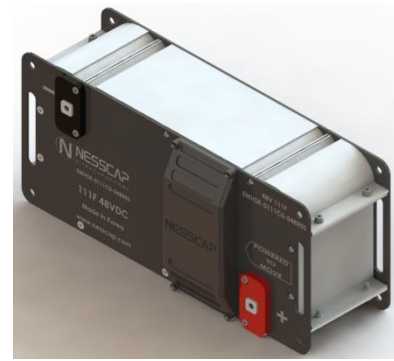


FEATURES

- » Rated voltage of 48V and capacitance of 111F
- » High power module with ultra-low ESR
- » Exceptional shock and vibration resistance
- » Long lifetimes with up to 1 million duty cycles
- » Integrated UMU (Ultracapacitor Management Unit) for effective cell balancing and monitoring
- » Typical applications:
 - Hybrid Bus, Transportation and Automotive
 - Wind Turbine, Industrial UPS and DVR



* Image is not to scale

SPECIFICATIONS

ELECTRICAL		EMHSR-0111C0-048R0S
Rated Voltage, V_R		48 V_{DC}
Surge Voltage ¹		51.3 V _{DC}
Rated Capacitance ²		111 F
Capacitance Tolerance	Maximum	0% / +20%
	Average ⁴	+5% / +10%
DC-ESR (Equivalent Series Resistance) ³	Maximum	7.1 mΩ
	Average ⁴	3.5 mΩ
Typical Leakage Current ⁵	Under 36V	4.2 mA
	Over 36V	44 ~ 58 mA
Maximum Peak Current, Non-repetitive ⁶		1,400 A
Maximum Stored Energy, E_{max} ⁷		35.5 Wh
Gravimetric Specific Energy ⁷		2.6 Wh/kg
Usable Specific Power ⁷		2.8 kW/kg
Impedance Match Specific Power ⁷		6.0 kW/kg

TEMPERATURE	
Operating Temperature Range	-40 ~ 65°C (Δ CAP<5% and Δ ESR<100% of initial value measured at 25°C)
Storage Temperature Range	-40 ~ 70°C (storage without charge)

LIFE	
Endurance (at V_R and 65°C) ⁸	1,500 hours
Room Temperature (at V_R and 25°C) ⁸	10 years
Cycle Life (at 25°C) ⁹	1,000,000 cycles
Shelf Life	2 years (stored without charge at under 70°C and 40% RH)

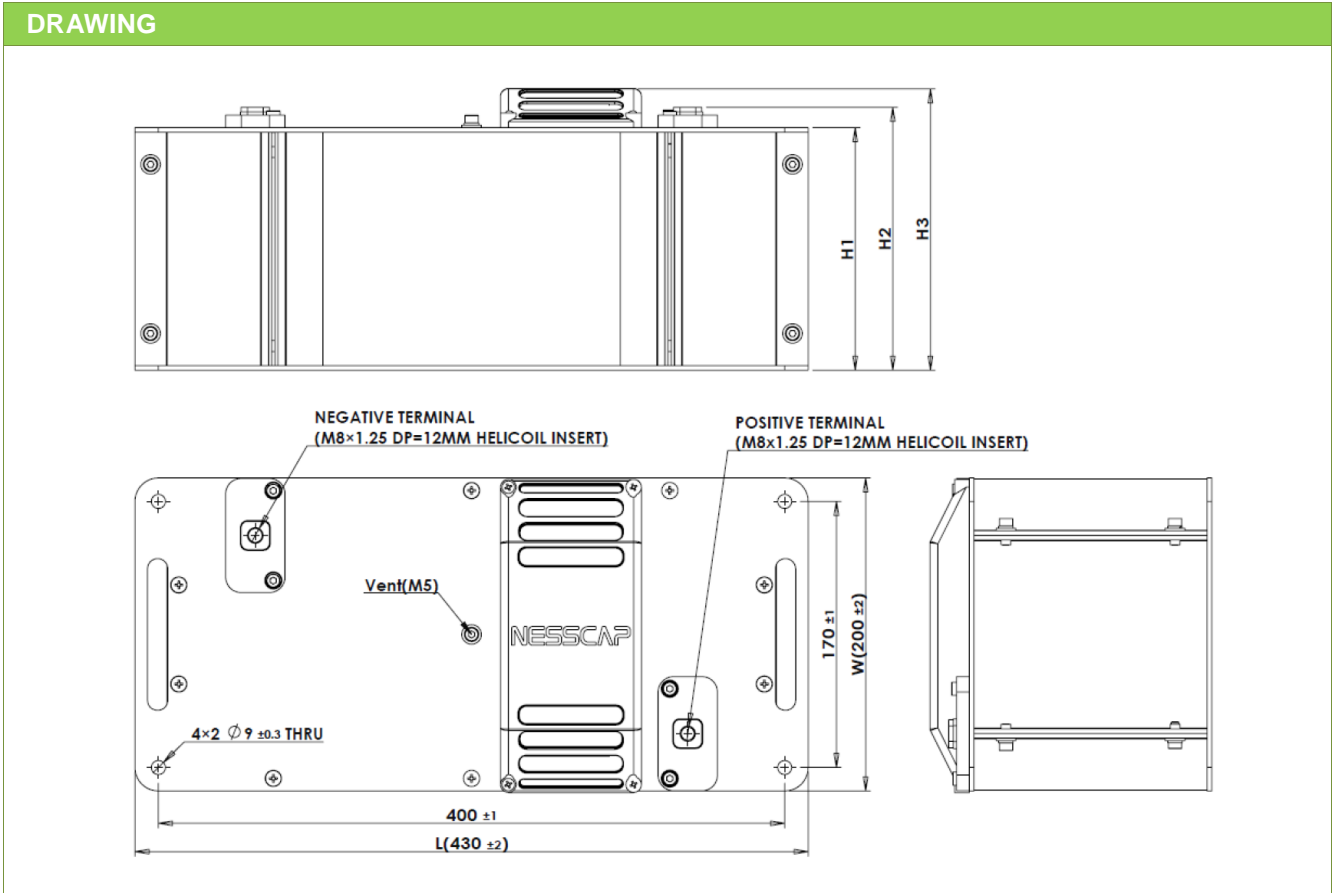
PHYSICAL	
Output Terminals	M8 screw holes
Insulation Coordination	IEC 61287-1 (Category: OV II) Rated insulation voltage: 1kV DC or 2.8kV AC (at 50Hz, 10 sec) Rated impulse withstand voltage: 6kV DC
Protection Degree	IEC 60529 IP 65 (Dust-tight and protected against water jets)
Vibration Specification	SAE J2380
Shock Specification	SAE J2464

SPECIFICATIONS (Cont'd)

UMU / MONITORING	
Cell Balancing	Active single cell balancing
Voltage Monitoring	5V, high and low over-voltage logic signal
Temperature Monitoring	Resistance via NTC thermistor (10kΩ at 25°C)
Connector	Deutsch 4-pin water-proof connector

THERMAL	
Typical Thermal Resistance, R_{th} (Temperature Sensor Output)	0.3 °C/W
Typical Thermal Capacitance, C_{th}	11,200 J/°C
Maximum Continuous Current ($\Delta T = 15^\circ\text{C}$) ¹⁰	80 A
Maximum Continuous Current ($\Delta T = 40^\circ\text{C}$) ¹⁰	130 A

SAFETY	
RoHS	Compliant
REACH	Cell-level compliant



DIMENSION & WEIGHT					
L (± 2.0)	W (± 2.0)	H1 (Max)	H2 (Max)	H3 (Max)	Nominal Weight
430 mm	200 mm	124 mm	134 mm	146 mm	13.5 kg

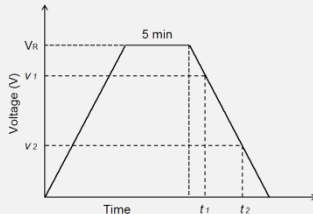
NOTE

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 48V-111F module, $4 \times 111 \times 48 = 21,300\text{mA} = 21.3\text{A}$
- > Constant voltage charge at V_R for 5min.
- > Constant current discharge with 4CV [mA] to 7.2V.

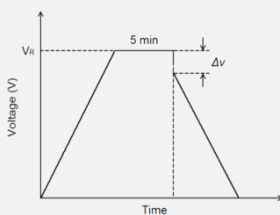


$$C = \frac{I \times (t_2 - t_1)}{v_1 - v_2}$$

- 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 100A to 45V.



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

- 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. Typical Leakage Current (LC)

- > LC under 36V (2V per cell) is equal to the LC of the cell measured at the cell's rated voltage and at room temperature after 72 hours.
- > LC over 36V (2V per cell) is the sum of the LC of the cell and the bypass current created by the active balancing circuit.

6. Maximum Peak Current

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

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

- 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) = $\frac{\frac{1}{2}CV_R^2}{3600}$
- > 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: $65 \pm 2^\circ\text{C}$, $25 \pm 2^\circ\text{C}$
 - Applied Voltage: $V_R \pm 0.02V$
- > End-of-Life Conditions:
 - Capacitance: -20% from the rated minimum value
 - DC-ESR: +100% from the rated maximum value
- > Capacitance and ESR measurements are taken at 25°C

9. Cycle Life

- > Test Conditions (1-minute cycle at room temperature):
 - Constant current charge from $1/2 V_R$ to V_R .
 - Constant current discharge from V_R to $1/2 V_R$.
 - Repeat the cycle for the desired number of times.

10. 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)

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