Maxwell Technologies’ 3V 3F 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*
- Straight and Bent Lead versions available
- 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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<td>BCAP0003 P300 X11</td>
<td>134995</td>
<td>6,000</td>
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<tr>
<td>BCAP0003 P300 X12</td>
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*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>
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<th>Unit</th>
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<tr>
<td></td>
<td><strong>ELECTRICAL</strong></td>
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<tr>
<td>$V_R$</td>
<td>Rated Voltage</td>
<td>–</td>
<td>–</td>
<td>3.0</td>
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<td>V</td>
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<td>$V_{SURGE}$</td>
<td>Surge Voltage</td>
<td>Note 1</td>
<td>–</td>
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<td>3.15</td>
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<td>$C_R$</td>
<td>Rated Capacitance</td>
<td>BOL, Note 2,8</td>
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<td>F</td>
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<td>$R_S$</td>
<td>Equivalent Series Resistance (ESR_{DC})</td>
<td>BOL, Note 2,8</td>
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<td>95</td>
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<td>$I_{LEAK}$</td>
<td>Leakage Current</td>
<td>Note 3,8</td>
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<td>µA</td>
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<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>
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<td>- Capacitance change $\Delta C$ from min $C_R$</td>
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<td>%</td>
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<td></td>
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<td>- Resistance change $\Delta R$ from max $R_S$</td>
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<td>+100</td>
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<td>%</td>
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<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>
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<td>–</td>
<td>hours</td>
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<td>- Capacitance change $\Delta C$ from min $C_R$</td>
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<td>-20</td>
<td>–</td>
<td>%</td>
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<tr>
<td></td>
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<td>- Resistance change $\Delta R$ from max $R_S$</td>
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<td>+100</td>
<td>–</td>
<td>%</td>
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<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>
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<tr>
<td></td>
<td></td>
<td>- Capacitance change $\Delta C$ from 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 max $R_S$</td>
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<td>+100</td>
<td>–</td>
<td>%</td>
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<tr>
<td>$n_{CYCLE}$</td>
<td>Projected Cycle Life</td>
<td>$T_A = 25\text{°C}$, EOL, Note 6,8</td>
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<td>1,000,000</td>
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<td>cycles</td>
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<td></td>
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<td>- Capacitance change $\Delta C$ from min $C_R$</td>
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<td>-20</td>
<td>–</td>
<td>%</td>
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<tr>
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<td>- Resistance change $\Delta R$ from 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>
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<td>4,000</td>
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<td>$t_{SHELF}$</td>
<td>Shelf Life</td>
<td>Stored uncharged, $T_A = 25\text{°C}$ and RH ≤ 50%</td>
<td>–</td>
<td>4</td>
<td>–</td>
<td>years</td>
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</tbody>
</table>
## PRODUCT SPECIFICATIONS & CHARACTERISTICS

Values are referenced at $T_a = \text{room temperature}$ and $V_{R} = 3.0V$ 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.

### POWER & ENERGY

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
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<th>Min</th>
<th>Typical</th>
<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>12.4</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>$E_d$</td>
<td>Gravimetric Specific Energy</td>
<td>BOL, Note 5,8</td>
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<td>Wh/kg</td>
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<td>$E_{\text{MAX}}$</td>
<td>Stored Energy</td>
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### TEMPERATURE

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<tr>
<td>$T_a$</td>
<td>Operating Temperature</td>
<td>Cell case temperature</td>
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<td>65</td>
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<td>$R_{th}$</td>
<td>Thermal Resistance</td>
<td>Case to ambient, Note 7</td>
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<td>$C_{th}$</td>
<td>Thermal Capacitance</td>
<td>–</td>
<td>1.3</td>
<td>–</td>
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<td>J/°C</td>
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</table>

### PHYSICAL

| m    | Mass | – | 1.4 | – | g |
| –    | Vibration – Sine Wave | IEC 60068-2-6 | – |
| –    | Shock | IEC 60068-2-27 | – |

### SAFETY

| –    | Certifications | UL810A, RoHS, REACH |
1. Surge Voltage
Absolute maximum voltage, non-repetitive. The duration must not exceed 1 second.

2. Rated Capacitance & ESR_{BOL} (Measurement Method)
- Capacitance: Constant current charge (10mA/F) to V_{n}, 5 min hold at V_{n} as constant current discharge (10mA/F) to 0.1V.
- ESR_{BOL}: Constant current charge (10mA/F) to V_{n}, 5 min hold at V_{n} as constant current discharge (40 °C, * V_{n} [mA]) to 0.1V.

\[
C_n = \frac{I_x (t_2 - t_1)}{V_n - V_1}
\]

where \( C_n \) is the capacitance (F); \( I_x \) is the absolute value of the discharge current (A); \( V_n \) is the rated voltage (V); \( V_1 \) is the measurement starting voltage, 0.8 X \( V_n \) (V); \( t_1 \) is the time from discharge start to reach \( V_1 \) (s); \( t_2 \) is the time from discharge start to reach \( V_n \) (s); \( R_1 \) is the DC equivalent series resistance (Ω); \( \Delta V \) 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. Initial leakage current can be higher.
  - If applicable, module leakage current can be 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.

\[
I_{PEAK} = \frac{\Delta V}{\Delta t / C_n + R_1}
\]

where \( I_{PEAK} \) is the maximum peak current (A); \( V_n \) is the rated voltage (V); \( \Delta t \) is the discharge time (sec); \( \Delta t = 1 \text{ sec} \) in this case; \( C_n \) is the rated BOL capacitance (F); \( R_1 \) is the maximum BOL ESR_{BOL} (O).

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

5. Energy & Power (Based on IEC 62576)
- Usable Specific Power, \( P_{U} \) (W/kg) = \( \frac{0.12 V_n^2}{R_1 \times m} \)
- Impedance Match Specific Power, \( P_{MAX} \) (W/kg) = \( \frac{0.25 V_n^2}{R_1 \times m} \)
- Gravimetric Specific Energy, \( E_{G} \) (Wh/kg) = \( \frac{E_{MAX}}{m} \)
- Stored Energy, \( E_{MAX} \) (Wh) = \( \frac{1}{2} C_n V_n^2 \)

where \( V_n \) is the rated voltage (V); \( R_1 \) is the typical BOL ESR_{BOL} (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.

\[
I_{MAX} = \sqrt{\frac{\Delta T}{R_1 + R_2}}
\]

where \( I_{MAX} \) is the maximum continuous current (A); \( \Delta T \) is the change in temperature (°C); \( R_1 \) is the typical thermal resistance (°C/W); \( R_2 \) is the maximum BOL ESR_{BOL} (Ω).

8. BOL & EOL Conditions
- BOL (Beginning of Life): Rated/Initial product performance
- EOL (End of Life):
  - Capacitance: 80% of min. BOL rating (0.8 x min. \( C_n \))
  - ESR_{EOL}: 200% of max. BOL rating (2 x max. \( R_1 \))

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.

**Introduction**

The BCAP0003 P300 X11 / X12 energy storage cell is a robust ultracapacitor solution in a leaded cylindrical style can. The 3.0V 3F 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.

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# MECHANICAL DRAWINGS

## BCAP0003 P300 X11

![Mechanical Drawing](image1.png)

## BCAP0003 P300 X12

![Mechanical Drawing](image2.png)

## Dimension (Tolerance)

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<th>D</th>
<th>d</th>
<th>A</th>
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<th>R</th>
<th>a</th>
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<td>7.0</td>
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