

# SKiiP 3614 GB12E4-6DUW



SKiiP® 4

## 2-pack-integrated intelligent Power System

### SKiiP 3614 GB12E4-6DUW

#### Features

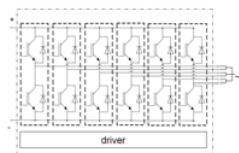
- Intelligent Power Module
- Integrated current and temperature measurement
- Integrated DC-link measurement
- Solder free power section
- IGBT4 and CAL4F technology
- $T_{jmax} = 175^{\circ}\text{C}$
- Safety isolated switching and sensor signals
- Digital signal transmission
- 100% tested IPM
- RoHS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

#### Typical Applications\*

- Renewable energies
- Traction
- Elevators
- Industrial drives

#### Remarks

For further information please refer to SKiiP@4 Technical Explanation



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Absolute Maximum Ratings				
Symbol	Conditions	Values	Unit	
<b>System</b>				
$V_{CC}$	Operating DC link voltage	900	V	
$V_{isol}$	DC, $t = 1$ 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	
$f_{out}$	fundamental output frequency	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	
$T_j$	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	
$T_j$	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	kV/ $\mu\text{s}$	
$f_{sw}$	switching frequency	5	kHz	

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
<b>IGBT</b>					
$V_{CE(sat)}$	$I_C = 3600$ 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	$\text{m}\Omega$
$E_{on} + E_{off}$	$I_C = 3600$ A $T_j = 150^{\circ}\text{C}$	$V_{CC} = 600$ V	1405		mJ
		$V_{CC} = 900$ V	2520		mJ
$R_{th(j-s)}$	per IGBT switch			0.0106	K/W
$R_{th(j-r)}$	per IGBT switch			0.0077	K/W

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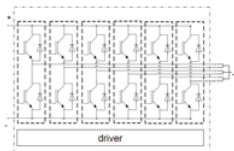
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Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
<b>Diode</b>					
$V_F = V_{EC}$	$I_F = 3600\text{ A}$ at terminal	$T_j = 25^{\circ}\text{C}$	2.33	2.65	V
		$T_j = 150^{\circ}\text{C}$	2.35	2.66	V
$V_{F0}$		$T_j = 25^{\circ}\text{C}$	1.30	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	mΩ
		$T_j = 150^{\circ}\text{C}$	0.40	0.43	mΩ
$E_{rr}$	$I_F = 3600\text{ A}$ $T_j = 150^{\circ}\text{C}$	$V_R = 600\text{ V}$	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			0.0158	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
$I_S$	$k_1 = 48\text{ mA/kHz}$ , $k_2 = 0.286\text{ mA/A}$	= 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		kΩ
$C_{IN}$	input capacitance		1		nF
$t_{pRESET}$	error memory reset time	1.3		2.9	s
$t_{pReset(OCP)}$	Over current reset time				μs
$t_{TD}$	top / bottom switch interlock time		3		μs
$t_{jitter}$	jitter clock time		52	58	ns
$t_{SIS}$	short pulse suppression time		0.6		μs
$t_{POR}$	Power-On-Reset completed		3.5		s
$V_{CEstat}$	Collector-Emitter Threshold Static Monitoring Voltage		7.5		V
$t_{bl}$	Collector-Emitter Threshold Static Monitoring Blanking Time		6		μs
$I_{digiout}$	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	μs
$I_{TRIPSC}$	over current trip level	5290	5400	5510	$A_{PEAK}$
$T_{trip}$	over temperature trip level	126	130	134	°C
$T_{DriverTrip}$	over temperature PCB trip level	113	120	124	°C
$V_{DCtrip}$	over voltage trip level,	950	980	1010	V
$f_{0Uana}$	bandwidth of DC-voltage measurement @ $V_{DCtrip}$ (-3dB)		2		kHz
$f_{0Iana}$	bandwidth of current measurement @ $I_{TRIPSC}$ (-3dB),		50		kHz
$f_{0Tana}$	bandwidth of temperature measurement @ $T_{trip}$ (-3dB)		5		Hz

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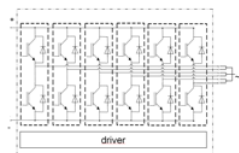
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>System</b>						
$t_{d(on)IO}$	$V_{CC} = 600\text{ V}$ $I_C = 3600\text{ A}$ $T_j = 25^{\circ}\text{C}$	turn on propagation delay time		2.8		$\mu\text{s}$
$t_{d(off)IO}$		turn off propagation delay time		2.6		$\mu\text{s}$
$dV_{CE}/dt_{on}$	$T_j = 25^{\circ}\text{C}$ $V_{CC} = 600\text{ V}$	$I_C = 0\text{ A}$		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 = 15 l/min, $T_{Fluid}=40^{\circ}\text{C}$ , water/glycol ratio 50%:50%				0.0051	K/W
$R_{CC+EE}$	terminals to chip, $T_s = 25^{\circ}\text{C}$			0.045		$\text{m}\Omega$
$L_{CE}$	commutation inductance			3		nH
$C_{CHC}$	coupling capacitance secondary to heat sink			8.4		nF
$C_{ps}$	coupling capacitance primary to secondary			0.102		nF
$I_{CES} + I_{RD}$	$V_{GE} = 0\text{ V}$ , $V_{CE} = 1200\text{ V}$ , $T_j = 25^{\circ}\text{C}$			0.527		mA
$M_{dc}$	DC terminals		6		8	Nm
$M_{ac}$	AC terminals		13		15	Nm
w	SKiiP System w/o heat sink			4.84		kg
$W_h$	heat sink			5.77		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
Overtoltage cat. acc. to IEC 60664-1 for mains	III
Overtoltage cat. acc. to UL 840 within mains	I
Overtoltage cat. acc. to UL 840 between mains and ground	III
Overtoltage 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 weatherprotected locations	Operation - ground vehicle installations	Operation - ship environment
Climatic conditions	1K2	2K2	3K3 <sub>(1)</sub>	5K1	6K1
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) 3K3: expanded temperature range: -40°C / +85°C

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

(3) 5M3, shock only 5M2, without impact from foreign bodies, stones

(4) no declaration due to customer-specific packing

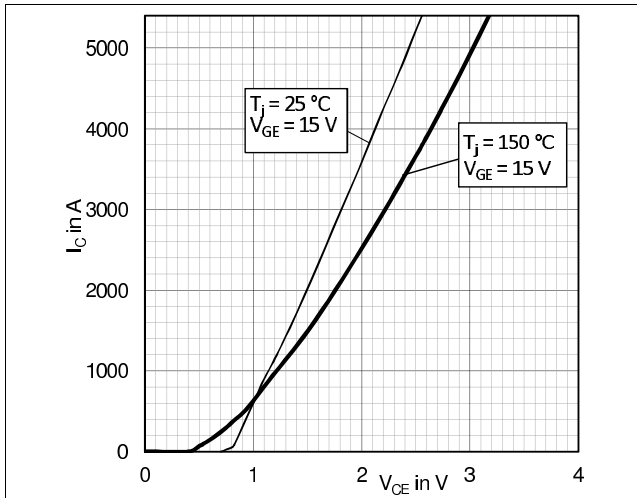


Fig. 1: Typical IGBT output characteristics

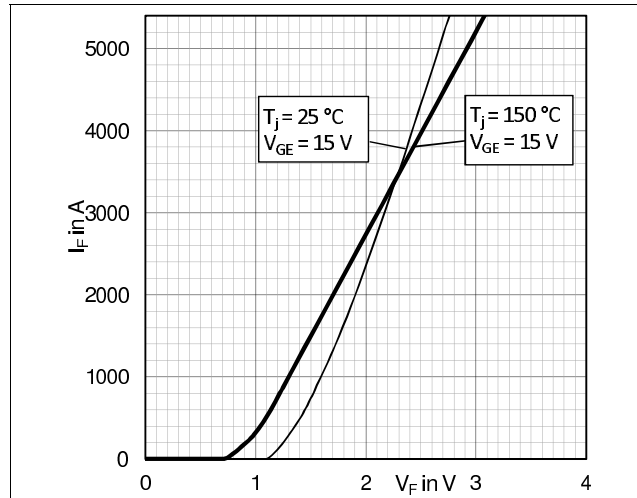


Fig. 2: Typical diode output characteristics

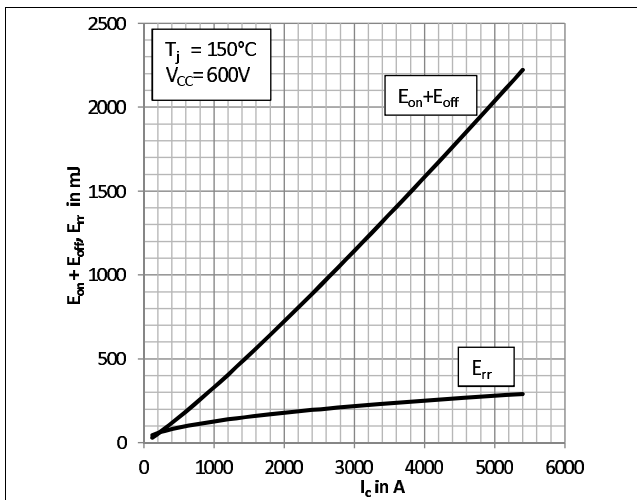


Fig. 3: Typical energy losses  $E = f(I_c, V_{cc}, T_j)$

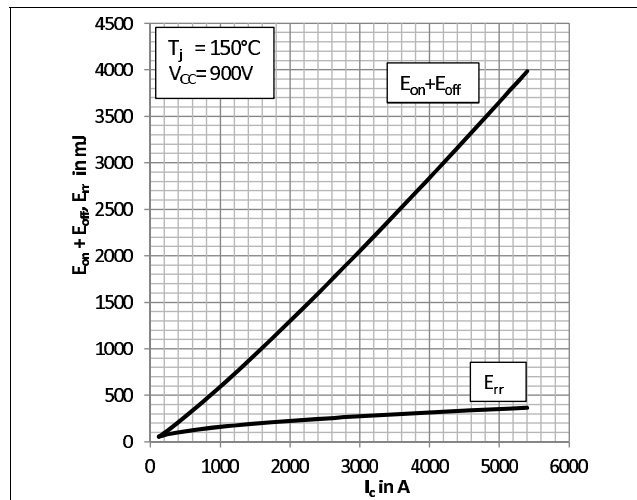


Fig. 4: Typical energy losses  $E = f(I_c, V_{cc}, T_j)$

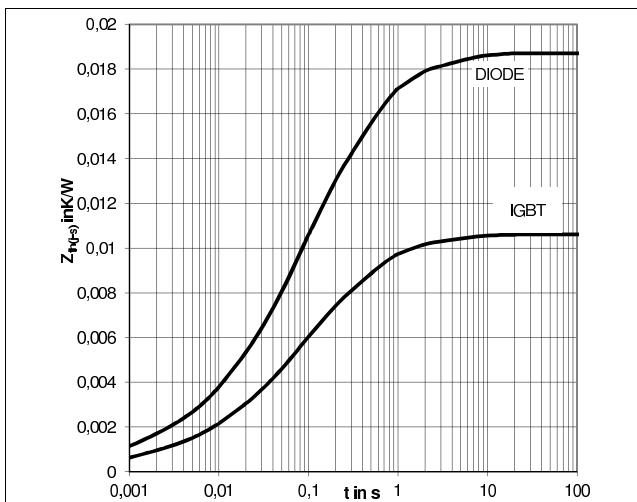


Fig. 5: Transient thermal impedance  $Z_{th}(j-s)$

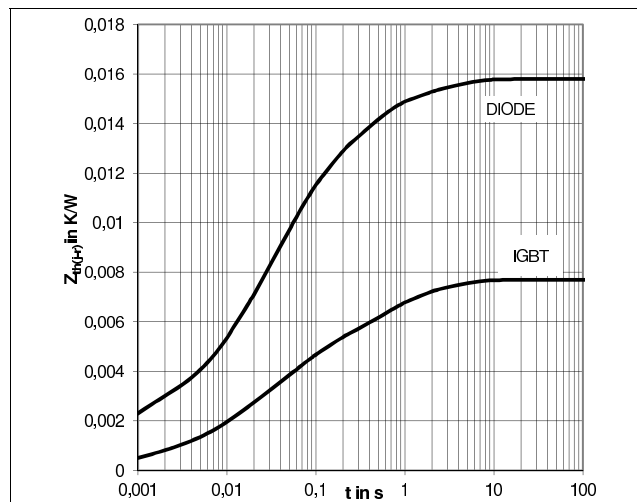


Fig. 6: Transient thermal impedance  $Z_{th}(j-r)$

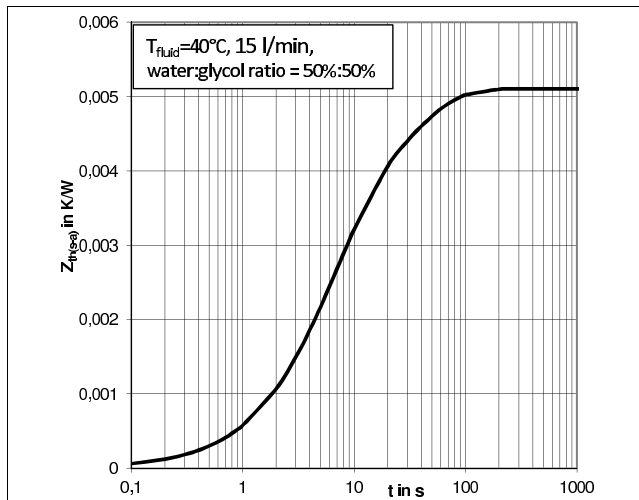


Fig. 7: Transient thermal impedance  $Z_{th}(s-a)$

	$R_{th} [K/W]$				
	1	2	3	4	5
$Z_{th(j-s)} I$	0,0007	0,0038	0,0042	0,0013	0,0006
$Z_{th(j-s)} D$	0,0013	0,0067	0,0074	0,0022	0,0011
$Z_{th(j-r)} I$	0,0009	0,0021	0,0026	0,0016	0,0005
$Z_{th(j-r)} D$	0,0011	0,0033	0,0061	0,0030	0,0023
$Z_{th(s-a)}$	0,0017	0,0034			

	$\tau [s]$				
	1	2	3	4	5
$Z_{th(j-s)} I$	3,6500	0,4100	0,0650	0,0090	0,0008
$Z_{th(j-s)} D$	3,6500	0,4100	0,0650	0,0090	0,0008
$Z_{th(j-r)} I$	2,7731	0,5071	0,0555	0,0105	0,0010
$Z_{th(j-r)} D$	2,6032	0,3312	0,0480	0,0109	0,0006
$Z_{th(s-a)}$	32,3020	5,9361			

Fig. 8: Coefficients of thermal impedances

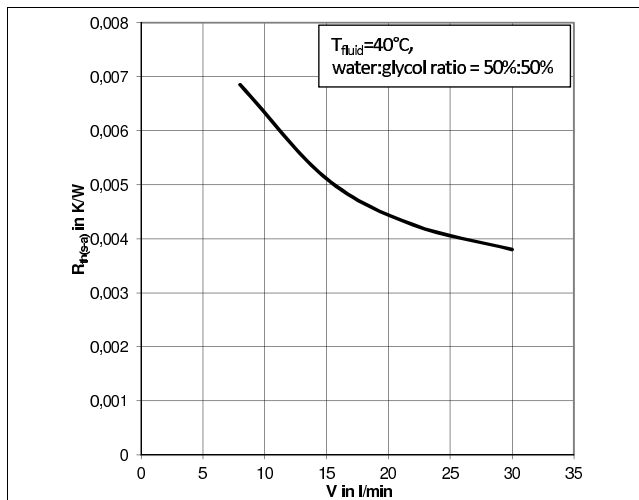


Fig. 9: Thermal resistance  $R_{th}(s-a)$  versus flow rate  $V$

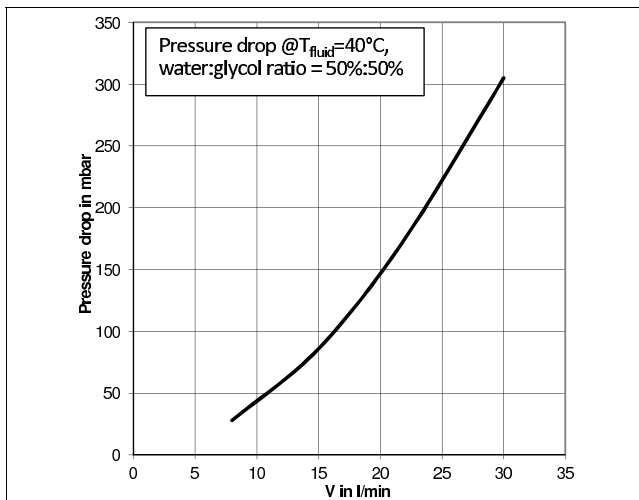
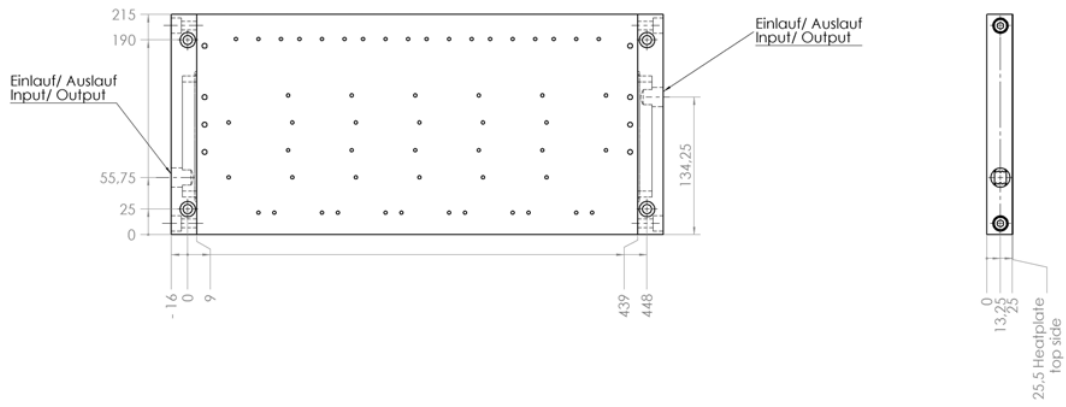
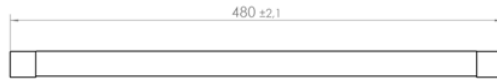


Fig. 10: Pressure drop  $\Delta p$  versus flow rate  $V$

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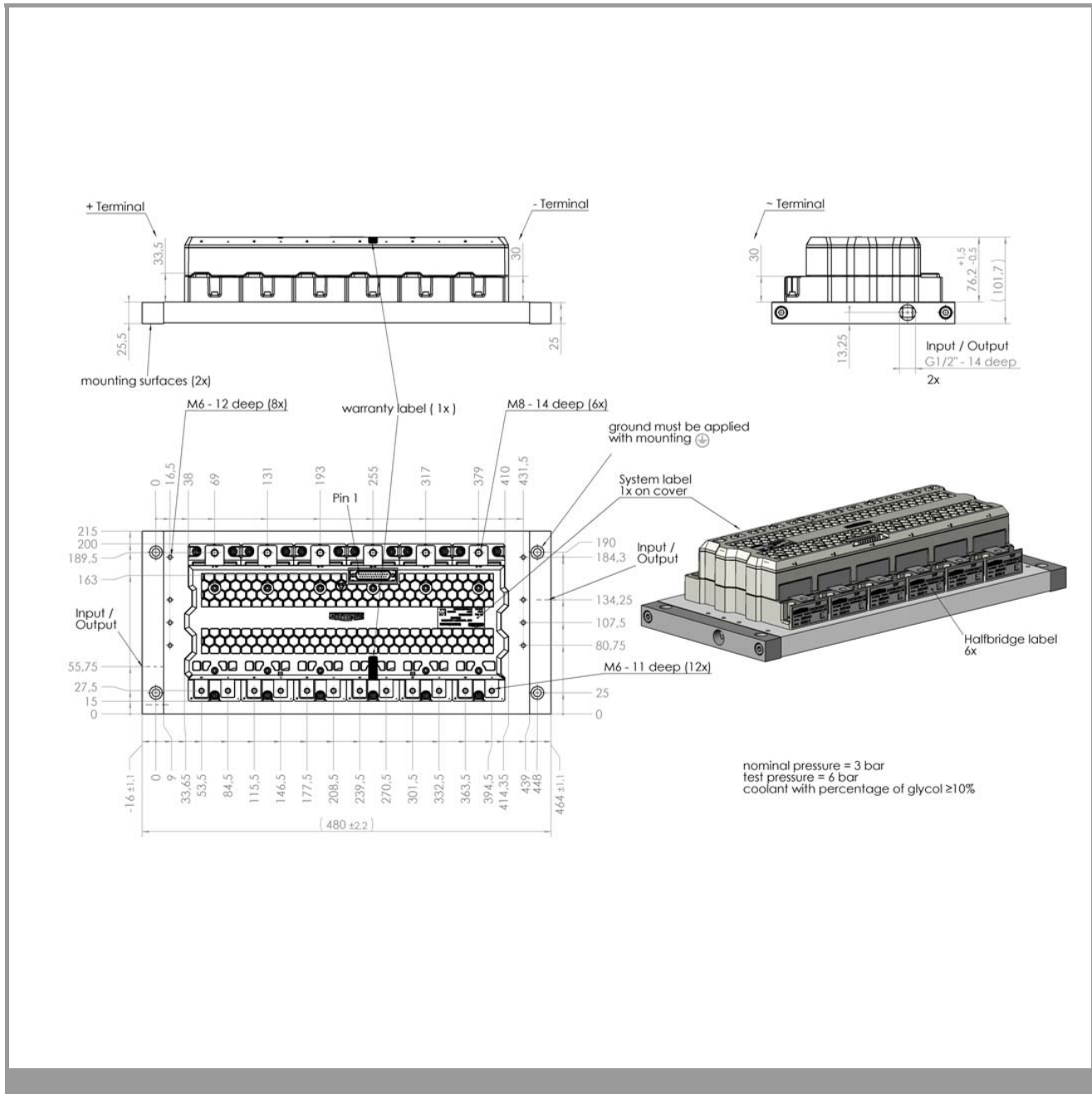


Nenndruck / Kühlsystem = 3 bar  
 Prüfdruck / Kühlsystem = 6 bar  
 Kühlmedium mit Glykolanteil  $\geq 10\%$

nominal pressure/cooling system = 3 bar  
 test pressure/cooling system = 6 bar  
 coolant with percentage of glycol  $\geq 10\%$

Heat sink

# SKiIP 3614 GB12E4-6DUW



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.