

5.0V 2.5F ULTRACAPACITOR MODULE

BMOD0002 P005 B02
EMHSR-0002C5-005R0

FEATURES AND BENEFITS

- High performance product with low ESR
- Exceptional shock and vibration resistance
- Long lifetimes with up to 500,000 duty cycles*
- Compliant with RoHS and REACH requirements

TYPICAL APPLICATIONS

- Automotive
- UPS System
- Actuators
- Emergency Lighting
- Telematics
- Security Equipment
- Backup System
- Smoke Detectors
- Advanced Metering



PRODUCT SPECIFICATIONS

ELECTRICAL

Rated Voltage, V_R	5.0 VDC
Surge Voltage ¹	5.4 VDC
Rated Capacitance, C^3	2.5 F
Min. / Max. Capacitance, Initial	2.25 F / 3 F
Typical Capacitance, Initial ^{2,3}	2.63 F
Rated (Max.) ESR _{DC} , Initial ³	85 mΩ
Typical ESR _{DC} , Initial ^{2,3}	69 mΩ
Maximum Leakage Current ⁴	8 μA
Maximum Peak Current, Non-repetitive ⁵	5.1 A

PHYSICAL

Nominal Mass	5.0 g
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POWER & ENERGY

Operating Temp. Range	Standard (-40°C to 65°C) at 5.0 V	Extended (-40°C to 85°C) at 4.6 V
Maximum Stored Energy, $E_{max}^{6,9}$	8.6 mWh	7.3 mWh
Gravimetric Specific Energy ⁶	1.7 Wh/kg	1.4 Wh/kg
Usable Specific Power ⁶	7.0 kW/kg	5.9 kW/kg
Impedance Match Specific Power ⁶	14.7 kW/kg	12.4 kW/kg

SAFETY

Certifications	RoHS, REACH
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TYPICAL CHARACTERISTICS

THERMAL

Typical Thermal Resistance (R_{th} , Housing) ⁸	69°C/W
Typical Thermal Capacitance (C_{th})	4.3 J/°C
Usable Continuous Current (BOL) ($\Delta T = 15^\circ C$) ^{8,10}	1.6 A
Usable Continuous Current (BOL) ($\Delta T = 40^\circ C$) ^{8,10}	2.6 A

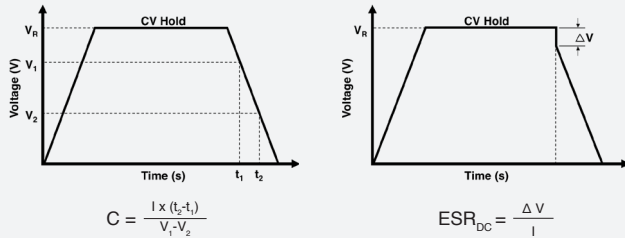
LIFE*

Projected DC Life at Room Temperature (At rated voltage and 25°C, EOL ¹⁰)	10 years
DC Life at High Temperature (At rated voltage and 65°C, EOL ¹⁰)	1,500 hours
DC Life at De-rated Voltage & Higher Temperature (At 4.6V and 85°C, EOL ¹⁰)	1,500 hours
Projected Cycle Life at Room Temperature ⁷ (Constant current charge-discharge from V_R to $1/2V_R$ at 25°C, EOL ¹⁰)	500,000 cycles
Shelf Life (Stored uncharged at 25°C, ≤ 50% RH)	4 years

*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: 5.0V 2.5F ULTRACAPACITOR MODULE

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_{DC} (measure method)
 - Capacitance: Constant current charge ($4 \times C \times V_R$ [mA]) to V_R , 5 min hold at V_R , constant current discharge ($4 \times C \times V_R$ [mA]) to 0.1 V.
e.g. in case of 5.0V 2.5F module, $4 \times 2.5 \times 5.0 = 50$ mA.
 - ESR_{DC}: Constant current charge ($4 \times C \times V_R$ [mA]) to V_R , 5 min hold at V_R , constant current discharge ($40 \times C \times V_R$ [mA]) to 0.1 V.
e.g. in case of 5.0V 2.5F module, charge with $4 \times 2.5 \times 5.0 = 50$ mA and discharge with $40 \times 2.5 \times 5.0 = 500$ mA.



where C is the capacitance (F);
I is the absolute value of the discharge current (A);
 V_R is the rated voltage (V);
 V_1 is the measurement start voltage, $0.8 \times V_R$ (V);
 V_2 is the measurement end voltage, $0.4 \times V_R$ (V);
 t_1 is the time from start of discharge to reach V_1 (s);
 t_2 is the time from start of discharge to reach V_2 (s);
ESR_{DC} is the DC-ESR (Ω);
ΔV 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.

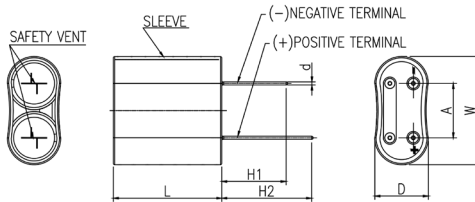
$$I = \frac{\frac{1}{2} V_R}{\Delta t / C + \text{ESR}_{DC}}$$

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, $E_{\max}(\text{Wh}) = \frac{\frac{1}{2} C V_R^2}{3,600}$
 - Gravimetric Specific Energy (Wh/kg) = $\frac{E_{\max}}{\text{mass}}$
 - Usable Specific Power (W/kg) = $\frac{0.12 V_R^2}{\text{ESR}_{DC} \times \text{mass}}$
 - Impedance Match Specific Power (W/kg) = $\frac{0.25 V_R^2}{\text{ESR}_{DC} \times \text{mass}}$
 - 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
 - $\Delta T = I_{\text{RMS}}^2 \times \text{ESR}_{DC} \times R_{th}$

where ΔT: Temperature rise over ambient (°C)
 I_{RMS} : Maximum continuous or RMS current (A)
 R_{th} : Thermal resistance, module to ambient (°C/W)
ESR_{DC}: Rated (Max.) ESR_{DC} (Ω).
(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

BMOD0002 P005 B02



When ordering, please reference the Maxwell Model Number below.

Maxwell Model Number: BMOD0002 P005 B02
Maxwell Part Number: 133731
Alternate Model Number: EMHSR-0002C5-005R0

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