3.0V 3400F ULTRACAPACITOR CELL

BCAP3400 P300 K04/05

Maxwell's Highest Power and Energy Cell

Maxwell Technologies' 3V 3400F ultracapacitor cell is designed to support the latest trends in renewable energy, industrial electrification and transportation. Designed from the ground up, Maxwell developed the 3V 3400F cell to be the highest energy, highest power workhorse of its ultracapacitor portfolio. Whether used alone, integrated into a module assembly, or in a hybrid configuration, Maxwell's 3V 3400F product will help reduce the overall cost and weight of the system while improving the customer's return on investment.

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

FEATURES AND BENEFITS

- High power and high energy
- 30 kW/kg of specified power
- 4.25 Wh of stored energy
- DuraBlue™ Shock and Vibration Technology
- Up to 1,000,000 duty cycles or 10-year DC life*
- Laser weldable or screw posts

TYPICAL APPLICATIONS

- Heavy transportation
  - Hybrid buses
  - Rail
  - Truck
  - Construction vehicles
- Heavy industrial and stationary solutions
  - Backup and UPS systems
- Grid and microgrid

ORDERING INFORMATION

Model Number	Part Number	Package Quantity
BCAP3400 P300 K04/05	**134144 / 134874**	**15**

PRODUCT SPECIFICATIONS

Values are referenced at T_A = 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. Additional terms and conditions, including the limited warranty, apply at the time of purchase.

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
ELECTRICAL						
C_R	Initial Rated Capacitance	Note 3	3,400	–	4,080	F
R_S	Initial Equivalent Series Resistance (ESR)	100ms, Note 3	–	0.15	0.24	mΩ
V_R	Maximum Rated Voltage		–	3.0	–	V
V_{MAX}	Absolute Maximum Voltage	Note 1	–	–	3.15	V
I_{DCMAX}	Maximum Continuous Current	Note 8, 10 - ΔT = 15°C (BOL) - ΔT = 40°C (BOL)	– –	140 225	– –	A_{RMS}
I_{ACMAX}	Maximum Peak Current	Note 5	–	–	2,800	A
I_{SHORT}	Short Circuit Current	Current possible with short circuit from V_R. Do not use as operating current.	–	20,000	–	A
I_{LEAK}	Leakage Current	At 25°C, Note 4	–	–	12	mA
LIFE						
t_{AGING}	Accelerated Aging	At V_R = 3V and T_A = 65°C (note 3,10) - Capacitance change ΔC from C_R - Resistance change ΔR from R_S	– – –	1,500 20 100	– – –	hours % %
t_{LIFE}	Projected Life Time	At V_R = 3V and T_A = 25°C (note 3,10) - Capacitance change ΔC from C_R - Resistance change ΔR from R_S	– – –	10 20 100	– – –	years % %
n_{LIFE}	Projected Cycle Life	At V_R = 3V and T_A = 25°C (note 3,7,10) - Capacitance change ΔC from C_R - Resistance change ΔR from R_S	– – –	1,000,000 25 100	– – –	cycles % %
t_{SHELF}	Shelf Life	Stored uncharged at 25°C, <50% RH	–	4	–	years
POWER & ENERGY						
P_d	Usable Specific Power	Note 6	9.07	14.5	–	kW/kg
P_{max}	Impedance Match Specific Power	Note 6	18.9	30	–	kW/kg
E_{MAX}	Specific Energy	Note 6	8.57	–	–	Wh/kg
E_{STORED}	Stored Energy	Note 6, 9	4.25	–	–	Wh

*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, cont.

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
TEMPERATURE						
T_A	Operating Temperature	Cell Case Temperature	-40	–	65	°C
T_{STG}	Storage Temperature	Stored Uncharged @ <50% Relative humidity (RH)	–	–	25	°C
R_{th}	Thermal Resistance	Case to Ambient, Note 8	–	3.2	–	°C/W
C_{th}	Thermal Capacitance		–	580	–	J/°C
PHYSICAL						
m	Mass		–	496	–	g
F_{M12}	Recommended Torque on Threaded Connectors (K04)	M12 Thread	10	12	14	Nm
–	Recommended Welding on Jove Terminal (K05)	Negative = 1100-F aluminum Positive = 1070-F aluminum Refer to Maxwell K2 Cell Family Welding Guidelines (www.maxwell.com)	–	–	–	–
–	Vibration Specification		ISO 16750-3 (Table 12)			–
–	Shock Specification		IEC60068-2-27			–
SAFETY						
–	Certifications		UL810a, RoHS, REACH			

TEST PROCEDURES

1. Surge Voltage
   Absolute maximum voltage, non-repetitive. Duration not to exceed 1 second.
2. "Typical" values represent mean values of production sample.
3. Capacitance and ESR_{DC} measured using 100 A test current at 25°C per document number 1007239 available at maxwell.com.
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.

   $$I = \frac{½V_R}{\Delta t / C + ESR_{DC}}$$

   where Δt is the discharge time (sec); Δt = 1 sec in this case.

   - 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, $E_{max}(Wh) = \frac{½CV_R^2}{3{,}600}$
   - Gravimetric Specific Energy (Wh/kg) = $\frac{E_{max}}{mass}$
   - Usable Specific Power (W/kg) = $\frac{0.12V_R^2}{ESR_{DC} \times mass}$
   - Impedance Match Specific Power (W/kg) = $\frac{0.25V_R^2}{ESR_{DC} \times mass}$
   - Presented Power and Energy values are calculated based on Rated Capacitance & Rated (Max.) ESR_{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
   - $\Delta T = I_{RMS}^2 \times ESR_{DC} \times R_{th}$

   where ΔT: Temperature rise over ambient (°C)
   I_{RMS}: Maximum continuous or RMS current (A)
   R_{th}: Thermal resistance, cell to ambient (°C/W)
   ESR_{DC}: Rated (Max.) $ESR_{DC}(\Omega)$.
   (Note: Design should consider EOL ESR_{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_{DC}: 2x max. BOL rating

TYPICAL PERFORMANCE

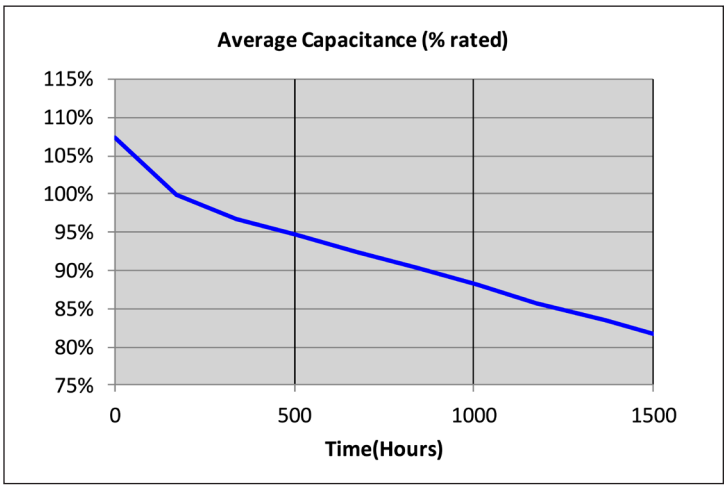


Figure 1: Accelerated Aging Capacitance Performance
V_R = 3V, T_A = 65°C

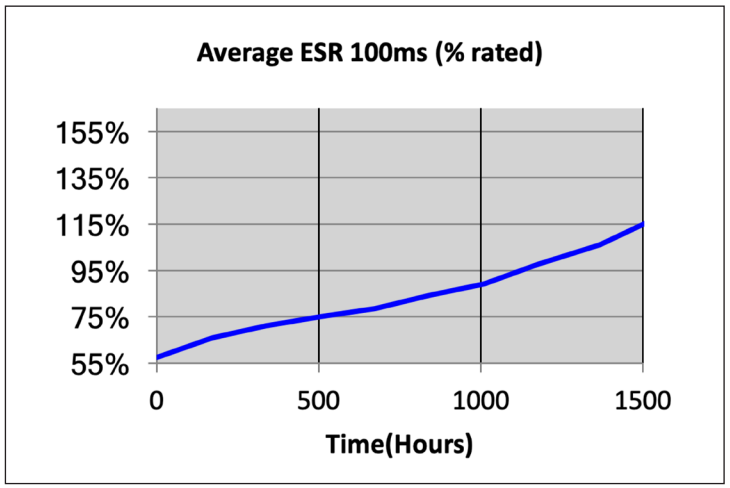


Figure 2: Accelerated Aging ESR Performance
V_R = 3V, T_A = 65°C

DETAILED PRODUCT DESCRIPTION

Introduction
The BCAP3400 P300 K04/K05 energy storage cell is a high power and energy design in the Maxwell driven industry-standard 60mm cylindrical form factor. The 3.0V 3400F cell design uses Maxwell's proprietary DuraBlue® Advanced Shock and Vibration technology to provide maximum vibration resistance and shock immunity.

Technology Overview
Electrochemical double layer capacitors (EDLCs), are also known as electric double layer capacitor, supercapacitors or ultracapacitors. They deliver energy at relatively high rates (beyond those accessible with batteries). Ultracapacitors store charge electrostatically (non-Faradaic) by reversible absorption 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 to even millions of times.

Ultracapacitor Construction
An ultracapacitor is constructed with symmetric carbon positive and negative electrodes separated by an insulating ion-permeable separator, packaged into a container then 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 >1500m^2 /g) with extremely small charge separation (Angstroms) that results in high capacitance.

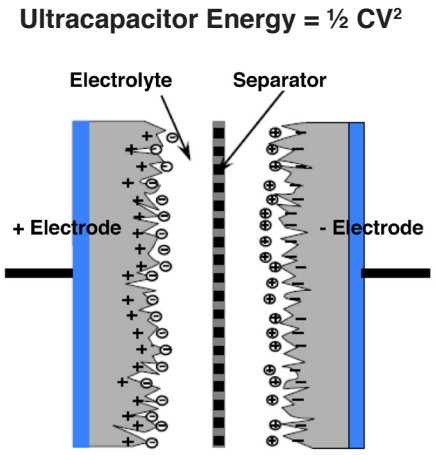
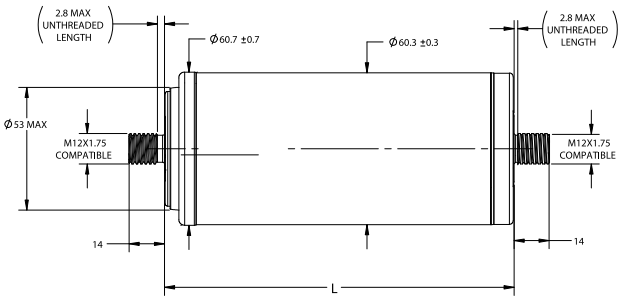


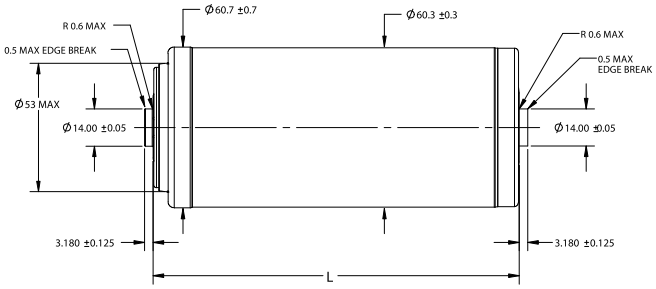
Figure 3: Ultracapacitor Structure Diagram

MECHANICAL DRAWINGS

BCAP3400 P300 K04



BCAP3400 P300 K05



DIMENSIONS	Min	Typical	Max	Unit
Length (L)	-0.3	138	+0.3	mm

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