

# 24V 9F ULTRACAPACITOR MODULE

## FEATURES AND BENEFITS

- Rated voltage of 24V and capacitance of 9F
- High performance module with low ESR
- Designed with compact and light-weight package
- Long lifetimes with up to 500,000 duty cycles\*
- Passive cell balancing

## TYPICAL APPLICATIONS

- Backup power for robotics
- Industrial applications



## PRODUCT SPECIFICATIONS & CHARACTERISTICS

BMOD0009 P024 B02  
EMHSR-0009C0-024R0

### ELECTRICAL

Rated Voltage, $V_R$	24 VDC
Surge Voltage <sup>1</sup>	31 VDC
Rated Capacitance, $C^3$	9 F
Min. / Max. Capacitance, Initial	9 F / 10.8 F
Typical Capacitance, Initial <sup>2,3</sup>	9.4 F
Rated (Max.) $ESR_{DC}$ , Initial <sup>3</sup>	139 mΩ
Typical $ESR_{DC}$ , Initial <sup>2,3</sup>	93 mΩ
Typical Leakage Current <sup>4</sup>	5 mA
Maximum Peak Current, Non-repetitive <sup>5</sup>	45 A

### PHYSICAL

Nominal Mass	410 g
Output Terminals	2 × AWG16 wires (positive / negative)
Insulation Coordination	IEC 60664-1 (Category: OV II)
Protection Degree	IEC 60529 – IP 20
Vibration	IEC 60068-2-6 Table B-1
Shock	IEC 60068-2-27

### POWER & ENERGY

Maximum Stored Energy, $E_{max}^{6,8}$	0.72 Wh
Gravimetric Specific Energy <sup>6</sup>	1.7 Wh/kg
Usable Specific Power <sup>6</sup>	1.2 kW/kg
Impedance Match Specific Power <sup>6</sup>	2.5 kW/kg

### TEMPERATURE

Operating Temperature Range	-40°C to +65°C
Storage Temperature Range (Stored without charge)	-40°C to +70°C

### LIFE\*

Projected DC Life at Room Temperature (At rated voltage and 25°C, EOL <sup>9</sup> )	10 years
DC Life at High Temperature (At rated voltage and 65°C, EOL <sup>9</sup> )	1,500 hours
Projected Cycle Life at Room Temperature <sup>7</sup> (Constant current charge-discharge from $V_R$ to $1/2V_R$ at 25°C, EOL <sup>9</sup> )	500,000 cycles
Shelf Life (Stored uncharged at 25°C)	4 years

### UMU / MONITORING

Cell Balancing	Passive single cell balancing
Over-Voltage Monitoring	Voltage check pin

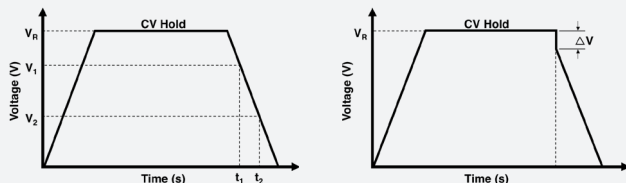
### SAFETY

Certifications	RoHS REACH, UL 810A (Cell Level)
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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.

# Datasheet: 24V 9F 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<sub>DC</sub> (measure method)
  - Capacitance: Constant current charge with 1A to V<sub>R</sub>, 5 min hold at V<sub>R</sub>, constant current discharge with 1A to 2.2V.
  - ESR<sub>DC</sub>: Constant current charge with 1A to V<sub>R</sub>, 5 min hold at V<sub>R</sub>, constant current discharge with (40 \* C \* V<sub>R</sub>[mA]) to 2.2V.  
e.g. in case of 24V 9F module, discharge with 40 \* 9 \* 24 = 8,640 mA.



$$C = \frac{I \times (t_2 - t_1)}{V_1 - V_2}$$

$$ESR_{DC} = \frac{\Delta V}{I}$$

where C is the capacitance (F);  
I is the absolute value of the discharge current (A);  
V<sub>R</sub> is the rated voltage (V);  
V<sub>1</sub> is the measurement start voltage, 0.8xV<sub>R</sub> (V);  
V<sub>2</sub> is the measurement end voltage, 0.4xV<sub>R</sub> (V);  
t<sub>1</sub> is the time from start of discharge to reach V<sub>1</sub> (s);  
t<sub>2</sub> is the time from start of discharge to reach V<sub>2</sub> (s);  
ESR<sub>DC</sub> is the DC-ESR (Ω);  
ΔV is the voltage drop during first 10ms of discharge (V).

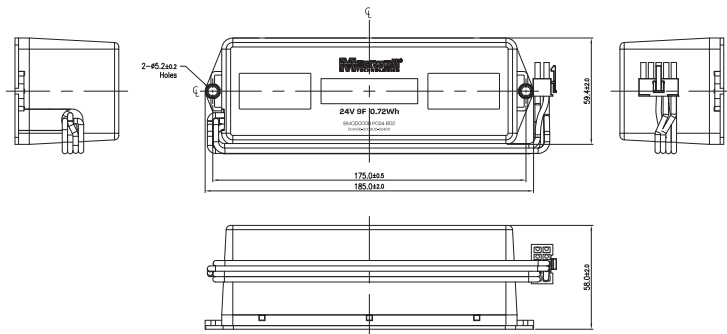
4. Typical Leakage Current
  - Current measured after 72 hrs at rated voltage and 25°C. Initial leakage current can be higher.
  - If applicable, module leakage current is the sum of cell and balancing circuit leakage currents.

5. Maximum Peak Current
  - Current needed to discharge cell/module from rated voltage to half-rated voltage in 1 second.
$$I = \frac{\frac{1}{2}V_R}{\Delta t / C + ESR_{DC}}$$

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<sub>max</sub> (Wh) =  $\frac{\frac{1}{2}CV_R^2}{3,600}$
  - 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<sub>DC</sub>, Initial values.
7. Cycle Life Test Profile  
Cycle life varies depending upon application-specific characteristics. Actual results will vary.
8. 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.
9. BOL: Beginning of Life, rated initial product performance  
EOL: End of Life criteria.
  - Capacitance: 80% of min. BOL rating
  - ESR<sub>DC</sub>: 2x max. BOL rating

## BMOD0009 P024 B02



When ordering, please reference the Maxwell Model Number below.

**Maxwell Model Number:** BMOD0009 P024 B02  
**Maxwell Part Number:** 133735  
**Alternate Model Number:** EMHSR-0009C0-024R0

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