelchair. The Lithium Ion battery is connected to a BMS system, which control the safety for single cells and the complete battery pack.

**NOTE:** A Lithium Ion battery may never be connected to a load or a battery charger without a BMS system connected.

The BMS system will secure that the single battery cells always are being recharged optimal and when the battery is being discharged, the BMS system will secure that no cells are being discharged below their minimum voltage level. This will keep the battery cells in a good condition and optimize the cycle life for the complete battery pack.

Should a short circuit occur in the connected load, DC wires or sockets, the BMS unit will shut down very rapidly for protecting the battery cells.

![BMS System](image1.jpg)

**Fig. 2**

![BMS System](image2.jpg)

**Fig. 3**

Above is showed 2 different BMS systems, which are developed exact to the vehicle application for charge / discharge performance and the physical size so it can fit into the battery box with battery cells.
# BMS Systems for electric wheelchairs

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Parameter</th>
<th>Parameter</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BMS version</td>
<td>8S-40A-100A</td>
<td>8S-60A-100A</td>
<td>8S-80A-120A</td>
</tr>
<tr>
<td>2</td>
<td>Charging voltage</td>
<td>29.1 ~ 29.3V</td>
<td>29.1 ~ 29.3V</td>
<td>29.1 ~ 29.3V</td>
</tr>
<tr>
<td>3</td>
<td>Charging current</td>
<td>40A</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>Continues discharge current</td>
<td>40A</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>Max. discharge current</td>
<td>100A / ≥15 sec.</td>
<td>100A / ≥15 sec.</td>
<td>120A / ≥15 sec.</td>
</tr>
<tr>
<td>6</td>
<td>Over current protection (100A load)</td>
<td>180A</td>
<td>400A</td>
<td>400A</td>
</tr>
<tr>
<td>7</td>
<td>Cell-self-consuming current (3.65V)</td>
<td>90~130µA</td>
<td>≤20µA</td>
<td>≤20µA</td>
</tr>
<tr>
<td>8</td>
<td>Cell balancing current (3.60±0.025V)</td>
<td>100mA</td>
<td>100mA</td>
<td>100mA</td>
</tr>
<tr>
<td>9</td>
<td>Cell balancing voltage</td>
<td>3.60±0.025V</td>
<td>3.60±0.025V</td>
<td>3.60±0.025V</td>
</tr>
<tr>
<td>10</td>
<td>Cell over charge VPOC</td>
<td>3.90±0.025V</td>
<td>3.90±0.025V</td>
<td>3.90±0.025V</td>
</tr>
<tr>
<td>11</td>
<td>Overcharge recovery voltage</td>
<td>3.80±0.05V</td>
<td>3.80±0.05V</td>
<td>3.80±0.05V</td>
</tr>
<tr>
<td>12</td>
<td>Over charge detection time-delay</td>
<td>0.96 - 1.40 sec.</td>
<td>0.96 - 1.40 sec.</td>
<td>0.96 - 1.40 sec.</td>
</tr>
<tr>
<td>13</td>
<td>Cell over discharge VPOC</td>
<td>2.00±0.05V</td>
<td>2.00±0.05V</td>
<td>2.00±0.05V</td>
</tr>
<tr>
<td>14</td>
<td>Over discharge recovery voltage</td>
<td>2.30±0.05V</td>
<td>2.30±0.05V</td>
<td>2.30±0.05V</td>
</tr>
<tr>
<td>15</td>
<td>Over discharge detection time-delay</td>
<td>115 ~ 173mS</td>
<td>115 ~ 173mS</td>
<td>115 ~ 173mS</td>
</tr>
<tr>
<td>16</td>
<td>Short-circuit protection</td>
<td>Self-recovery</td>
<td>Self-recovery</td>
<td>Self-recovery</td>
</tr>
<tr>
<td>17</td>
<td>Impedance</td>
<td>3~8mΩ</td>
<td>&lt;10mΩ</td>
<td>&lt;10mΩ</td>
</tr>
<tr>
<td>18</td>
<td>Working temperature range</td>
<td>-40°C - +85°C</td>
<td>-40°C - +85°C</td>
<td>-40°C - +85°C</td>
</tr>
<tr>
<td>19</td>
<td>Dimensions</td>
<td>112 x 74 x 12 mm</td>
<td>135 x 96 x 12 mm</td>
<td>160 x 153 x 30 mm</td>
</tr>
<tr>
<td>20</td>
<td>Weight</td>
<td>150G</td>
<td>220G</td>
<td>800G</td>
</tr>
</tbody>
</table>

**NOTE:** Other versions of BMS systems can be developed, according to customers requirements!