# SkelMod 54V277F

+ 54V DC nominal voltage

- + Ultra-low ESR
- + Long lifetime 1 million duty cycles
- + Integrated Supercapacitor Management System for effective cell balancing
- + CAN bus communication
- + Natural cooling
- + High Power output
- + IP65



General Specifications	Value	Unit
Electrical		
Rated voltage $V_{_{ m R}}$	54	V
Rated capacitance	277	F
Rated DC 10ms ESR	3.3	mΩ
Rated DC 1s ESR	4.4	mΩ
Rated maximum peak current (for 1 s duration) <sup>1, 9</sup>	3.371	kA
Short circuit current (For informational purposes - do not use as operating current.)	16.4*	kA
Maximum stored energy <sup>2</sup>	112.1	Wh
Cells in total	18	pcs
Cell type	SCX5000	

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

## Connectors

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

Temperature and Life	Value	Unit
Operating temperature range		
Minimum	-40	°C
Maximum	+65	°C
Storage temperature range (uncharged	)	
Minimum	-40	°C
Maximum	+50	°C
Environmental conditions		
Altitude class (EN 50125-1:2014)	A1 - 1400 m from sea level	
Yearly average relative humidity (EN 50125-1:2014)	75%	
Life		
Lifetime @ 54V and maximum operating temperature	1500	Hours
Storage life @ RT, uncharged	10	Years
Projected cycle life @ RT, between 54 V and 27 V	1,000,000	Cycles
Capacitance decrease 20% from rated value; resistance increase 100% from rated value		



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## Supercapacitor management system

Cell balancing method	Controlled Resistive Balancing
Temperature reading	4 NTC sensors
Voltage monitoring/balancing	Individual cells
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 l²t
Supercapacitor monitoring range	4 - 54 V
Maximum allowed cell imbalance for module discharge to 0V	0.3 V*
Normally open fault line maximum allowable current	0.1 A
Communication interface	Can bus 2.0B
Communication protocol	SAE J1939

Value; Unit

\*Refer to user manual for addional information

### Standards (railway application)

(realities) application)	Value
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

Value

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

#### System level electical parameters (EN 50124-1:2017 & EN 60077-1:2017)

Value; Unit 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 3.3 kV AC, 1 min\*\* terminal to enclosure Dielectric withstand voltage power 3.3 kV AC, 1 min\*\* terminal to AUX signals Dielectric withstand voltage AUX 500 V AC, 1 min\*\* signals to enclosure 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

Energy	Value	Unit
Max stored energy <sup>2</sup>	112.1	Wh
Specific energy <sup>3</sup>	7.0	Wh/kg
Energy density <sup>4</sup>	8.3	Wh/L
Power	Value	Unit
Rated nominal power, calculated from 1	0 ms ESR	
Power <sup>5</sup>	220.9	kW
Specific power, matched Impedance 6	13.8	kW/kg
Power density, matched Impedance 7	16.4	kW/L
Rated practical power, calculated from	1 s ESR	
Power <sup>5</sup>	165.7	kW
Specific power, matched Impedance 6	10.4	kW/kg
Power density, matched impedance <sup>7</sup>	12.3	kW/L
Thermal	Value	Unit
Thermal Thermal resistance given at $\Delta T$ 30 °C ( $R_{th}$ ) <sup>e</sup>	Value 0.41	Unit °C/W
Thermal resistance given at $\Delta T$ 30 °C ( $R_{th}$ ) <sup>8</sup> Thermal capacitance ( $C_{th}$ )	0.41	°C/W
Thermal resistance given at $\Delta T$ 30 °C (R <sub>th</sub> ) <sup>8</sup> Thermal capacitance (C <sub>th</sub> ) Max continuous current <sup>10</sup> , $\Delta T$ = 15°C	0.41 18	°C/W kJ/°C
Thermal resistance given at $\Delta T$ 30 °C ( $R_{th}$ ) <sup>8</sup> Thermal capacitance ( $C_{th}$ )	0.41 18 91	°C/W kJ/°C A
Thermal resistance given at $\Delta T$ 30 °C (R <sub>th</sub> ) <sup>8</sup> Thermal capacitance (C <sub>th</sub> ) Max continuous current <sup>10</sup> , $\Delta T$ = 15°C Max continuous current <sup>10</sup> , $\Delta T$ = 30°C	0.41 18 91 129	°C/W kJ/°C A A
Thermal resistance given at $\Delta T$ 30 °C (R <sub>th</sub> ) <sup>8</sup> Thermal capacitance (C <sub>th</sub> ) Max continuous current <sup>10</sup> , $\Delta T$ = 15°C Max continuous current <sup>10</sup> , $\Delta T$ = 30°C Max continuous current <sup>10</sup> , $\Delta T$ = 40°C	0.41 18 91 129 149	°C/W kJ/°C A A A
Thermal resistance given at $\Delta T$ 30 °C (R <sub>th</sub> ) <sup>8</sup> Thermal capacitance (C <sub>th</sub> ) Max continuous current <sup>10</sup> , $\Delta T$ = 15°C Max continuous current <sup>10</sup> , $\Delta T$ = 30°C Max continuous current <sup>10</sup> , $\Delta T$ = 40°C Physical parameters	0.41 18 91 129 149 Value	°C/W kJ/°C A A A Unit
Thermal resistance given at $\Delta T$ 30 °C ( $R_{th}$ ) <sup>8</sup> Thermal capacitance ( $C_{th}$ ) Max continuous current <sup>10</sup> , $\Delta T$ = 15°C Max continuous current <sup>10</sup> , $\Delta T$ = 30°C Max continuous current <sup>10</sup> , $\Delta T$ = 40°C Physical parameters Mass. Typical	0.41 18 91 129 149 Value 16	°C/W kJ/°C A A A Unit kg L
Thermal resistance given at $\Delta T$ 30 °C ( $R_{th}$ ) <sup>8</sup> Thermal capacitance ( $C_{th}$ ) Max continuous current <sup>10</sup> , $\Delta T$ = 15°C Max continuous current <sup>10</sup> , $\Delta T$ = 30°C Max continuous current <sup>10</sup> , $\Delta T$ = 40°C Physical parameters Mass. Typical Volume	0.41 18 91 129 149 Value 16 13.5 422 x 194	°C/W kJ/°C A A A Unit

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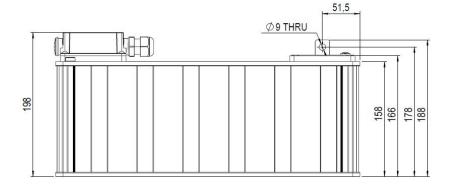
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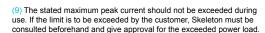
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1) Maximum peak current (1 sec) = 
$$\frac{\frac{1}{2} \text{ CV}}{\text{C} \times \text{ESR} + 1\text{s}}$$
 (2)  $\text{E}_{\text{stored}} = \frac{\frac{1}{2} \text{ CV}^2}{3600}$  (3)  $\text{E}_{\text{specific}} = \frac{\text{E}_{\text{stored}}}{\text{mass}}$   
(4)  $\text{E}_{\text{stored}} = \frac{\text{E}_{\text{stored}}}{(1 - 1)^2}$  (5)  $\text{P}_{\text{stored}} = \frac{\text{V}^2}{(1 - 1)^2}$  (6)  $\text{P}_{\text{stored}} = \frac{\text{P}_{\text{max}}}{(1 - 1)^2}$ 

$$\frac{P_{\text{max}}}{V_{\text{density}}} = \frac{V_{\text{specific}}}{V_{\text{specific}}} = \frac{V_{\text{max}}}{M_{\text{specific}}} = \frac{V_{\text{max}}}{M_{\text{specific}}} = \frac{V_{\text{max}}}{M_{\text{specific}}} = \frac{V_{\text{specific}}}{M_{\text{specific}}} = \frac{V_{\text{specific}}}{M_{specific}} = \frac{V_{specific}}{M_{specific}} = \frac{$$

(7) 
$$P_{density} = \frac{\Gamma_{max}}{volume}$$
 (8)  $R_{th} = \frac{\Delta T}{DC \ 1s \ ESR \times I^2}$ 





(10) These values of current refer to begin of life conditions of the product, for system design 200% ESR should be considered .

#### Standard markings

Name of manufacturer, part number, serial number, rated voltage
 Rated capacitance, negative and positive terminals, warning marking

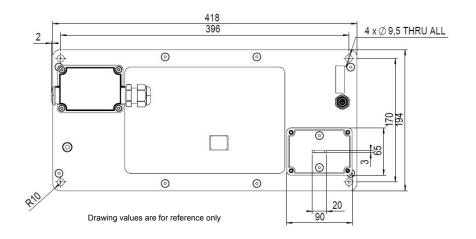
Total energy in watt-hours

#### Notes

 + All information provided on this data sheet and all subsequent supercapacitors sales and testing are subject to Standard
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 General Terms of Sale for Skeleton Technologies GmbH
 + 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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