Maxwell Technologies’ 3V 50F ultracapacitor cell is part of Maxwell’s latest full-featured 3.0V product platform designed to provide energy storage in support of the latest trends in renewable energy, smart grid, and IoT. Designed from the ground up, Maxwell developed the 3V small cell products to be high energy, high power solutions that also incorporate the XP™ technology offering enhanced performance under adverse environmental conditions. Whether used alone, integrated into a module assembly, or in a hybrid configuration, Maxwell’s 3V products will help reduce the overall cost and size of the system while improving return on investments for the customer.

Ultracapacitors are the technology of choice for high energy and high power applications because of their longer operating lifetime, low maintenance requirements, and superior cold weather performance when compared to batteries.

**FEATURES AND BENEFITS**
- Enhanced performance under adverse environmental conditions
- Updated Bill of Materials compared to earlier 2.7V XP products resulting in improved performance at higher voltage
- Long lifetimes with up to 1,000,000 duty cycles*
- Compliant with UL, RoHS and REACH requirements

**TYPICAL APPLICATIONS**
- Actuators
- Emergency Lighting
- Telematics / IoT
- Automotive
- Security Equipment
- Backup and UPS Systems
- Advanced Metering

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Part Number</th>
<th>Package Quantity (MOQ)</th>
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<tbody>
<tr>
<td>BCAP0050 P300 X11</td>
<td>135003</td>
<td>800</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.
## PRODUCT SPECIFICATIONS & CHARACTERISTICS

Values are referenced at $T_A = \text{room temperature}$ and $V_R = 3.0\text{V}$ rated voltage (unless otherwise noted). Min and Max values indicate product specifications. Typical results will vary and are provided for reference only. Additional terms and conditions, including the limited warranty, apply at the time of purchase. See the warranty details for applicable operating and use requirements.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$V_R$</td>
<td>Rated Voltage</td>
<td></td>
<td>–</td>
<td>–</td>
<td>3.0</td>
<td>V</td>
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<tr>
<td>$V_{SURGE}$</td>
<td>Surge Voltage</td>
<td>Note 1</td>
<td>–</td>
<td>–</td>
<td>3.15</td>
<td>V</td>
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<tr>
<td>$C_R$</td>
<td>Rated Capacitance</td>
<td>BOL, Note 2,8</td>
<td>45.0</td>
<td>50.0</td>
<td>60.0</td>
<td>F</td>
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<tr>
<td>$R_S$</td>
<td>Equivalent Series Resistance ($ESR_{DC}$)</td>
<td>BOL, Note 2,8</td>
<td>–</td>
<td>10</td>
<td>16</td>
<td>mΩ</td>
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<tr>
<td>$I_{LEAK}$</td>
<td>Leakage Current</td>
<td>Note 3,8</td>
<td>–</td>
<td>–</td>
<td>150</td>
<td>µA</td>
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<tr>
<td>$I_{PEAK}$</td>
<td>Peak Current</td>
<td>BOL, Note 4,8</td>
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<td>–</td>
<td>41</td>
<td>A</td>
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<tr>
<td>$I_{MAX}$</td>
<td>Continuous Current</td>
<td>BOL, Note 7,8</td>
<td>–</td>
<td>–</td>
<td>6.4</td>
<td>A$_{RMS}$</td>
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### LIFE

<table>
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<tr>
<th>Symbol</th>
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<th>Conditions</th>
<th>Min</th>
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<th>Max</th>
<th>Unit</th>
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<tr>
<td>$t_{65C}$</td>
<td>High Temperature Life</td>
<td>$V_R = 3\text{V}$ and $T_A = 65\text{°C}$, EOL, Note 8</td>
<td>–</td>
<td>2,000</td>
<td>–</td>
<td>hours</td>
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<tr>
<td></td>
<td></td>
<td>- Capacitance change $\Delta C$ from $\text{min } C_R$</td>
<td>–</td>
<td>-20</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Resistance change $\Delta R$ from $\text{max } R_S$</td>
<td>–</td>
<td>+100</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td>$t_{85C}$</td>
<td>De-rated Voltage &amp; Higher Temperature Life</td>
<td>$V_R = 2.7\text{V}$ and $T_A = 85\text{°C}$, EOL, Note 8</td>
<td>–</td>
<td>1,500</td>
<td>–</td>
<td>hours</td>
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<tr>
<td></td>
<td></td>
<td>- Capacitance change $\Delta C$ from $\text{min } C_R$</td>
<td>–</td>
<td>-20</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Resistance change $\Delta R$ from $\text{max } R_S$</td>
<td>–</td>
<td>+100</td>
<td>–</td>
<td>%</td>
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<tr>
<td>$t_{25C}$</td>
<td>Projected Life Time</td>
<td>$V_R = 3\text{V}$ and $T_A = 25\text{°C}$, EOL, Note 8</td>
<td>–</td>
<td>10</td>
<td>–</td>
<td>years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Capacitance change $\Delta C$ from $\text{min } C_R$</td>
<td>–</td>
<td>-20</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Resistance change $\Delta R$ from $\text{max } R_S$</td>
<td>–</td>
<td>+100</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td>$n_{CYCLE}$</td>
<td>Projected Cycle Life</td>
<td>$T_A = 25\text{°C}$, EOL, Note 6,8</td>
<td>–</td>
<td>1,000,000</td>
<td>–</td>
<td>cycles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Capacitance change $\Delta C$ from $\text{min } C_R$</td>
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<td>-20</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td></td>
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<td>- Resistance change $\Delta R$ from $\text{max } R_S$</td>
<td>–</td>
<td>+100</td>
<td>–</td>
<td>%</td>
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<tr>
<td>$h_{LIFE}$</td>
<td>Biased Humidity Life</td>
<td>$V_R = 3\text{V}$, $T_A = 60\text{°C}$, and RH = 90%</td>
<td>–</td>
<td>4,000</td>
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<td>hours</td>
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<tr>
<td>$t_{SHELF}$</td>
<td>Shelf Life</td>
<td>Stored uncharged, $T_A = 25\text{°C}$ and RH &lt; 50%</td>
<td>–</td>
<td>4</td>
<td>–</td>
<td>years</td>
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</tbody>
</table>
## PRODUCT SPECIFICATIONS & CHARACTERISTICS

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<th>Max</th>
<th>Unit</th>
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<tr>
<td>$P_d$</td>
<td>Usable Specific Power</td>
<td>BOL, Note 5,8</td>
<td>–</td>
<td>9.3</td>
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<td>kW/kg</td>
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<td>$P_{\text{MAX}}$</td>
<td>Impedance Match Specific Power</td>
<td>BOL, Note 5,8</td>
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<td>kW/kg</td>
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<tr>
<td>$E_d$</td>
<td>Gravimetric Specific Energy</td>
<td>BOL, Note 5,8</td>
<td>–</td>
<td>5.4</td>
<td>–</td>
<td>Wh/kg</td>
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<td>$E_{\text{MAX}}$</td>
<td>Stored Energy</td>
<td>BOL, Note 5,8,9</td>
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### TEMPERATURE

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<tr>
<td>$T_a$</td>
<td>Operating Temperature</td>
<td>Cell case temperature</td>
<td>-40</td>
<td>25</td>
<td>65</td>
<td>°C</td>
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<tr>
<td>$R_{\text{th}}$</td>
<td>Thermal Resistance</td>
<td>Case to ambient, Note 7</td>
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<td>23</td>
<td>–</td>
<td>°C/W</td>
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<tr>
<td>$C_{\text{th}}$</td>
<td>Thermal Capacitance</td>
<td></td>
<td>–</td>
<td>16</td>
<td>–</td>
<td>J/°C</td>
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### PHYSICAL

<table>
<thead>
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<th>Symbol</th>
<th>Parameter</th>
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<th>11.6</th>
<th>–</th>
<th>g</th>
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<tr>
<td>–</td>
<td>Vibration – Sine Wave</td>
<td>IEC 60068-2-6</td>
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<tr>
<td>–</td>
<td>Shock</td>
<td>IEC 60068-2-27</td>
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</table>

### SAFETY

| –      | Certifications         | UL810A, RoHS, REACH    |   |      |   |   |

**Note**: BOL refers to baseline operating levels.
NOTES

1. Surge Voltage
   Absolute maximum voltage, non-repetitive. The duration must not exceed 1 second.

2. Rated Capacitance & ESR<sub>BOL</sub> (Measurement Method)
   - Capacitance: Constant current charge (10mA/F) to \( V_{10} \) 5 min hold at \( V_{10} \)
     constant current discharge (10mA/F) to 0.1V.
   - ESR<sub>BOL</sub>: Constant current charge (10mA/F) to \( V_{10} \) 5 min hold at \( V_{10} \)
     constant current discharge (40 °C \( C_{n} \) \( V_{10} \) [mA]) to 0.1V.

   \[
   C_n = \frac{I \times \Delta t}{\Delta V - \Delta t}
   \]
   where \( C_n \) is the capacitance (F);
   \( I \) is the absolute value of the discharge current (A);
   \( \Delta t \) is the discharge time (sec);
   \( \Delta t = 1 \) sec in this case;
   \( \Delta V \) is the voltage drop during first 10ms of discharge (V);

3. Leakage Current (Measurement Method)
   - Current measured after 72 hours of constant voltage hold at \( V_n \) and 25°C.

   Leakage current can be higher.
   - If applicable, module leakage current is the sum of cell leakage current and
     bypass current created by balancing circuit.

4. Peak Current
   - Current needed to discharge cell or module from \( V_n \) to 1/2\( V_n \), in 1 second.
   \[
   I_{PEAK} = \frac{\Delta V}{R_s}
   \]
   where \( I_{PEAK} \) is the maximum peak current (A);
   \( V_n \) is the rated voltage (V);
   \( \Delta V \) is the voltage drop during first 10ms of discharge (V);

5. Energy & Power (Based on IEC 62576)
   - Usable Specific Power, \( P_u \) (W/kg) = \[
   0.12V_n^2 \frac{I}{R_s + m}
   \]
   - Impedance Match Specific Power, \( P_{MAX} \) (W/kg) = \[
   0.25V_n^2 \frac{I}{R_s + m}
   \]
   - Gravimetric Specific Energy, \( E_{GMAX} \) (Wh/kg) = \[
   \frac{E_{MAX}}{m}
   \]
   - Stored Energy, \( E_{MAX} \) (Wh) = \[
   \frac{1}{2} C_n \times V_n^2
   \]
   where \( V_n \) is the rated voltage (V);
   \( R_s \) is the typical BOL ESR<sub>BOL</sub> (Ω);
   \( m \) is the typical mass (kg);
   \( C_n \) is the rated BOL capacitance (F).

6. Projected Cycle Life
   - Constant current charge-discharge cycle from \( V_n \) to 1/2\( V_n \) at 25°C.
   - Cycle life is dependent upon application-specific characteristics. Actual results will vary.

7. Continuous Current & Thermal Resistance
   - Maximum current which can be used continuously within the allowed
     temperature range.
   \[
   I_{MAX} = \sqrt{\frac{\Delta T}{R_T + R_s}}
   \]
   where \( I_{MAX} \) is the maximum continuous current (A);
   \( \Delta T \) is the change in temperature (°C);
   \( R_T \) is the typical thermal resistance (°C/W);
   \( R_s \) is the maximum BOL ESR<sub>BOL</sub> (Ω).

8. BOL & EOL Conditions
   - BOL (Beginning of Life): Rated/Initial product performance
     - Capacitance: 80% of min. BOL rating (0.8 x min. \( C_n \))
     - ESR<sub>BOL</sub>: 200% of max. BOL rating (2 x max. \( R_s \))

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

DETAILED PRODUCT DESCRIPTION

Introduction
The BCAP0050 P300 X11 energy storage cell is a robust ultracapacitor
solution in a leaded cylindrical style can. The 3.0V 50F cell design uses
Maxwell’s proprietary XP™ high heat and humidity environmental technology
to provide maximum life under adverse conditions.

Technology Overview
Ultracapacitor, also known as supercapacitor or electric double layer capacitor
(EDLC), delivers energy at relatively high rates (beyond those accessible
with batteries). Ultracapacitors store charge electrostatically (non-Faradaic)
by reversible adsorption of the electrolyte onto electrochemically stable high
surface area carbon electrodes. Charge separation occurs on polarization at
the electrode/electrolyte interface, producing a double layer. This mechanism
is highly reversible, allowing the ultracapacitor to be charged and discharged
hundreds of thousands of times.*

Ultracapacitor Construction
An ultracapacitor is constructed with symmetric carbon positive and negative
electrodes separated by an insulating ion-permeable separator and packaged
into a container filled with organic electrolyte (salt/solvent) designed to
maximize ionic conductivity and electrode wetting. It is the combination of high
surface-area activated carbon electrodes (typically >1500m²/g) with extremely
small charge separation (Angstroms) that results in high capacitance.

*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.
# Mechanical Drawings

**BCAP0050 P300 X11**

![Mechanical Drawing](image)

<table>
<thead>
<tr>
<th>Dimension (Tolerance)</th>
<th>L (±1.0)</th>
<th>D (+0.5)</th>
<th>d (±0.05)</th>
<th>A (±0.5)</th>
<th>H1 (min)</th>
<th>H2 (min)</th>
<th>UNIT</th>
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<tbody>
<tr>
<td>BCAP0050 P300 X11</td>
<td>41.0</td>
<td>18.0</td>
<td>0.80</td>
<td>7.5</td>
<td>15.0</td>
<td>19.0</td>
<td>mm</td>
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</table>

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