

DATA SHEET

SkelMod 51V
177F

- + 51 V DC nominal voltage
- + Rail-certified
- + Ultra-low ESR
- + Long lifetime - 1 million duty cycles
- + Integrated Ultracapacitor Management System for effective cell balancing
- + CAN bus communication
- + Natural cooling
- + High Power output
- + IP65



MODULE ELECTRICAL PARAMETERS

UNIT

VALUE

| | | |
|--|------------|---------|
| Rated voltage V_R | V | 51 |
| Surge voltage | V | 54 |
| Rated capacitance | F | 177 |
| DC 10ms ESR rated | m Ω | 3.3 |
| DC 1s ESR rated | m Ω | 4.0 |
| Maximum peak current (for 1 s duration) ¹ | A | 2643 |
| Short circuit current | kA | 15.45* |
| Maximum stored energy ² | Wh | 63.9 |
| Cells in total | pcs. | 18 |
| Cell type | | SCA3200 |

**Based on rated voltage and rated ESR. Based on typical ESR value, 19 kA should be considered for protective circuitry sizing.*

LIFE

| | |
|---|------------------|
| Life at 51 V and maximum operating temperature | 1500 hours |
| Life at 48 Volt and Maximum Operating Temperature | 2500 hours |
| Shelf life @ RT, uncharged | 10 years |
| Projected cycle life @ RT between 51 V and 25.5 V | 1 000 000 cycles |
| Projected cycle life @ RT between 48 V and 24 V | 2 000 000 cycles |

Capacitance decrease 20% from rated value; resistance increase 100% from rated value

ENVIRONMENTAL CONDITIONS

| | |
|--|----------------------------|
| Operating temperature range | -40 °C to +65 °C |
| Storage temperature range | -40 °C to +50 °C |
| Altitude class (EN 50125-1:2014) | A1 - 1400 m from sea level |
| Yearly average relative humidity (EN 50125-1:2014) | 75% |

ULTRACAPACITOR MANAGEMENT SYSTEM ELECTRICAL PARAMETERS

| | |
|---|--------------------------------|
| Cell balancing method | Controlled Resistive Balancing |
| Temperature reading | 4 NTC sensors |
| Voltage monitoring/balancing | Individual Cell |
| Nominal auxiliary supply voltage (EN 50155:2017) | 24 V |
| Auxiliary supply voltage range (EN 50155:2017) | 16 - 33 V |
| Interruptions on power supply voltage class (EN 50155:2017) | S2 - 10 ms |
| Supply change over class (EN 50155:2017) | C1 - 14.4V for 100 ms |
| Auxiliary supply current at nominal voltage | max. 0.1 A |
| Inrush current | 0.00156 I _t |
| Ultracapacitor monitoring range | 4 - 54 V |
| Maximum allowed cell imbalance for module discharge to 0V | 0.3V* |
| Normally open fault line maximum allowable current | 0.1 A |
| Communication interface | CAN bus 2.0B |
| Communication protocol | SAE J1939 |

*Refer to user manual for additional information

SYSTEM LEVEL ELECTRICAL PARAMETERS (EN 50124-1:2017 & EN 60077-1:2017)

| | |
|--|--------------------|
| Maximum series working voltage | 750 V DC |
| Rated isolation voltage | 900 V DC |
| Rated impulse voltage | 5 kV |
| Overvoltage category | OV2 |
| Pollution degree | PD4* |
| Dielectric withstand voltage power terminal to enclosure | 3.3 kV AC, 1 min** |
| Dielectric withstand voltage power terminal to AUX signals | 3.3 kV AC, 1 min** |
| Dielectric withstand voltage AUX signals to enclosure | 500 V AC, 1 min** |
| CAN bus to AUX power isolation | Not isolated |

*With IP covers installed on the power terminals, otherwise PD3

**Type test values, refer to user manual for routine test values

CONNECTORS

| | |
|--|--|
| Power connector | Ø 9 mm Trough hole |
| Communications connector on the device | Phoenix Contact female M12 X-coded 8-pos (Mfg part #:1424177) |

STANDARDS (RAILWAY APPLICATION)

| | |
|--------------------------------------|-------------------------------|
| General rules for electric equipment | EN 60077-1:2017 |
| Insulation coordination | EN 50124-1:2017 |
| Environmental conditions | EN 50125-1:2014 |
| Protective provisions | EN 50153:2014+A1:2017+A2:2020 |
| Electromagnetic compatibility | EN 50121-3-2:2016+A1:2019 |
| Fire protection | EN 45545-2:2013+A1:2015 |
| Shock and vibration | EN 61373:2010/AC:2017 |
| Crimped connections requirements | EN 60352-2:2006/A1:2013 |
| Capacitors for power electronics | EN 61881-3:2012/A1:2013 |
| Electronic equipment requirements | EN 50155:2017 |

Certified according to EN 45545-2:2015 + A1:2013 by TÜV Rheinland Rail Certification B.V., certificate number TRRC/CB 21/293-V01, issued on 2021-03-16. The certificate can be seen at skeletontech.com/downloads.

STANDARDS

| | |
|---|-------------------------------|
| Degrees of protection provided by enclosure | EN 60529:1991/A2:2014/AC:2019 |
|---|-------------------------------|

TECHNICAL SPECIFICATIONS

UNIT

VALUE

Energy

| | | |
|--------------------------------|-------|------|
| Max stored energy ² | Wh | 63.9 |
| Specific energy ³ | Wh/kg | 4.0 |
| Energy density ⁴ | Wh/L | 4.7 |

Nominal Power (calculated from DC 10ms ESR, for comparison)

| | | |
|---|-------|-------|
| Power (matched impedance) ⁵ | kW | 197.0 |
| Practical specific power (matched impedance) ⁶ | kW/kg | 12.3 |
| Practical power density (matched impedance) ⁷ | kW/L | 14.6 |

Practical Power (calculated from DC 1s ESR, for engineering)

| | | |
|---|-------|-------|
| Power (matched impedance) ⁵ | kW | 162.6 |
| Practical specific power (matched impedance) ⁶ | kW/kg | 10.2 |
| Practical power density (matched impedance) ⁷ | kW/L | 12.0 |

Thermal Parameters (based on DC 1s ESR)

| | | |
|--|-------|------|
| Thermal resistance given at ΔT 30 °C (R_{th}) ⁸ | °C/W | 0.41 |
| Thermal capacitance (C_{th}) | kJ/°C | 18 |
| Maximum continuous current (ΔT 15 °C) | A | 91 |
| Maximum continuous current (ΔT 30 °C) | A | 135 |
| Maximum continuous current (ΔT 40 °C) | A | 160 |

Physical Parameters

| | | |
|--|----|-----------------|
| Mass | kg | 16.0 |
| Volume | L | 13.5 |
| Length x width x height | mm | 422 x 194 x 198 |
| Ingress protection (EN 60529:1991+A2:2014+AC:2019) | | IP65 |
| Shock and vibration class (EN 61373:2010+AC:2017) | | 1B |



$$1 \quad \text{Maximum peak current}(1s) = \frac{C \times \frac{1}{2} \times V}{C \times \text{ESR} + 1s}$$

$$2 \quad E_{\text{stored}} = \frac{1}{2} \times C \times V^2$$

$$3 \quad E_{\text{specific}} = \frac{E_{\text{stored}}}{\text{mass}}$$

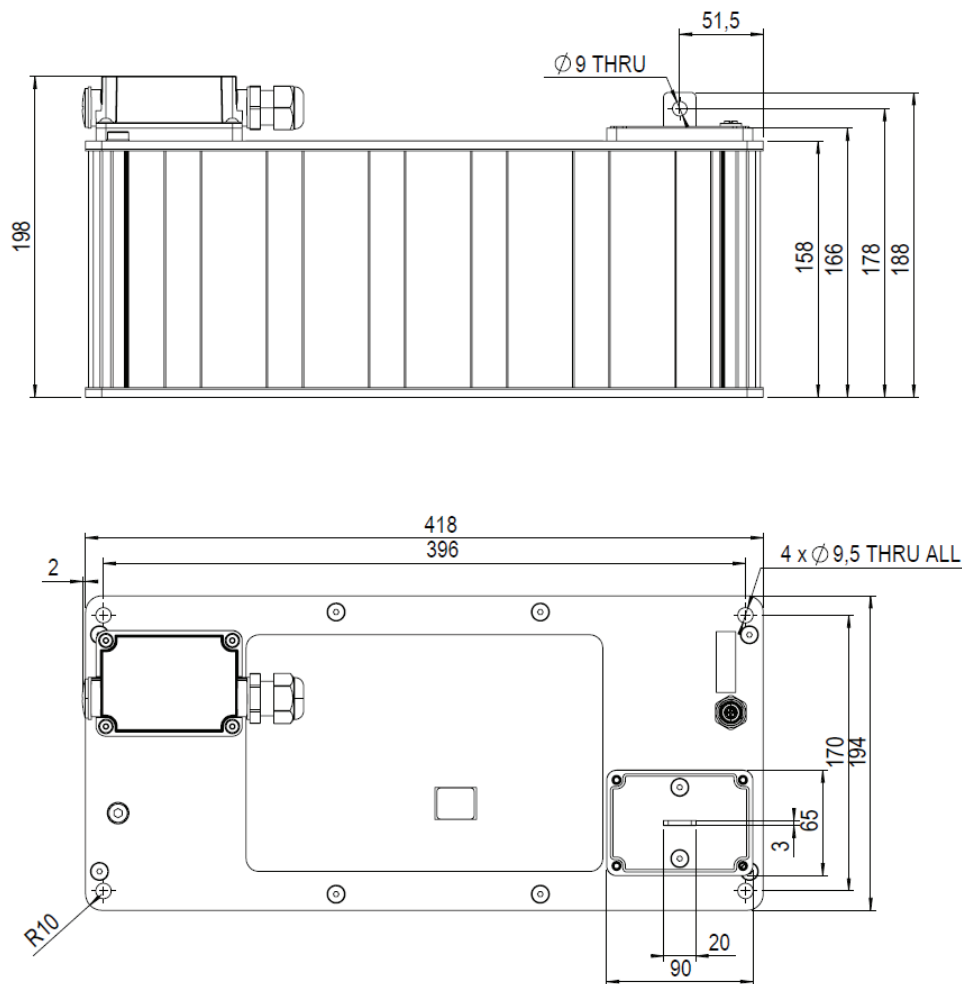
$$4 \quad E_{\text{density}} = \frac{E_{\text{stored}}}{\text{volume}}$$

$$5 \quad P_{\text{max}} = \frac{V^2}{4 \times \text{ESR}}$$

$$6 \quad P_{\text{specific}} = \frac{P_{\text{max}}}{\text{mass}}$$

$$7 \quad P_{\text{density}} = \frac{P_{\text{max}}}{\text{volume}}$$

$$8 \quad R_{th} = \frac{\Delta T}{DC \ 1s \ ESR \times I^2}$$



Drawing values are for reference only

STANDARD MARKINGS

- + Name of Manufacturer, Part number, Serial number, Rated voltage
- + Rated capacitance, Negative and positive terminals, Warning marking
- + Total energy in watt-hours

NOTES

- + All information provided on this data sheet and all subsequent ultracapacitors sales and testing are subject to Standard Terms of Service (ToS) available on www.skeletontech.com, document *General Terms of Sale for Skeleton Technologies OÜ*
- + For ultracapacitors, the power values are often calculated using nominal resistance values (DC 10 ms ESR). For engineering purposes, practical values based on total resistance (DC 1s ESR) are preferred.
- + All calculated values according to beginning-of-life conditions.
- + Mounting Recommendation: Please refer to the user manual for installation recommendations.
- + No cables included with the modules.
- + IP covers not included, sold as separate components, part #:
 - + IP covers kit - 7100026 (including red and black covers, cable glands and fasteners for the covers)

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