# XP™ 2.7V 25F ULTRACAPACITOR CELL

## FEATURES AND BENEFITS
- Enhanced performance under adverse environmental conditions
- Patented improvements both in structure and in sealing
- Long lifetimes with up to 500,000 duty cycles*
- Compliant with UL, RoHS and REACH requirements

## TYPICAL APPLICATIONS
- Actuators
- Emergency Lighting
- Telematics
- Automotive
- Security Equipment
- Backup System
- Smoke Detectors
- Advanced Metering

## PRODUCT SPECIFICATIONS
### ELECTRICAL
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage, ( V_r )</td>
<td>2.7 VDC</td>
</tr>
<tr>
<td>Surge Voltage(^1)</td>
<td>2.85 VDC</td>
</tr>
<tr>
<td>Rated Capacitance, ( C^3 )</td>
<td>25 F</td>
</tr>
<tr>
<td>Min. / Max. Capacitance, Initial</td>
<td>22.5 F / 30 F</td>
</tr>
<tr>
<td>Typical Capacitance, Initial(^2,3)</td>
<td>24.8 F</td>
</tr>
<tr>
<td>Rated (Max.) ( ESR_{dc} ), Initial(^3)</td>
<td>25 mΩ</td>
</tr>
<tr>
<td>Typical ( ESR_{dc} ), Initial(^2,3)</td>
<td>16 mΩ</td>
</tr>
<tr>
<td>Typical ( ESR_{dc} ), Initial, 5 sec(^2,3)</td>
<td>27 mΩ</td>
</tr>
<tr>
<td>Maximum Leakage Current, Non-repetitive(^4)</td>
<td>49 μA</td>
</tr>
<tr>
<td>Maximum Peak Current, Non-repetitive(^5)</td>
<td>20 A</td>
</tr>
</tbody>
</table>

### PHYSICAL
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Mass</td>
<td>6.8 g</td>
</tr>
</tbody>
</table>

### POWER & ENERGY
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temp. Range, Standard (-40°C to 65°C) at 2.7 V</td>
<td></td>
</tr>
<tr>
<td>Maximum Stored Energy, ( E_{max} )(^6,9)</td>
<td>25.3 mWh</td>
</tr>
<tr>
<td>Gravimetric Specific Energy(^6)</td>
<td>3.7 Wh/kg</td>
</tr>
<tr>
<td>Usable Specific Power(^6)</td>
<td>5.1 kW/kg</td>
</tr>
<tr>
<td>Impedance Match Specific Power(^6)</td>
<td>10.7 kW/kg</td>
</tr>
<tr>
<td>Operating Temp. Range, Extended (-40°C to 85°C) at 2.3 V</td>
<td></td>
</tr>
<tr>
<td>Maximum Stored Energy</td>
<td>18.3 mWh</td>
</tr>
<tr>
<td>Gravimetric Specific Energy(^6)</td>
<td>2.7 Wh/kg</td>
</tr>
<tr>
<td>Usable Specific Power(^6)</td>
<td>3.7 kW/kg</td>
</tr>
<tr>
<td>Impedance Match Specific Power(^6)</td>
<td>7.7 kW/kg</td>
</tr>
</tbody>
</table>

### SAFETY
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certifications</td>
<td>RoHS, REACH, UL 810A</td>
</tr>
</tbody>
</table>

### TYPICAL CHARACTERISTICS
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>THERMAL</td>
<td></td>
</tr>
<tr>
<td>Typical Thermal Resistance (( R_{in} ), Housing)(^8)</td>
<td>43°C/W</td>
</tr>
<tr>
<td>Typical Thermal Capacitance (( C_{in} ))</td>
<td>5.5 J/°C</td>
</tr>
<tr>
<td>Usable Continuous Current (BOL) ( (\Delta T = 15 \degree C)(^8,10)</td>
<td>3.7 A</td>
</tr>
<tr>
<td>Usable Continuous Current (BOL) ( (\Delta T = 40 \degree C)(^8,10)</td>
<td>6.1 A</td>
</tr>
<tr>
<td>LIFE(^*)</td>
<td></td>
</tr>
<tr>
<td>Projected DC Life at Room Temperature ( (\text{At rated voltage and 25°C, EOL}^{10}) )</td>
<td>10 years</td>
</tr>
<tr>
<td>DC Life at High Temperature ( (\text{At rated voltage and 65°C, EOL}^{10}) )</td>
<td>1,500 hours</td>
</tr>
<tr>
<td>DC Life at De-rated Voltage &amp; Higher Temperature ( (\text{At 2.3V and 85°C, EOL}^{10}) )</td>
<td>1,500 hours</td>
</tr>
<tr>
<td>Projected Cycle Life at Room Temperature(^7) ( (\text{Constant current charge-discharge from } V_r \text{ to } 1/2V_r \text{ at 25°C, EOL}^{10}) )</td>
<td>500,000 cycles</td>
</tr>
<tr>
<td>Biased Humidity Life ( (\text{At rated voltage, 60°C, and 90% RH}) )</td>
<td>3,000 hours</td>
</tr>
<tr>
<td>Shelf Life ( (\text{Stored uncharged at 25°C, } \leq 50% \text{ RH}) )</td>
<td>4 years</td>
</tr>
</tbody>
</table>

*Results may vary. Additional terms and conditions, including the limited warranty, apply at the time of purchase. See the warranty details for applicable operating and use requirements.
Datasheet: XP™ 2.7V 25F ULTRACAPACITOR CELL

1. Surge Voltage
   Absolute maximum voltage, non-repetitive. Duration not to exceed 1 second.

2. “Typical” values represent mean values of production sample.

3. Rated Capacitance & ESR\textsubscript{DC} (measure method)
   - Capacitance: Constant current charge (10 mA/F) to \( V_{max} \) 5 min hold at \( V_{max} \) constant current discharge 10 mA/F to 0.1V.
     e.g. in case of 2.7V 25F cell, 10 * 25 = 250 mA
   - ESR\textsubscript{DC}: Constant current charge (10 mA/F) to \( V_{max} \) 5 min hold at \( V_{max} \) constant current discharge (40 * C * \( V_{max}\textsubscript{mA} \)) to 0.1 V.
     e.g. in case of 2.7V 25F cell, charge with 10 * 25 = 250 mA and discharge with 40 * 25 * 2.7 = 2,700 mA

\begin{align*}
C &= \frac{\int (I(t)) dt}{V_{max}} \\
ESR\textsubscript{DC} &= \frac{\Delta V}{I}
\end{align*}

where \( C \) is the capacitance (F);
\( I \) is the absolute value of the discharge current (A);
\( V_{max} \) is the rated voltage (V);
\( V_{th} \) is the measurement start voltage, 0.8x\( V_{max} \), (V);
\( V_{th} \) is the measurement end voltage, 0.4x\( V_{max} \), (V);
\( t_{th} \) is the time from start of discharge to \( V_{max} \) (s);
\( t_{th} \) is the time from start of discharge to \( V_{th} \) (s);
ESR\textsubscript{DC} is the DC-ESR (Ω);
\( \Delta V \) is the voltage drop during first 10ms of discharge (V).


4. Maximum Leakage Current
   - Current measured after 72 hrs at rated voltage and 25°C. Initial leakage current can be higher.
   - If applicable, module leakage current is the sum of cell and balancing circuit leakage currents.

5. Maximum Peak Current
   - Current needed to discharge cell/module from rated voltage to half-rated voltage in 1 second.

\begin{align*}
I &= \frac{\Delta V}{\Delta t / C + ESR\textsubscript{DC}} \\
\text{where } \Delta t &= 1 \text{ sec in this case.}
\end{align*}

- The stated maximum peak current should not be used in normal operation and is only provided as a reference value.

6. Energy & Power (Based on IEC 62391-2)
   - Maximum Stored Energy, \( E_{max}(\text{Wh}) = \frac{\delta C V^2}{2} \)
   - Gravimetric Specific Energy (Wh/kg) = \( \frac{E_{max}}{\text{mass}} \)
   - Usable Specific Power (W/kg) = \( \frac{E_{max}}{0.12 V^2} \times \text{mass} \)
   - Impedance Match Specific Power (W/kg) = \( \frac{0.25 V^2}{\text{ESR}_{DC} x \text{mass}} \)
   - Presented Power and Energy values are calculated based on Rated Capacitance & Rated (Max.) ESR\textsubscript{DC}, Initial values.

7. Cycle Life Test Profile
   Cycle life varies depending upon application-specific characteristics. Actual results will vary.

8. Temperature Rise at Constant Current
   \( \Delta T = I_{max}^2 x ESR_{DC} x R_{th} \)
   \( \text{where } \Delta T: \text{Temperature rise over ambient (°C)} \)
   \( I_{max}: \text{Maximum continuous or RMS current (A)} \)
   \( R_{th}: \text{Thermal resistance, cell to ambient (°C/W)} \)
   \( ESR_{DC}: \text{Rated (Max.) ESR}_{DC} \)
   (Note: Design should consider EOL ESR\textsubscript{DC} for application temperature rise evaluation.)

9. Per United Nations material classification UN3499, all Maxwell ultracapacitors have less than 10 Wh capacity to meet the requirements of Special Provisions 361. Both individual ultracapacitors and modules composed of those ultracapacitors shipped by Maxwell can be transported without being treated as dangerous goods (hazardous materials) under transportation regulations.

10. BOL: Beginning of Life, rated initial product performance
    EOL: End of Life criteria:
    - Capacitance: 80% of min. BOL rating
    - ESR\textsubscript{DC}: 2x max. BOL rating

BCAP0025 P270 X01

When ordering, please reference the Maxwell Model Number below.

Maxwell Model Number: BCAP0025 P270 X01
Maxwell Part Number: 133519
Alternate Model Number: ESHSR-0025C0-002R7UC

The information in this document is correct at time of printing and is subject to change without notice. Images are not to scale. Products and related processes may be covered by one or more U.S. or international patents and pending applications. Please see www.maxwell.com/patents for more information.

Maxwell Technologies, Inc.
Global Headquarters
3888 Calle Fortunada
San Diego, CA 92123
USA
Tel: +1 (858) 503-3300
Fax: +1 (858) 503-3301

Maxwell Technologies SA
Route de Montena 65
CH-1728 Rossens
Switzerland
Tel: +41 (0)26 411 85 00
Fax: +41 (0)26 411 85 05

Maxwell Technologies, GmbH
Leopoldstrasse 244
80807 Munich
Germany
Tel: +49 (0)89 4161403 0
Fax: +49 (0)89 4161403 99

Maxwell Technologies
Shanghai Trading Co., Ltd.
Room 1005, 1006, and 1007
No. 1896, Gonghexin Road,
Jin An District, Shanghai 2000072,
P.R. China
Tel: +86 21 3852 4000
Fax: +82 31 286 6767

Maxwell Technologies
Shanghai Trading Co., Ltd.
Room 1005, 1006, and 1007
No. 1896, Gonghexin Road,
Jin An District, Shanghai 2000072,
P.R. China
Tel: +86 21 3852 4000
Fax: +82 31 286 6767

MAXWELL TECHNOLOGIES, MAXWELL, MAXWELL CERTIFIED INTEGRATOR, ENABLING ENERGY’S FUTURE, DURALBLIE, NESSCAP, XP, BOOSTCAP, D CELL, CONDIS and their respective designs and/or logos are either trademarks or registered trademarks of Maxwell Technologies, Inc., and/or its affiliates, and may not be copied, imitated or used, in whole or in part, without the prior written permission Maxwell Technologies, Inc. All contents copyright © 2018 Maxwell Technologies, Inc. All rights reserved. No portion of these materials may be reproduced in any form, or by any means, without prior written permission from Maxwell Technologies, Inc.

Page 2 >> Document number: 3001979-EN.3 >> maxwell.com