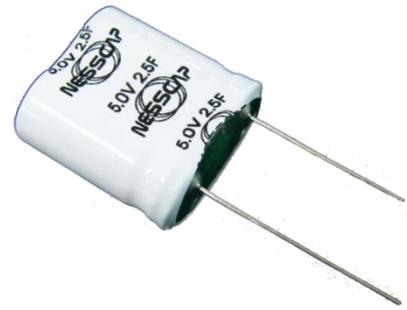


FEATURES

- » High performance module ultra-low ESR
- » Long lifetimes with up to 500,000 duty cycles
- » Rated voltage of 5V and capacitance of 2.5F
- » Serial connection of two 5F cells
- » Compliant with RoHS and REACH requirements



* Image is not to scale

SPECIFICATIONS

ELECTRICAL		EMHSR-0002C5-005R0
Rated Voltage (V_R) at 65°C		5 VDC
Rated Voltage (V_R) at 85°C		4.6 VDC
Surge Voltage ¹		5.4 VDC
Rated Capacitance ²		2.5 F
Capacitance Tolerance	Max.	-10% / +20%
	Avg. ⁴	-5% / +5%
DC-ESR ³	Max.	69 mΩ
	Avg. ⁴	55 mΩ
Max. Leakage Current ⁵		0.008 mA
Maximum Peak Current, Non-repetitive ⁶	at 65°C	5.3 A
	at 85°C	4.9 A
Max. Stored Energy (E_{max}) at V_R ⁷	at 65°C	8.6 mWh
	at 85°C	7.3 mWh
Gravimetric Specific Energy ⁷	at 65°C	1.7 Wh/kg
	at 85°C	1.4 Wh/kg
Usable Specific Power ⁷	at 65°C	8.6 kW/kg
	at 85°C	7.3 kW/kg
Impedance Match / Specific Power ⁷	at 65°C	18.1 kW/kg
	at 85°C	15.3 kW/kg

TEMPERATURE	
Operating Temperature Range	-40 ~ 65°C (up to 85°C with de-rated voltage) ($\Delta CAP < 5\%$ and $\Delta ESR < 300\%$ of initial values measured at 25°C, with linear voltage de-rating to 2.3V @ 85°C)
Storage Temperature Range	-40 ~ 70°C (storage without charge)

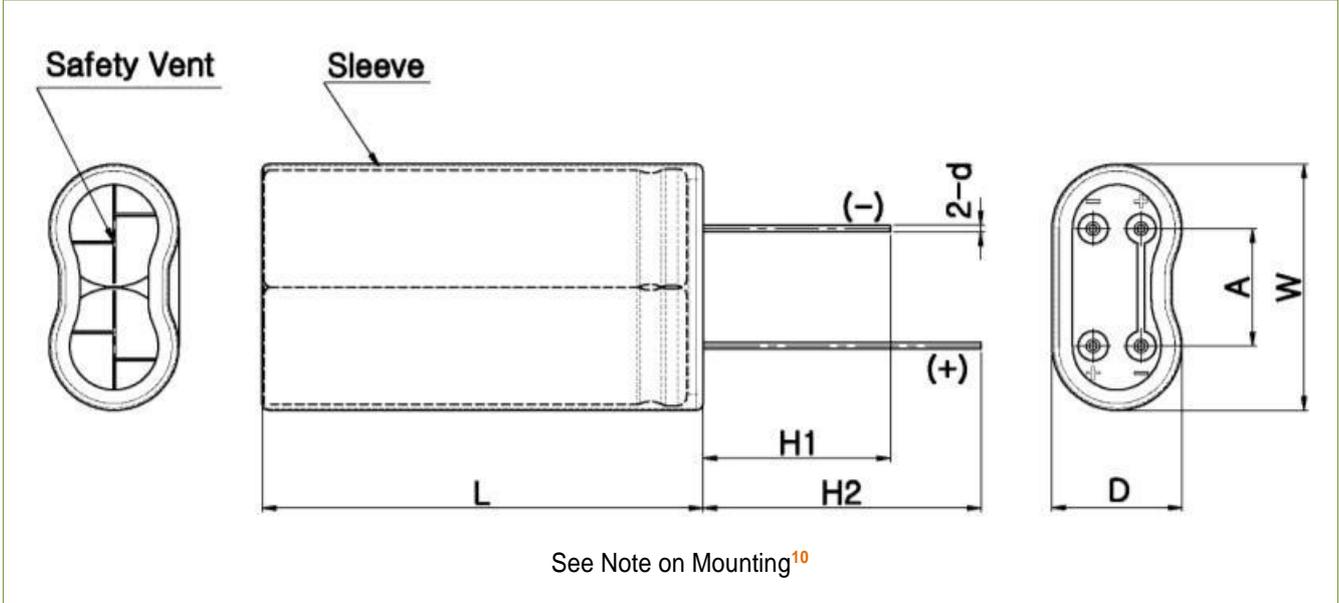
LIFE		
Endurance ⁸	at 65°C, 5.0V	1,500 hours
	at 85°C, 4.6V	1,000 hours
Room Temperature (at V_R and 25°C) ⁸	10 years	
Cycle Life (at 25°C)	500,000 cycles (Estimated value Cycled from V_R to $1/2V_R$ using 100mA/F const. current with 10sec rest Between charge and discharge steps)	
Shelf Life	2 years (Stored without charge at or under 70°C and under 40% RH)	

ENVIRONMENTAL	
RoHS	Compliant
REACH	Compliant

SPECIFICATIONS (Cont'd)

THERMAL	
Typical Thermal Resistance, R_{th}	69°C/W
Typical Thermal Capacitance, C_{th}	4.3 J/°C
Maximum Continuous Current ($\Delta T = 15^\circ\text{C}$) ⁹	1.7 A
Maximum Continuous Current ($\Delta T = 40^\circ\text{C}$) ⁹	2.9 A

DRAWING



DIMENSION & WEIGHT

D (Max)	12 mm
L (Max)	23 mm
W (Max)	21.5 mm
d (± 0.05)	0.6 mm
H1 (Min)	15 mm
H2 (Min)	19 mm
A (± 0.1)	10.6 mm
Nominal Weight	5.0 g

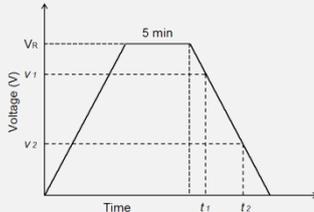
NOTE

1. Surge Voltage

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

2. Rated Capacitance (Measurement Method)

- > Constant current charge with 4CV [mA] to V_R
e.g. In case of 5V-2.5F module, $4 \times 2.5 \times 5 = 50\text{mA}$
- > Constant voltage charge at V_R for 5min.
- > Constant current discharge with 4CV [mA] to 0.4V.

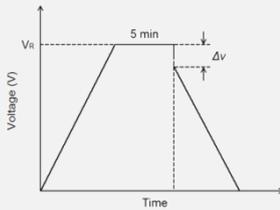


$$C = \frac{I \times (t_2 - t_1)}{v_1 - v_2}$$

where C is the capacitance (F);
 I is the absolute value of the discharge current (A);
 v_1 is the measurement starting 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 discharge start to reach v_1 (s);
 t_2 is the time from discharge start to reach v_2 (s)

3. DC-ESR (Measurement Method)

- > Constant current charge with 4CV [mA] to V_R .
- > Constant voltage charge at V_R for 5min.
- > Constant current discharge with 40CV [mA] to 4V.



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

where ESR_{DC} is the DC-ESR (Ω);
 Δv is the voltage drop during first 10ms of discharge (V);
 I is the absolute value of the discharge current (A)

4. Average

- > Typical value or percentage spread that may be present in one shipment

5. Maximum Leakage Current (Measurement Method)

- > The capacitor is charged to the rated voltage at 25°C.
- > Leakage current is the current after 72 hours that is required to keep the capacitor charged at the rated voltage

6. Maximum Peak Current

- > Current for 1-second discharging from the rated voltage to the half rated voltage under the constant current discharging mode

where I is the maximum peak current (A);
 V_R is the rated voltage (V);
 Δt is the discharge time (sec); $\Delta t = 1$ sec in this case;
 C is the rated capacitance (F);
 ESR_{DC} is the maximum DC-ESR (Ω);

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

7. Energy & Power

> Maximum Stored Energy, E_{max} (Wh) = $\frac{1/2 CV_R^2}{3600}$

> Gravimetric Specific Energy (Wh/kg) = $\frac{E_{Max}}{Weight}$

> Usable Specific Power (W/kg) = $\frac{0.12V_R^2}{ESR_{DC} \times Weight}$

> Impedance Match Specific Power (W/kg) = $\frac{0.25V_R^2}{ESR_{DC} \times Weight}$

8. Endurance and Room Temperature DC Life

- > Test Conditions:
 - Temperature: $65 \pm 2^\circ\text{C}$, $85 \pm 2^\circ\text{C}$, $25 \pm 2^\circ\text{C}$
 - Applied Voltage: $V_R \pm 0.02V$
- > End-of-Life Conditions:
 - Capacitance: -30% from the rated minimum value
 - DC-ESR: +100% from the rated maximum value

> Capacitance and ESR measurements are taken at 25°C

9. Maximum Continuous Current

- > Current which can be used within the allowed temperature range under the constant current discharging mode

$$I = \sqrt{\frac{\Delta T}{R_{th} \times ESR_{DC}}}$$

where I is the maximum continuous current (A);
 ΔT is the change in temperature ($^\circ\text{C}$);
 R_{th} is the thermal resistance ($^\circ\text{C/W}$);
 ESR_{DC} is the DC-ESR (Ω)

10. Mounting

- > Provide properly spaced holes for mounting according to the cell dimensions as to minimize leads being mechanically stressed.
- > Do not place any copper patterns, including the ground pattern, or through-hole via underneath the cell or on the underside of the PCB (if a double-sided PCB is used) as the electrolyte inside the cell, if it should leak, can corrode, short-circuit, the patterns and/or damage other components nearby. Spacing of 1mm or more should be provided in between the footprint of the cell and the nearest copper pattern.
- > Protective coating of components nearby on the PCB is recommended to reduce the risk of them being damaged in an event of electrolyte leakage.
- > Provide at least 2mm clearance above the safety vent and do not position anything above the safety vent that may be damaged by vent rupture.
- > Place cells on the PCB taking into account that the cells may not be completely hermetic during its lifetime. Electrolyte vapor and gases generated during normal use may escape the package during normal operation.
- > Soldering recommendation for small and medium size cells available on www.nesscap.com under Support > Download.

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