

# SKiiP 2414 GB17E4-4DUL V2



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
- 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

#### Footnotes

<sup>1)</sup>With assembly of suitable MKP capacitor per terminal

<sup>2)</sup>The specified maximum operation junction temperature  $T_{vjop}$  can be > 150°C for a max. of 1000cum. Operations hours

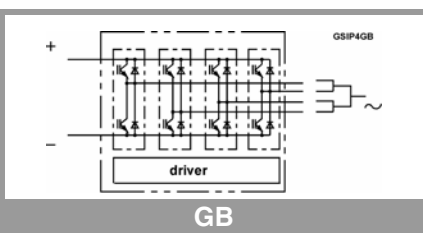
Absolute Maximum Ratings			
Symbol	Conditions	Values	Unit
<b>System</b>			
$V_{CC}^{1)}$	Operating DC link voltage	1300	V
$V_{isol}$	DC, $t = 1$ s, each polarity	5600	V
$I_{t(RMS)}$	per AC terminal, rms, sinusoidal current	500	A
$I_{max (peak)}$	max. peak current of power section	3600	A
$I_{FSM}$	$T_j = 175$ °C, $t_p = 10$ ms, sin 180°	15885	A
$I^2t$	$T_j = 175$ °C, $t_p = 10$ ms, diode	1262	kA <sup>2</sup> s
$f_{out}$	fundamental output frequency (sinusoidal)	1	kHz
$T_{stg}$	storage temperature	-40 ... 85	°C

<b>IGBT</b>				
$V_{CES}$	$T_j = 25$ °C	1700	V	
$I_C$	$T_j = 175$ °C	$T_s = 25$ °C	3385	A
		$T_s = 70$ °C	2723	A
$I_{Cnom}$		2400	A	
$T_j^{2)}$	junction temperature	-40 ... 175	°C	

<b>Diode</b>				
$V_{RRM}$	$T_j = 25$ °C	1700	V	
$I_F$	$T_j = 175$ °C	$T_s = 25$ °C	2362	A
		$T_s = 70$ °C	1869	A
$I_{Fnom}$		2400	A	
$T_j^{2)}$	junction temperature	-40 ... 175	°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	kV/μs
$f_{sw}$	switching frequency	10	kHz

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
<b>IGBT</b>					
$V_{CE(sat)}$	$I_C = 2400$ A at terminal	$T_j = 25$ °C	2.12	2.43	V
		$T_j = 150$ °C	2.53	2.79	V
$V_{CE0}$		$T_j = 25$ °C	1.10	1.20	V
		$T_j = 150$ °C	1.00	1.10	V
$r_{CE}$	at terminal	$T_j = 25$ °C	0.42	0.51	mΩ
		$T_j = 150$ °C	0.64	0.70	mΩ
$E_{on} + E_{off}$	$I_C = 2400$ A $T_j = 150$ °C	$V_{CC} = 900$ V	1780		mJ
		$V_{CC} = 1300$ V	2840		mJ
$R_{th(j-s)}$	per IGBT switch			0.0138	K/W
$R_{th(j-r)}$	per IGBT switch			0.008	K/W



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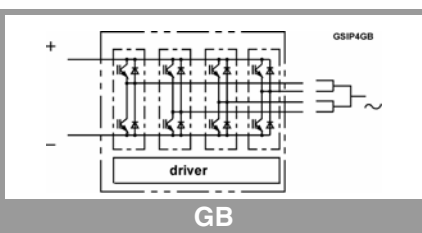
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- <sup>1)</sup>With assembly of suitable MKP capacitor per terminal
- <sup>2)</sup>The specified maximum operation junction temperature  $T_{vjop}$  can be  $> 150^{\circ}\text{C}$  for a max. of 1000cum. Operations hours

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Diode</b>						
$V_F = V_{EC}$	$I_F = 2400\text{ A}$ at terminal	$T_j = 25^{\circ}\text{C}$		2.02	2.34	V
		$T_j = 150^{\circ}\text{C}$		2.27	2.62	V
$V_{F0}$		$T_j = 25^{\circ}\text{C}$		1.21	1.36	V
		$T_j = 150^{\circ}\text{C}$		0.99	1.12	V
$r_F$	at terminal	$T_j = 25^{\circ}\text{C}$		0.34	0.41	m $\Omega$
		$T_j = 150^{\circ}\text{C}$		0.53	0.63	m $\Omega$
$E_{rr}$	$I_F = 2400\text{ A}$ $T_j = 150^{\circ}\text{C}$	$V_R = 900\text{ V}$		412		mJ
		$V_R = 1300\text{ V}$		664		mJ
$R_{th(j-s)}$	per diode switch				0.0281	K/W
$R_{th(j-r)}$	per diode switch				0.02	K/W
<b>Driver</b>						
$V_s$	supply voltage non stabilized		19.2	24	28.8	V
$I_{SO}$	bias current @ $V_s = 24\text{V}$ , $f_{sw} = 0$ , $I_{AC} = 0$			260		mA
$I_S$	$k_1 = 58\text{ mA/kHz}$ , $k_2 = 0.0015\text{ mA/A}^2$ , $f_{out} = 50\text{Hz}$ , sinusoidal current		$= 260$	$+ k_1 * f_{sw}$	$+ k_2 * I_{AC}^2$	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			500		ms
$t_{pReset(OCP)}$	Over current reset time, FRT-function can be activated via CAN interface					$\mu\text{s}$
$t_{TD}$	top / bottom switch interlock time			3		$\mu\text{s}$
$t_{jitter}$	jitter clock time			50	58	ns
$t_{SIS}$	short pulse suppression time			0.6		$\mu\text{s}$
$t_{POR}$	Power-On-Reset completed				1	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
$t_{d(err)}$	Error delay time (from detection to HALT), (depends on kind of error)		3		370	$\mu\text{s}$
$I_{TRIPSC}$	over current trip level		3600			$A_{PEAK}$
$I_{LL}$				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, ,		1300	1340	1380	V
$V_{DCtripLL}$				n.a.		V



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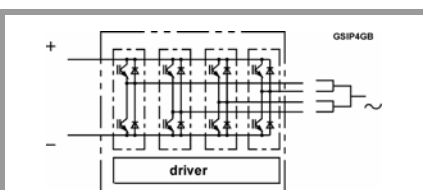
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Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
<b>System</b>					
$t_{d(on)IO}$	$V_{CC} = 1300\text{ V}$ $I_C = 2400\text{ A}$ $T_j = 25^{\circ}\text{C}$		2.8		$\mu\text{s}$
$t_{d(off)IO}$	$T_j = 25^{\circ}\text{C}$		2.6		$\mu\text{s}$
$dV_{CE}/dt_{on}$	$T_j = 25^{\circ}\text{C}$ $V_{CC} = 1300\text{ V}$		14		$\text{kV}/\mu\text{s}$
					$\text{kV}/\mu\text{s}$
$dV_{CE}/dt_{off}$			10		$\text{kV}/\mu\text{s}$
$R_{th(s-a)}$	flow rate = $550\text{ m}^3/\text{h}$ , $T_a=25^{\circ}\text{C}$ , 500m above sea level			0.0225	$\text{K}/\text{W}$
$R_{CC'+EE'}$	measured per switch, $T_s = 25^{\circ}\text{C}$		0.0675		$\text{m}\Omega$
$L_{CE}$	commutation inductance		4.5		$\text{nH}$
$C_{CHC}$	coupling capacitance secondary to heat sink		6		$\text{nF}$
$C_{ps}$	coupling capacitance primary to secondary		0.08		$\text{nF}$
$I_{CES} + I_{RD}$	$V_{GE} = 0\text{ V}$ , $V_{CE} = 1700\text{ V}$ , $T_j = 25^{\circ}\text{C}$		0.199		$\text{mA}$
$M_{dc}$	DC terminals	6		8	$\text{Nm}$
$M_{ac}$	AC terminals	13		15	$\text{Nm}$
w	SKiiP System w/o heat sink		3.22		$\text{kg}$
$w_h$	heat sink		8		$\text{kg}$



GB

## Isolation coordination acc. to EN 50178 and IEC 61800-5-1

Maximum grid RMS voltage, line-to-line, grounded delta mains	690V+20%
Installation altitude for maximum grid RMS voltage, line-to-line, grounded delta mains	2000m
Maximum grid RMS voltage, line-to-line, star point grounded mains	690V+20%
Installation altitude for maximum grid RMS voltage, line-to-line, star point grounded mains	4000m
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

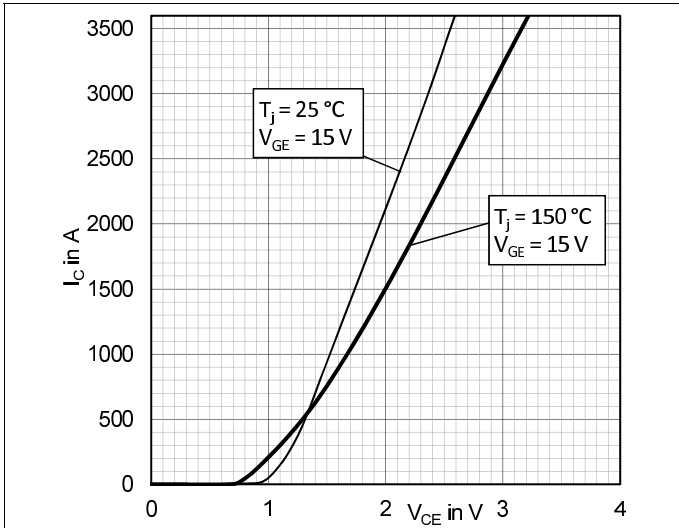


Fig. 1: Typical IGBT output characteristics

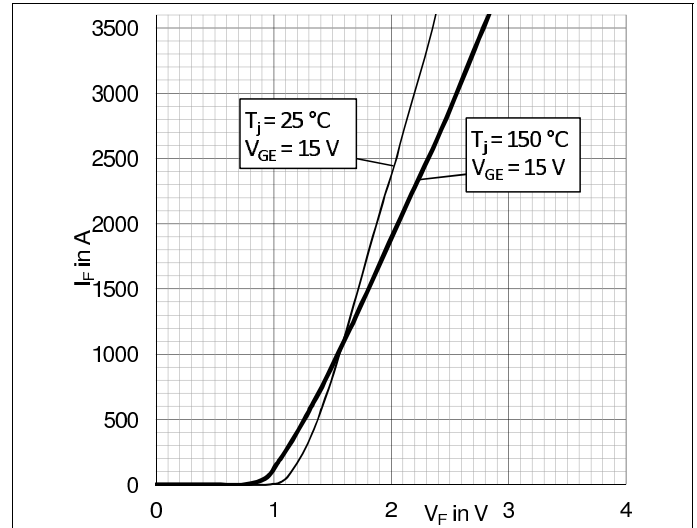


Fig. 2: Typical diode output characteristics

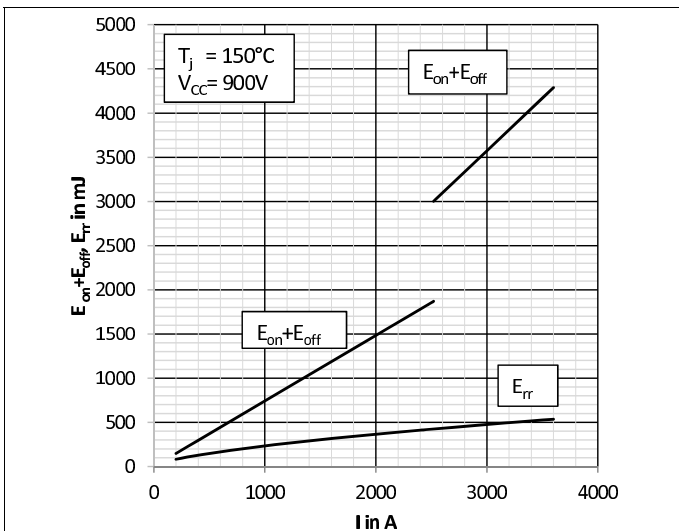


Fig. 3: Typical switching energy  $E = f(I_C)$

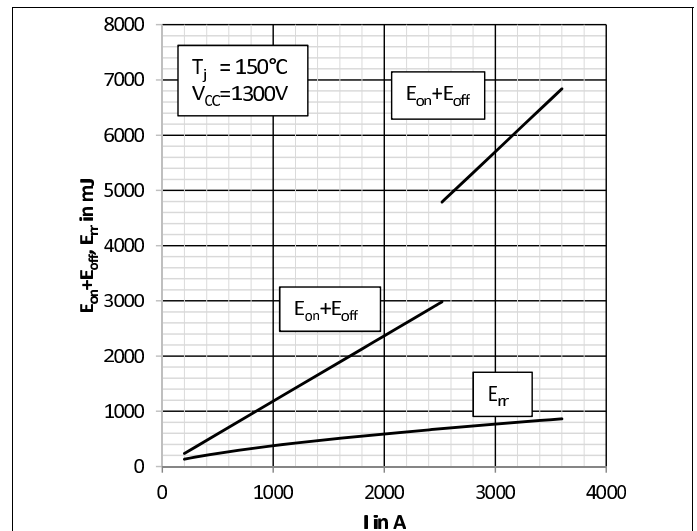


Fig. 4: Typical switching energy  $E = f(I_C)$

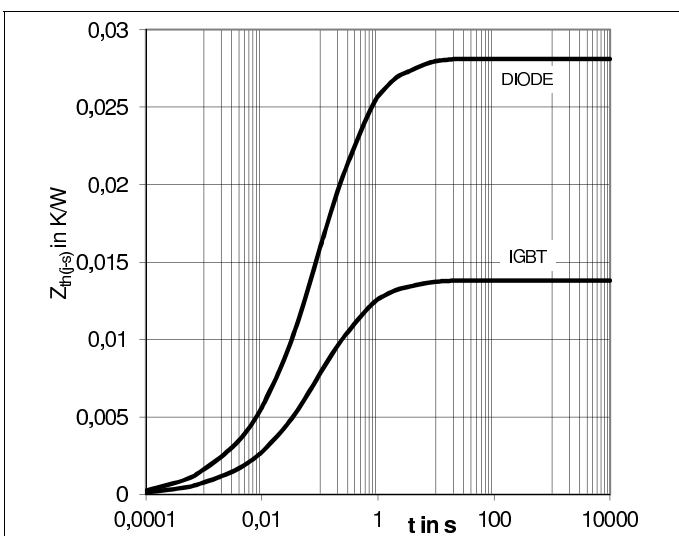


Fig. 5: Transient thermal impedance  $Z_{th}(j-s)$

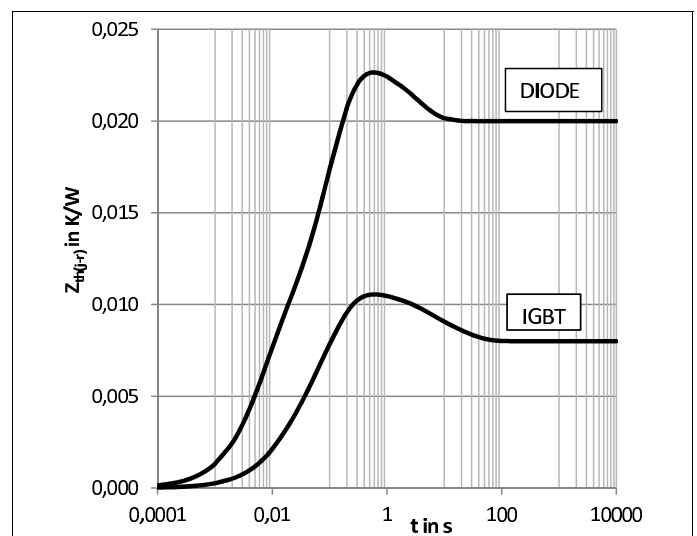


Fig. 6: Transient thermal impedance  $Z_{th}(j-r)$

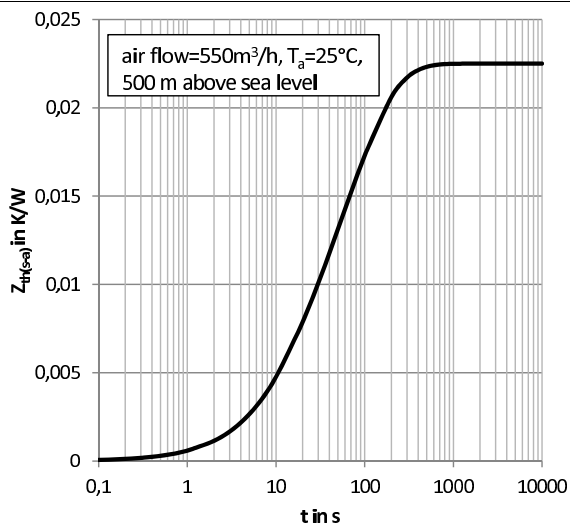


Fig. 7: Transient thermal impedance Zth(s-a)

	R <sub>th</sub> [K/W]				
	1	2	3	4	5
Z <sub>th(j-s)</sub> I	0,0010	0,0049	0,0055	0,0017	0,0007
Z <sub>th(j-s)</sub> D	0,0020	0,0100	0,0112	0,0034	0,0015
Z <sub>th(j-r)</sub> I	0,0021	0,0029	0,0058	-0,0013	-0,0015
Z <sub>th(j-r)</sub> D	0,0075	0,0060	0,0098	-0,0033	0,0000
Z <sub>th(s-a)</sub>	0,0012	0,0052	0,0123	0,0038	0,0000
	tau [s]				
	1	2	3	4	5
Z <sub>th(j-s)</sub> I	3,6500	0,4100	0,0650	0,0090	0,0008
Z <sub>th(j-s)</sub> D	3,6500	0,4100	0,0650	0,0090	0,0008
Z <sub>th(j-r)</sub> I	0,0130	0,0500	0,1200	4,4000	21,000
Z <sub>th(j-r)</sub> D	0,0060	0,0650	0,1300	3,2500	1,0000
Z <sub>th(s-a)</sub>	9,000	18,900	73,000	161,000	1,0000

Fig. 8: Coefficients of thermal impedances

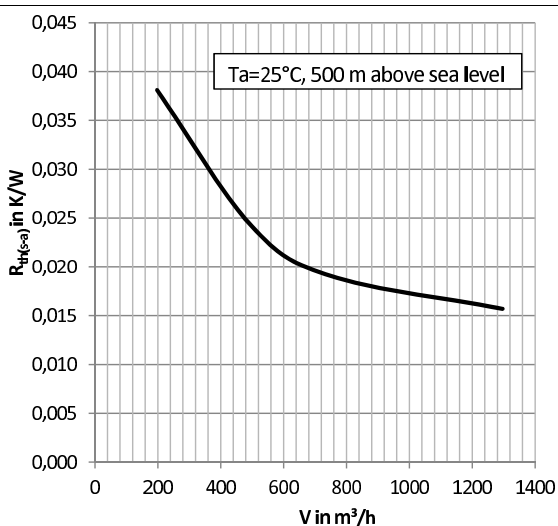


Fig. 9: Thermal resistance Rth(s-a) versus flow rate V

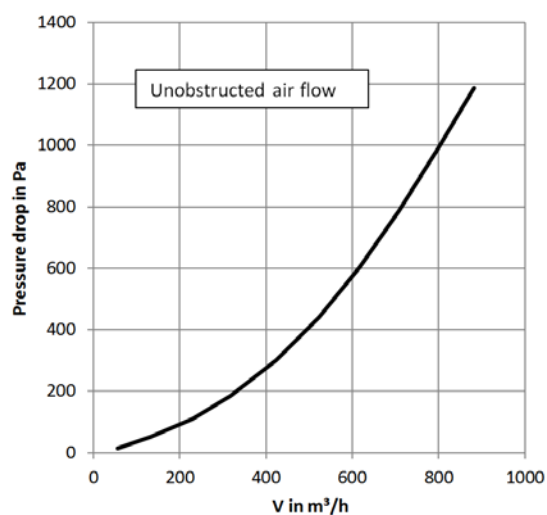
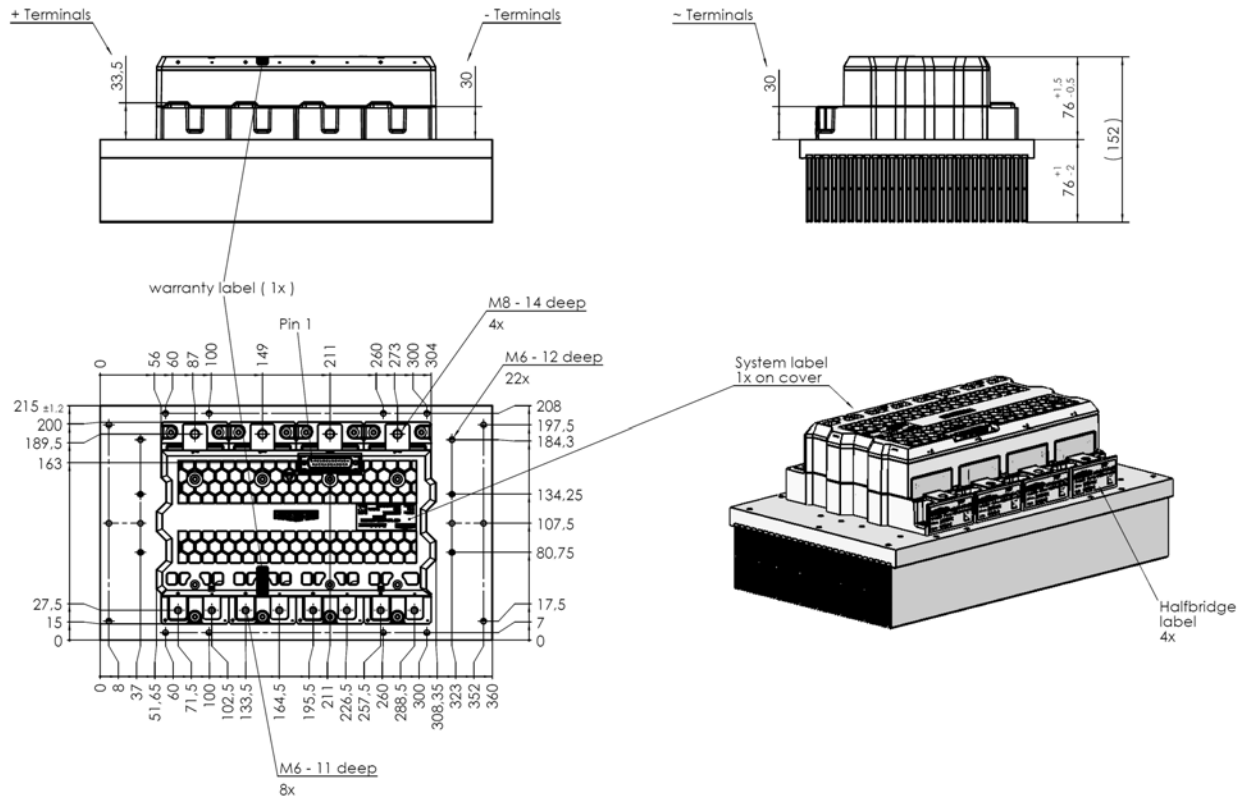


Fig. 10: Pressure drop Δp versus flow rate V

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## System

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

### \*IMPORTANT INFORMATION AND WARNINGS

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