

# 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

#### Electrical

Value	Unit
Rated voltage $V_R$	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

#### 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

## Supercapacitor management system

	Value; Unit
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 I <sub>2t</sub>
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

\*Refer to user manual for additional information

## Standards (railway 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

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](https://www.skeletontech.com/downloads).

## Standards

Degrees of protection provided by enclosure	EN 60529:1991/A2:2014/AC:2019
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## System level electrical 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 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

## 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
<b>Rated nominal power, calculated from 10 ms ESR</b>		
Power <sup>5</sup>	220.9	kW
Specific power, matched Impedance <sup>6</sup>	13.8	kW/kg
Power density, matched Impedance <sup>7</sup>	16.4	kW/L

## Rated practical power, calculated from 1 s ESR

Power <sup>5</sup>	165.7	kW
Specific power, matched Impedance <sup>6</sup>	10.4	kW/kg
Power density, matched impedance <sup>7</sup>	12.3	kW/L

## Thermal

	Value	Unit
Thermal resistance given at $\Delta T$ 30 °C ( $R_{th}$ ) <sup>8</sup>	0.41	°C/W
Thermal capacitance ( $C_{th}$ )	18	kJ/°C
Max continuous current <sup>10</sup> , $\Delta T$ = 15°C	91	A
Max continuous current <sup>10</sup> , $\Delta T$ = 30°C	129	A
Max continuous current <sup>10</sup> , $\Delta T$ = 40°C	149	A

## Physical parameters

	Value	Unit
Mass. Typical	16	kg
Volume	13.5	L
Length x width x height	422 x 194 x 198	mm
Ingress protection (EN 60529:1991+A2:2014+AC:2019)	IP65	
Shock and vibration class (EN 61373:2010+AC:2017)	1B	

$$(1) \text{ Maximum peak current (1 sec)} = \frac{\frac{1}{2} CV}{C \times \text{ESR} + 1\text{s}} \quad (2) E_{\text{stored}} = \frac{\frac{1}{2} CV^2}{3600} \quad (3) E_{\text{specific}} = \frac{E_{\text{stored}}}{\text{mass}}$$

$$(4) E_{\text{density}} = \frac{E_{\text{stored}}}{\text{volume}} \quad (5) P_{\text{max}} = \frac{V^2}{4 \times \text{ESR}} \quad (6) P_{\text{specific}} = \frac{P_{\text{max}}}{\text{mass}}$$

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

(9) The stated maximum peak current should not be exceeded during use. If the limit is to be exceeded by the customer, Skeleton must be consulted beforehand and give approval for the exceeded power load.

(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 Terms of Service (ToS) available on [www.skeletontech.com](http://www.skeletontech.com), document 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)

