

# SKiiP 3614 GB12E4-6DUL



SKiiP® 4

## 2-pack-integrated intelligent Power System

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#### Features

- Intelligent Power Module
- Integrated current and temperature measurement
- Integrated DC-link measurement
- Solder free power section
- IGBT4 and CAL4F technology
- $T_{jmax} = 175^{\circ}\text{C}$
- Safety isolated switching and sensor signals
- Digital signal transmission
- CAN Interface
- 100% tested IPM
- RoHS compliant
- UL file no. E242581

#### Typical Applications\*

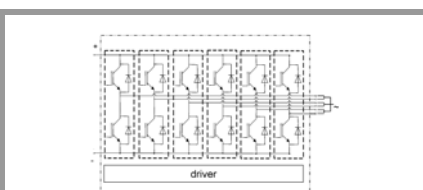
- Renewable energies
- Traction
- Elevators
- Industrial drives

#### Remarks

For further information please refer to SKiiP@4 Technical Explanation

#### Footnote

- <sup>1)</sup> With assembly of suitable MKP capacitor per terminal  
<sup>2)</sup> The specified maximum operation junction temperature  $T_{vjop}$  is  $150^{\circ}\text{C}$



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Absolute Maximum Ratings						
Symbol	Conditions		Values	Unit		
<b>System</b>						
$V_{CC}^{1)}$	Operating DC link voltage		900	V		
$V_{isol}$	DC, $t = 1\text{ s}$ , each polarity		4300	V		
$I_{t(RMS)}$	per AC terminal, rms, sinusoidal current		500	A		
$I_{max (peak)}$	max. peak current of power section		5400	A		
$I_{FSM}$	$T_j = 175^{\circ}\text{C}$ , $t_p = 10\text{ ms}$ , $\sin 180^{\circ}$		16547	A		
$I^2t$	$T_j = 175^{\circ}\text{C}$ , $t_p = 10\text{ ms}$ , diode		1369	$\text{kA}^2\text{s}$		
$f_{out}$	fundamental output frequency (sinusoidal)		1	kHz		
$T_{stg}$	storage temperature		-40 ... 85	$^{\circ}\text{C}$		
<b>IGBT</b>						
$V_{CES}$	$T_j = 25^{\circ}\text{C}$		1200	V		
$I_C$	$T_j = 175^{\circ}\text{C}$	$T_s = 25^{\circ}\text{C}$	4664	A		
		$T_s = 70^{\circ}\text{C}$	3792	A		
$I_{Cnom}$			3600	A		
$T_j^{2)}$	junction temperature		-40 ... 175	$^{\circ}\text{C}$		
<b>Diode</b>						
$V_{RRM}$	$T_j = 25^{\circ}\text{C}$		1200	V		
$I_F$	$T_j = 175^{\circ}\text{C}$	$T_s = 25^{\circ}\text{C}$	3558	A		
		$T_s = 70^{\circ}\text{C}$	2821	A		
$I_{Fnom}$			3600	A		
$T_j^{2)}$	junction temperature		-40 ... 175	$^{\circ}\text{C}$		
<b>Driver</b>						
$V_s$	power supply		19.2 ... 28.8	V		
$V_{iH}$	input signal voltage (high)		$V_s + 0.3$	V		
$dv/dt$	secondary to primary side		75	$\text{kV}/\mu\text{s}$		
$f_{sw}$	switching frequency		5	kHz		
<b>Characteristics</b>						
Symbol	Conditions		min.	typ.	max.	Unit
<b>IGBT</b>						
$V_{CE(sat)}$	$I_C = 3600\text{ A}$ at terminal	$T_j = 25^{\circ}\text{C}$	2.01	2.26	V	
		$T_j = 150^{\circ}\text{C}$	2.49	2.69	V	
$V_{CE0}$		$T_j = 25^{\circ}\text{C}$	0.80	0.90	V	
		$T_j = 150^{\circ}\text{C}$	0.70	0.80	V	
$r_{CE}$	at terminal	$T_j = 25^{\circ}\text{C}$	0.34	0.38	$\text{m}\Omega$	
		$T_j = 150^{\circ}\text{C}$	0.50	0.53	$\text{m}\Omega$	
$E_{on} + E_{off}$	$I_C = 3600\text{ A}$ $T_j = 150^{\circ}\text{C}$	$V_{CC} = 600\text{ V}$	1405	$\text{mJ}$		
		$V_{CC} = 900\text{ V}$	2520	$\text{mJ}$		
$R_{th(j-s)}$	per IGBT switch				0.0106	K/W
$R_{th(j-r)}$	per IGBT switch				0.004	K/W

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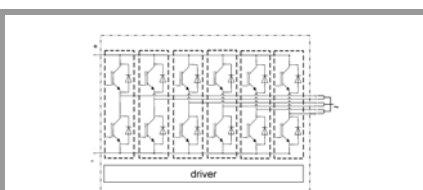
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Diode</b>						
$V_F = V_{EC}$	$I_F = 3600\text{ A}$ at terminal	$T_j = 25^{\circ}\text{C}$		2.33	2.65	V
		$T_j = 150^{\circ}\text{C}$		2.35	2.66	V
$V_{F0}$		$T_j = 25^{\circ}\text{C}$		1.30	1.50	V
		$T_j = 150^{\circ}\text{C}$		0.90	1.10	V
$r_F$	at terminal	$T_j = 25^{\circ}\text{C}$		0.29	0.32	m $\Omega$
		$T_j = 150^{\circ}\text{C}$		0.40	0.43	m $\Omega$
$E_{rr}$	$I_F = 3600\text{ A}$ $T_j = 150^{\circ}\text{C}$	$V_R = 600\text{ V}$		238		mJ
		$V_R = 900\text{ V}$		300		mJ
$R_{th(j-s)}$	per diode switch				0.0187	K/W
$R_{th(j-r)}$	per diode switch				0.011	K/W
<b>Driver</b>						
$V_s$	supply voltage non stabilized		19.2	24	28.8	V
$I_{SO}$	bias current @ $V_s = 24\text{ V}$ , $f_{sw} = 0$ , $I_{AC} = 0$			430		mA
$I_s$	$k_1 = 48\text{ mA/kHz}$ , $k_2 = 0.286\text{ mA/A}$ , $f_{out} = 50\text{ Hz}$ , sinusoidal current		= 430	$+ k_1 * f_{sw}$	$+ k_2 * I_{AC}$	mA
$V_{IT+}$	input threshold voltage (HIGH)		$0,7 * V_s$			V
$V_{IT-}$	input threshold voltage (LOW)				$0,3 * V_s$	V
$R_{IN}$	input resistance			13		k $\Omega$
$C_{IN}$	input capacitance			1		nF
$t_{pRESET}$	error memory reset time		1300		2900	ms
$t_{pReset(OCP)}$	Over current reset time					$\mu\text{s}$
$t_{TD}$	top / bottom switch interlock time			3		$\mu\text{s}$
$t_{jitter}$	jitter clock time			52	58	ns
$t_{SIS}$	short pulse suppression time			0.6		$\mu\text{s}$
$t_{POR}$	Power-On-Reset completed			3.5		s
$I_{digiout}$	digital output sink current (HALT-signal)				16	mA
$V_{it+ HALT}$	input threshold voltage HIGH HALT (Low -->High)		$0,6 * V_s$			V
$V_{it-HALT}$	input threshold voltage LOW HALT (High --> Low)				$0.4 * V_s$	V
$t_{d(terr)}$	Error delay time (from detection to HALT), (depends on kind of error)		1.8		170	$\mu\text{s}$
$I_{TRIPSC}$	over current trip level		5290	5400	5510	$A_{PEAK}$
$I_{LL}$				n.a.		$A_{PEAK}$
$T_{trip}$	over temperature trip level		128	135	142	$^{\circ}\text{C}$
$T_{DriverTrip}$	over temperature PCB trip level		113	120	124	$^{\circ}\text{C}$
$V_{DCtrip}$	over voltage trip level, can be deactivated via CAN interface,		950	980	1010	V
$V_{DCtripLL}$				n.a.		V



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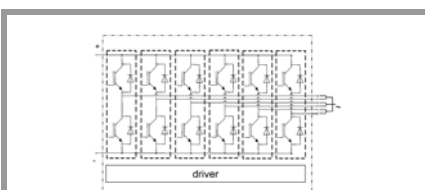
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>System</b>						
$t_{d(on)IO}$	$V_{CC} = 600\text{ V}$ $I_C = 3600\text{ A}$ $T_j = 25^{\circ}\text{C}$	turn on propagation delay time		2.8		$\mu\text{s}$
$t_{d(off)IO}$	$T_j = 25^{\circ}\text{C}$	turn off propagation delay time		3.8		$\mu\text{s}$
$dV_{CE}/dt_{on}$	$T_j = 25^{\circ}\text{C}$ $V_{CC} = 600\text{ V}$	$I_C = 0\text{ A}$		9		$\text{kV}/\mu\text{s}$
		$I_C = 3600\text{ A}$		3		$\text{kV}/\mu\text{s}$
$dV_{CE}/dt_{off}$		$I_C = 3600\text{ A}$		3		$\text{kV}/\mu\text{s}$
$R_{th(s-a)}$	flow rate = $480\text{ m}^3/\text{h}$ , $T_a=25^{\circ}\text{C}$ , 500m above sea level				0.0187	$\text{K}/\text{W}$
$R_{CC'+EE'}$	terminals to chip, $T_s = 25^{\circ}\text{C}$			0.045		$\text{m}\Omega$
$L_{CE}$	commutation inductance			3		$\text{nH}$
$C_{CHC}$	coupling capacitance secondary to heat sink			8.4		$\text{nF}$
$C_{ps}$	coupling capacitance primary to secondary			0.102		$\text{nF}$
$I_{CES} + I_{RD}$	$V_{GE} = 0\text{ V}$ , $V_{CE} = 1200\text{ V}$ , $T_j = 25^{\circ}\text{C}$			0.527		$\text{mA}$
$M_{dc}$	DC terminals		6		8	$\text{Nm}$
$M_{ac}$	AC terminals		13		15	$\text{Nm}$
w	SKiiP System w/o heat sink			4.84		$\text{kg}$
$w_h$	heat sink			10.45		$\text{kg}$



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Isolation coordination acc. to EN 50178 and IEC 61800-5-1	
Maximum grid RMS voltage, line-to-line, grounded delta mains	480V+20%
Installation altitude for maximum grid RMS voltage, line-to-line, grounded delta mains	4000m
Maximum grid RMS voltage, line-to-line, star point grounded mains	480V+20%
Installation altitude for maximum grid RMS voltage, line-to-line, star point grounded mains	8000m
Maximum transient peak voltage between low voltage circuit and mains	1900V
Pollution degree acc. to IEC 60664-1 outside the moulded power section	2
Overvoltage cat. acc. to IEC 60664-1 for mains	III
Overvoltage cat. acc. to UL 840 within mains	I
Overvoltage cat. acc. to UL 840 between mains and ground	III
Overvoltage cat. acc. to UL 840 between mains and low voltage circuit	III
Basic isolation	between heat sink and mains
Reinforced isolation	between low voltage circuit and mains
Protection level acc. to IEC 60529	IP00

## Environmental conditions acc. to IEC 60721

	Storage	Transportation	Operation stationary use at weather protected locations	Operating ground vehicle installations	Operating ship environment
Climatic conditions	1K2 <sub>(1)</sub>	2K2 <sub>(1)</sub>	3K3 <sub>(1)</sub>	5K1 <sub>(1)</sub>	6K1 <sub>(1)</sub>
Biological conditions	1B1	2B1	3B1	5B1	6B1
Chemically active substances (excluded: salt spray)	1C2	2C1	3C2	5C2	6C2
Mechanically active substances	1S1	2S1	3S1	5S1	6S1
Mechanical conditions	1M3	(4)	3M6 <sub>(2)</sub>	5M3 <sub>(3)</sub>	6M3
Contaminating fluids	---	---	---	5F1	---

(1) expanded temperature range: -40°C / +85°C. Please note: by operation near 85°C the life time of product is reduced.

(2) 3M7 possible, but due to the mechanic load capacity of external components like DC-Link capacitors limited to 3M6

(3) 5M3 without impact of foreign bodies, stones

(4) no declaration due to customer-specific packing

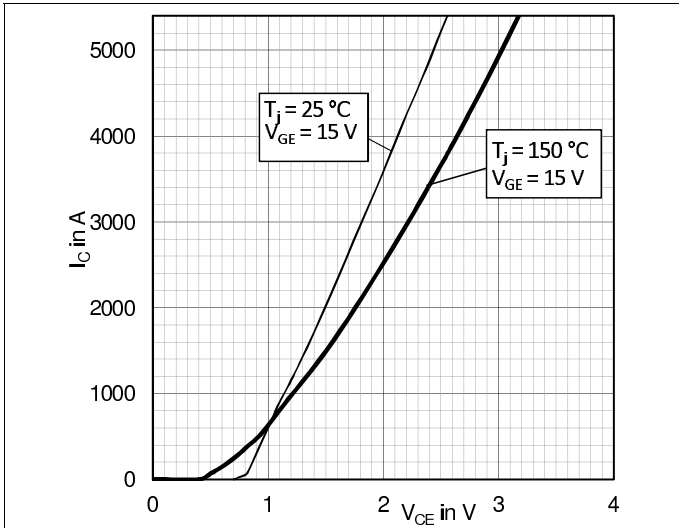


Fig. 1: Typical IGBT output characteristics

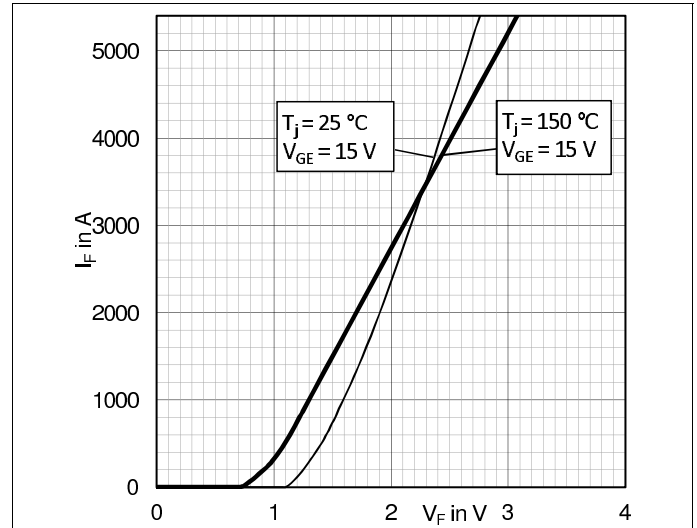


Fig. 2: Typical diode output characteristics

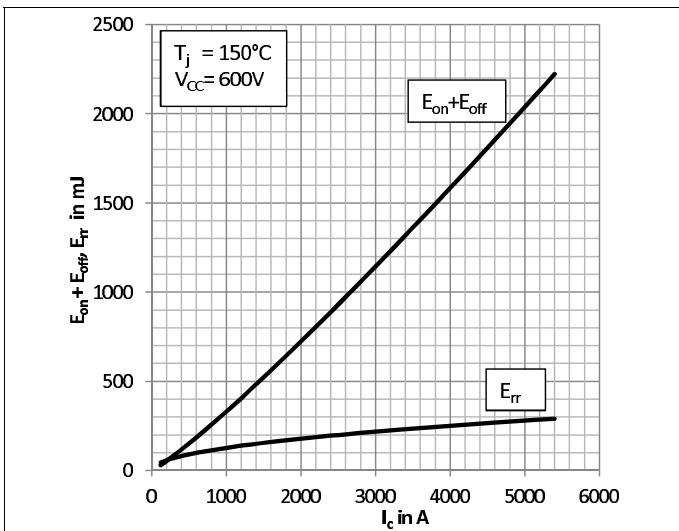


Fig. 3: Typical switching energy  $E = f(I_C)$

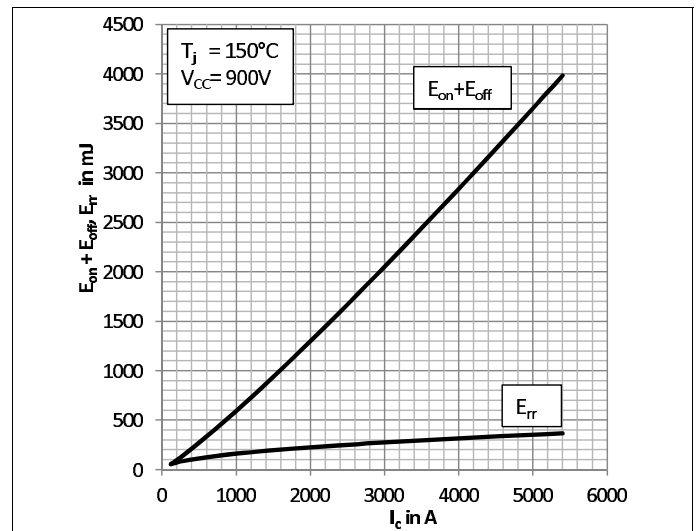


Fig. 4: Typical switching energy  $E = f(I_C)$

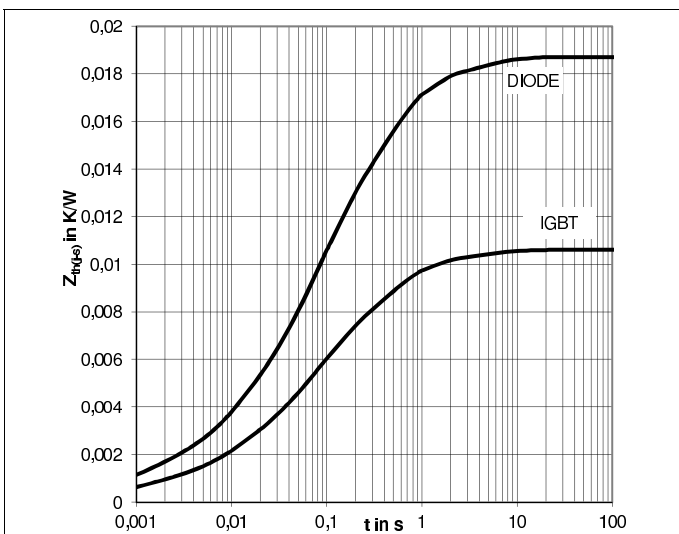


Fig. 5: Transient thermal impedance  $Z_{th}(j-s)$

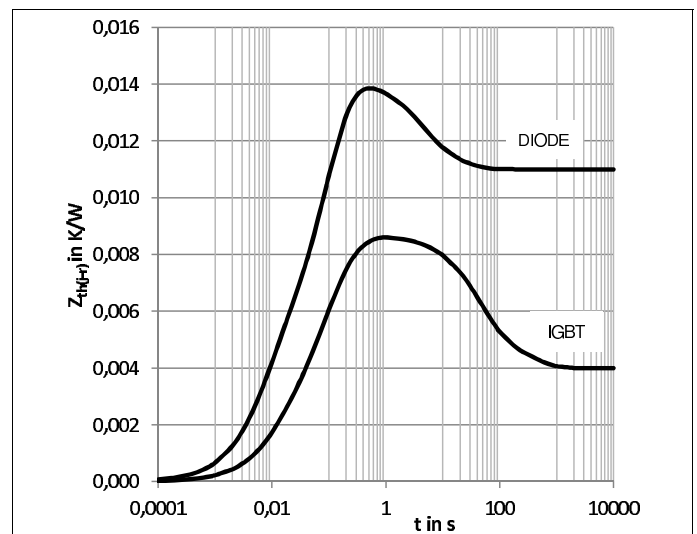


Fig. 6: Transient thermal impedance  $Z_{th}(j-r)$

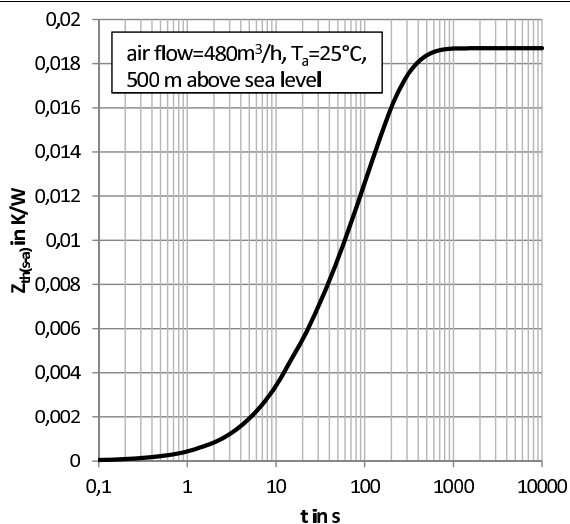


Fig. 7: Transient thermal impedance  $Z_{th}(s-a)$

	$R_{th}$ [K/W]				
	1	2	3	4	5
$Z_{th(f-s)} I$	0,0007	0,0038	0,0042	0,0013	0,0006
$Z_{th(f-s)} D$	0,0013	0,0067	0,0074	0,0022	0,0011
$Z_{th(f-r)} I$	0,0017	0,0044	0,0026	-0,0035	-0,0012
$Z_{th(f-r)} D$	0,0041	0,0035	0,0066	-0,0023	-0,0009
$Z_{th(s-a)}$	0,0036	0,0090	0,0061	0,0000	0,0000
	tau [s]				
	1	2	3	4	5
$Z_{th(f-s)} I$	3,6500	0,4100	0,0650	0,0090	0,0008
$Z_{th(f-s)} D$	3,6500	0,4100	0,0650	0,0090	0,0008
$Z_{th(f-r)} I$	0,0110	0,0700	0,2000	44,900	337,00
$Z_{th(f-r)} D$	0,0070	0,0620	0,1100	4,2000	20,000
$Z_{th(s-a)}$	12,000	84,000	167,00	1,0000	1,0000

Fig. 8: Coefficients of thermal impedances

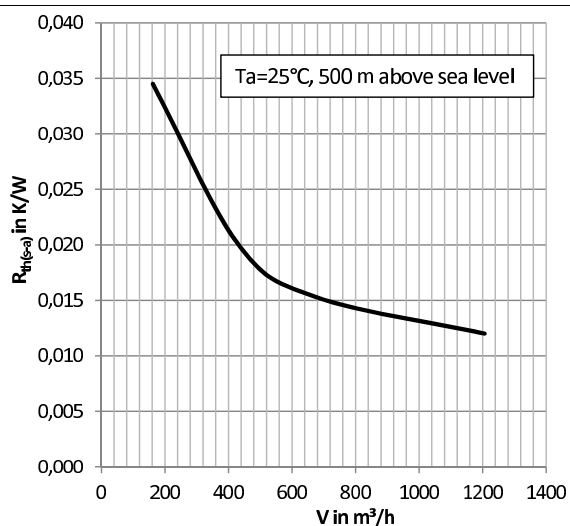


Fig. 9: Thermal resistance  $R_{th}(s-a)$  versus flow rate  $V$

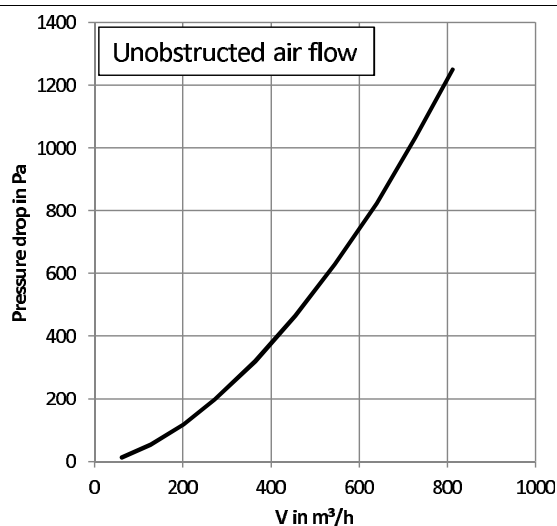
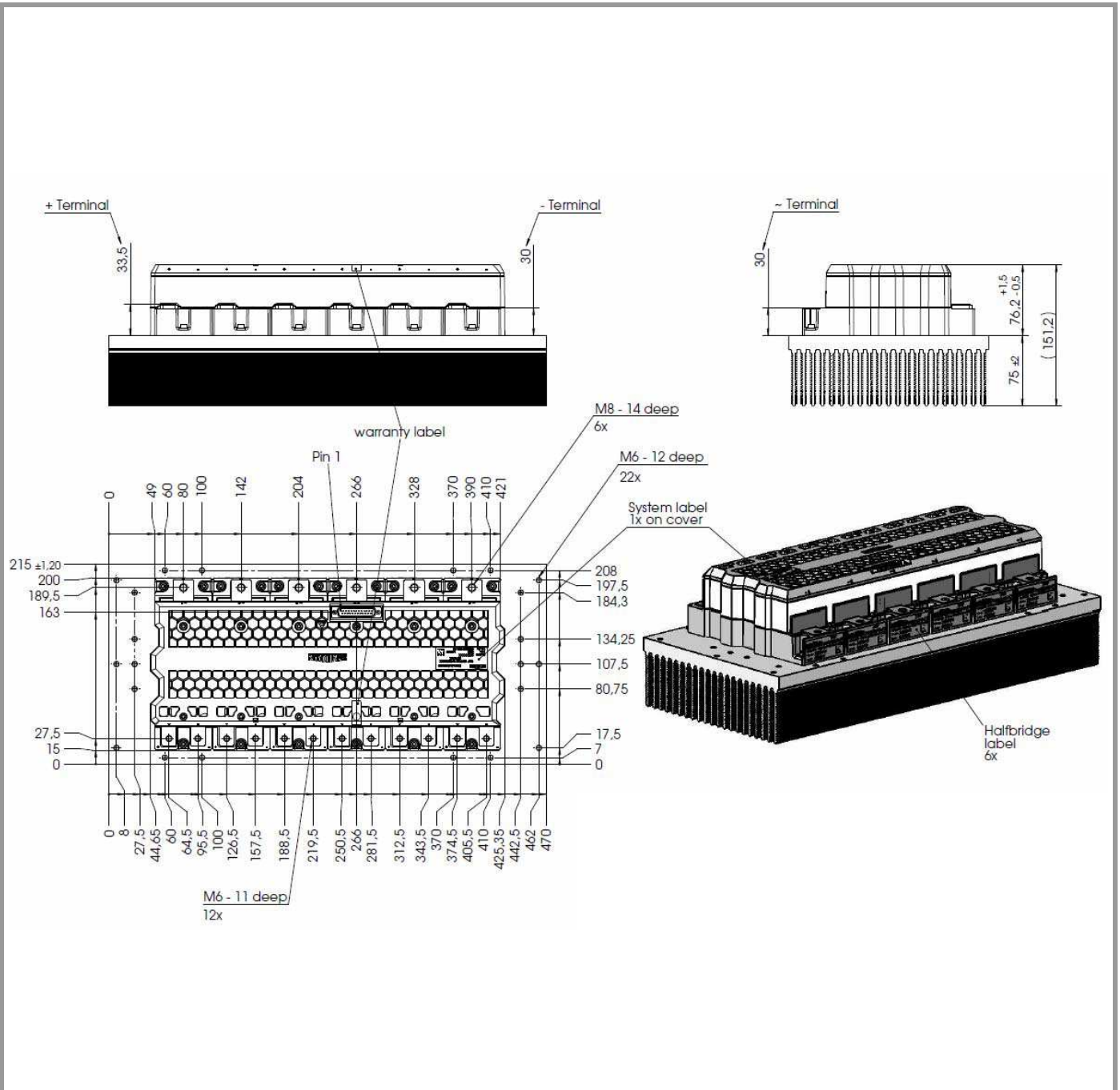


Fig. 10: Pressure drop  $\Delta p$  versus flow rate  $V$

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## System

This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, Chapter IX

\* The specifications of our components may not be considered as an assurance of component characteristics. Components have to be tested for the respective application. Adjustments may be necessary. The use of SEMIKRON products in life support appliances and systems is subject to prior specification and written approval by SEMIKRON. We therefore strongly recommend prior consultation of our staff.