

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
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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



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

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

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

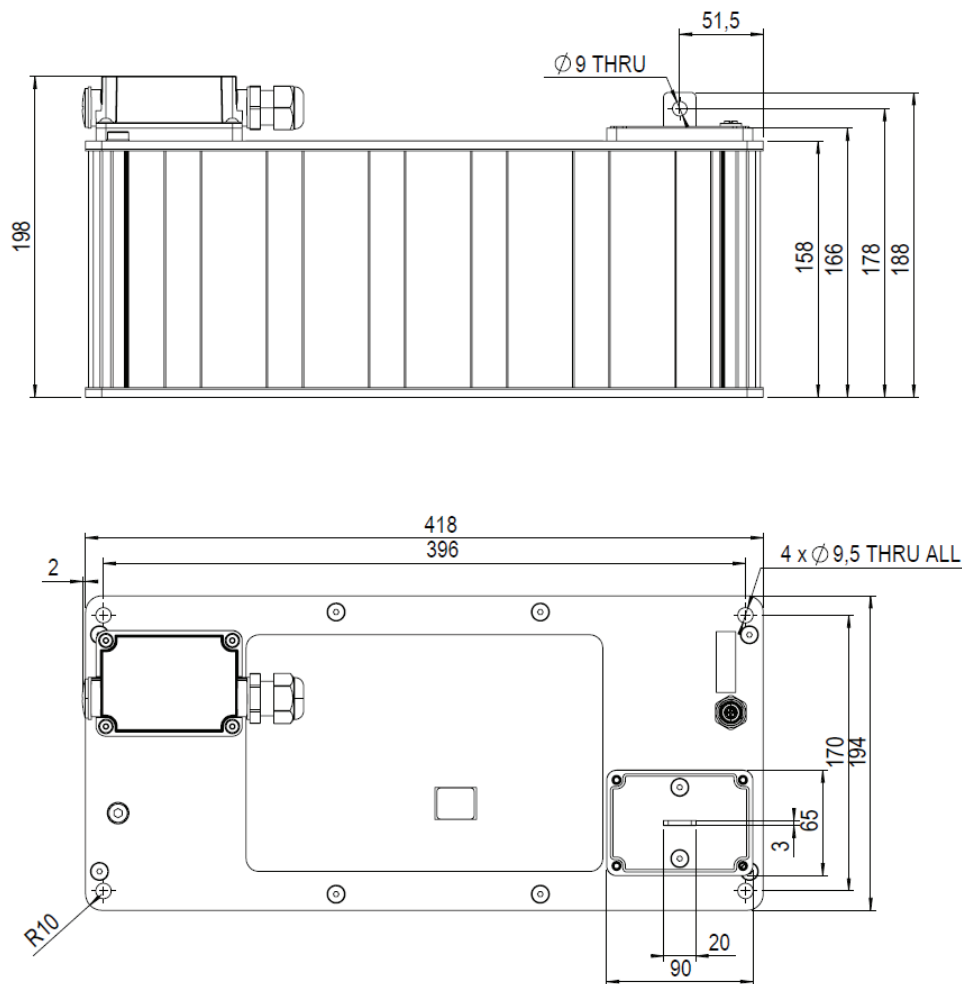
$$4 \quad E_{\text{density}} = \frac{E_{\text{stored}}}{\text{volume}}$$

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

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

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

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



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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