DATA SHEET

SkelMod 51V177F

+ 51V DC nominal voltage
+ Rail-certified
+ 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
Product code	6730146	
Rated voltage V_R	51	V
Surge voltage	54	V
Rated capacitance	177	F
Rated DC 10ms ESR	3.3	mΩ
Rated DC 1s ESR	4.0	mΩ
Rated maximum peak current (for 1 s duration) [1, 9]	2.64	kA
Short circuit current (For informational purposes - do not use as operating current.)	15.45*	kA
Maximum stored energy [2]	63.9	Wh
Cells in total	18	pcs

** 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	Value	Unit
Minimum	-40	°C
Maximum	+65	°C

Storage temperature range (uncharged)	Value	Unit
Minimum	-40	°C
Maximum	+50	°C

Environmental conditions	Value
Altitude class (EN 50125-1:2014)	A1 - 1400 m from sea level
Yearly average relative humidity (EN 50125-1:2014)	75%

Life	Value	Unit
Lifetime @ 51V and maximum operating temperature	1500	Hours
Lifetime @ 48V and maximum operating temperature	2500	Hours
Storage 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

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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 50155:2021)	24 V
Auxiliary supply voltage range (EN 50155:2021)	16 - 33 V
Interruptions on power supply voltage class (EN 50155:2021)	S2 (10 ms)
Supply change over class (EN 50155:2021)	C1 - 14.4V for 100 ms
Auxiliary supply current at nominal voltage	max. 0.1 A
Inrush current	0.00156 I^2t
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 addional 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 45545-2:2020+A1:2023
Shock and vibration	EN 61373:2010/ AC:2017-09
Crimped connections requirements	EN 60352-2:2006/ A1:2013
Capacitors for power electronics	EN 61881-3:2012/ A1:2013
Electronic equipment requirements	EN 50155:2021

Certified according to EN 45545-2:2020 + A1:2023 by TÜV Rheinland Rail Certification B.V., certificate number TRRC/CB 25/135-V01 , issued on 15.01.2025. The certificate can be seen at www.skeletontech.com/downloads.

Standards

Degrees of protection provided by enclosure	EN 60529:2001/ 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 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 [2]	63.9	Wh
Specific energy [3]	4.0	Wh/kg
Energy density [4]	4.7	Wh/L

Power

	Value	Unit
Rated nominal power, calculated from 10 ms ESR		
Power [5]	197.0	kW
Specific power, matched Impedance [6]	12.3	kW/kg
Power density, matched Impedance [7]	14.6	kW/L
Rated practical power, calculated from 1 s ESR		
Power [5]	162.6	kW
Specific power, matched Impedance [6]	10.2	kW/kg
Power density, matched impedance [7]	12.0	kW/L

Thermal

	Value	Unit
Thermal resistance given at ΔT 30 °C (R_{th})[8]	0.41	°C/W
Thermal capacitance (C_{th})	18	kJ/°C
Max continuous current [10], ΔT = 15°C	91	A
Max continuous current [10], ΔT = 30°C	135	A
Max continuous current [10], ΔT = 40°C	156	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:2017-09)	1B	

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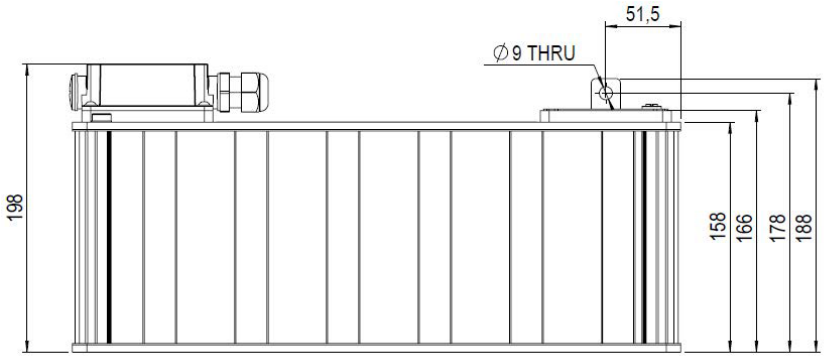
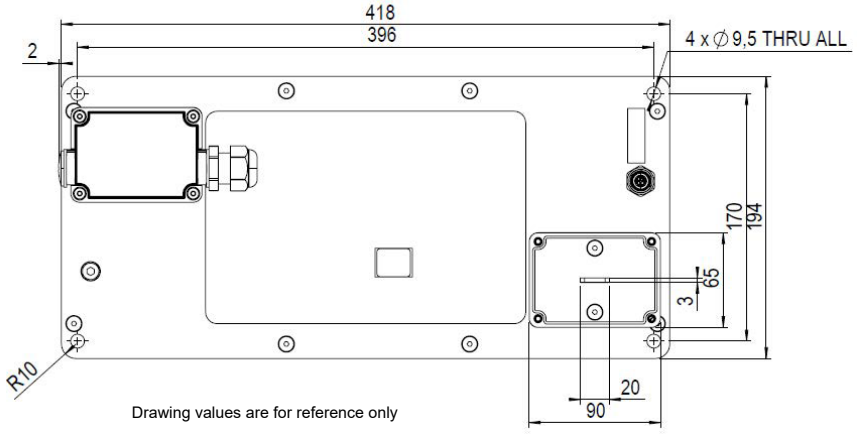
(1) Maximum peak current (1 sec) = $\frac{½\ CV}{C \times ESR + 1s}$ (2) $E_{stored} = \frac{½\ CV^2}{3600}$ (3) $E_{specific} = \frac{E_{stored}}{mass}$

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

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





Drawing values are for reference only

(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, 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)

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