

**SKiiP® 3**

## 2-pack-integrated intelligent Power System

### SKiiP 1013 GB172-2DW V3

#### Features

- SKiiP technology inside
- Trench IGBTs
- CAL diode technology
- Integrated current sensor
- Integrated temperature sensor
- Integrated heat sink
- UL recognized File no. E63532

#### Typical Applications\*

- Renewable energies
- Traction
- Elevators
- Industrial drives

#### Footnotes

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

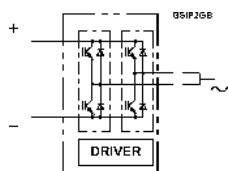
| Absolute Maximum Ratings |                                                                    | $T_s = 25^\circ\text{C}$ unless otherwise specified |                       |
|--------------------------|--------------------------------------------------------------------|-----------------------------------------------------|-----------------------|
| Symbol                   | Conditions                                                         | Values                                              | Unit                  |
| <b>System</b>            |                                                                    |                                                     |                       |
| $V_{CC}^{1)}$            | Operating DC link voltage                                          | 1200                                                | V                     |
| $V_{isol}$               | DC, $t = 1\text{ s}$ , main terminals to heat sink                 | 5600                                                | V                     |
| $I_{t(RMS)}$             | per AC terminal, $T_{terminal} < 115^\circ\text{C}$                | 400                                                 | A                     |
| $I_{FSM}$                | $T_j = 150^\circ\text{C}$ , $t_p = 10\text{ ms}$ , sin $180^\circ$ | 6900                                                | A                     |
| $I^2t$                   | $T_j = 150^\circ\text{C}$ , $t_p = 10\text{ ms}$ , diode           | 238                                                 | $\text{kA}^2\text{s}$ |
| $f_{out}$                | fundamental output frequency                                       | 1                                                   | kHz                   |
| $T_{stg}$                | storage temperature                                                | -40 ... 85                                          | $^\circ\text{C}$      |

|             |                           |                          |                  |
|-------------|---------------------------|--------------------------|------------------|
| <b>IGBT</b> |                           |                          |                  |
| $V_{CES}$   | $T_j = 25^\circ\text{C}$  | 1700                     | V                |
| $I_C$       | $T_j = 150^\circ\text{C}$ | $T_s = 25^\circ\text{C}$ | 1072             |
|             |                           | $T_s = 70^\circ\text{C}$ | 824              |
| $I_{Cnom}$  |                           | 1000                     | A                |
| $T_j$       | junction temperature      | -40 ... 150              | $^\circ\text{C}$ |

|              |                           |                          |                  |
|--------------|---------------------------|--------------------------|------------------|
| <b>Diode</b> |                           |                          |                  |
| $V_{RRM}$    | $T_j = 25^\circ\text{C}$  | 1700                     | V                |
| $I_F$        | $T_j = 150^\circ\text{C}$ | $T_s = 25^\circ\text{C}$ | 879              |
|              |                           | $T_s = 70^\circ\text{C}$ | 669              |
| $I_{Fnom}$   |                           | 830                      | A                |
| $T_j$        | junction temperature      | -40 ... 150              | $^\circ\text{C}$ |

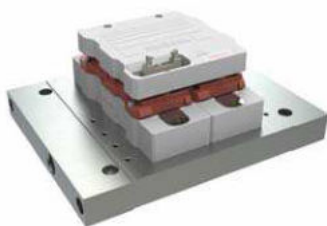
|               |                                         |           |                         |
|---------------|-----------------------------------------|-----------|-------------------------|
| <b>Driver</b> |                                         |           |                         |
| $V_s$         | power supply                            | 13 ... 30 | V                       |
| $V_{iH}$      | input signal voltage (high)             | 15 + 0.3  | V                       |
| $V_{isolIPD}$ | QPD $\leq 10\text{ pC}$ , PRIM to POWER | 1500      | V                       |
| $dv/dt$       | secondary to primary side               | 75        | $\text{kV}/\mu\text{s}$ |
| $f_{sw}$      | switching frequency                     | 14        | kHz                     |

| Characteristics    |                                                   | $T_s = 25^\circ\text{C}$ unless otherwise specified |      |        |                  |
|--------------------|---------------------------------------------------|-----------------------------------------------------|------|--------|------------------|
| Symbol             | Conditions                                        | min.                                                | typ. | max.   | Unit             |
| <b>IGBT</b>        |                                                   |                                                     |      |        |                  |
| $V_{CE(sat)}$      | $I_C = 600\text{ A}$<br>at terminal               | $T_j = 25^\circ\text{C}$                            | 1.9  | 2.4    | V                |
|                    |                                                   | $T_j = 125^\circ\text{C}$                           | 2.2  |        | V                |
| $V_{CE0}$          |                                                   | $T_j = 25^\circ\text{C}$                            | 1.00 | 1.20   | V                |
|                    |                                                   | $T_j = 125^\circ\text{C}$                           | 0.90 | 1.10   | V                |
| $r_{CE}$           | at terminal                                       | $T_j = 25^\circ\text{C}$                            | 1.48 | 2      | $\text{m}\Omega$ |
|                    |                                                   | $T_j = 125^\circ\text{C}$                           | 2.1  | 2.5    | $\text{m}\Omega$ |
| $E_{on} + E_{off}$ | $I_C = 600\text{ A}$<br>$T_j = 125^\circ\text{C}$ | $V_{CC} = 900\text{ V}$                             | 390  |        | mJ               |
|                    |                                                   | $V_{CC} = 1200\text{ V}$                            | 575  |        | mJ               |
| $R_{th(j-s)}$      | per IGBT switch                                   |                                                     |      | 0.03   | K/W              |
| $R_{th(j-r)}$      | per IGBT switch                                   |                                                     |      | 0.0425 | K/W              |



**S23**

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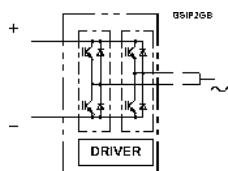
#### Typical Applications\*

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#### Footnotes

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

| Characteristics                    |                                                                              |                                              | T <sub>s</sub> = 25°C unless otherwise specified |                                                                                    |        |                   |
|------------------------------------|------------------------------------------------------------------------------|----------------------------------------------|--------------------------------------------------|------------------------------------------------------------------------------------|--------|-------------------|
| Symbol                             | Conditions                                                                   |                                              | min.                                             | typ.                                                                               | max.   | Unit              |
| Diode                              |                                                                              |                                              |                                                  |                                                                                    |        |                   |
| V <sub>F</sub> = V <sub>EC</sub>   | I <sub>F</sub> = 600 A<br>at terminal                                        | T <sub>j</sub> = 25 °C                       |                                                  | 2.00                                                                               | 2.15   | V                 |
|                                    |                                                                              | T <sub>j</sub> = 125 °C                      |                                                  | 1.80                                                                               |        | V                 |
| V <sub>F0</sub>                    | at terminal                                                                  | T <sub>j</sub> = 25 °C                       |                                                  | 1.1                                                                                | 1.2    | V                 |
|                                    |                                                                              | T <sub>j</sub> = 125 °C                      |                                                  | 0.8                                                                                | 0.9    | V                 |
| r <sub>F</sub>                     |                                                                              | T <sub>j</sub> = 25 °C                       |                                                  | 1.5                                                                                | 1.6    | mΩ                |
|                                    |                                                                              | T <sub>j</sub> = 125 °C                      |                                                  | 1.7                                                                                | 1.8    | mΩ                |
| E <sub>rr</sub>                    | I <sub>F</sub> = 600 A<br>T <sub>j</sub> = 125 °C                            | V <sub>R</sub> = 900 V                       |                                                  | 72                                                                                 |        | mJ                |
|                                    |                                                                              | V <sub>R</sub> = 1200 V                      |                                                  | 86                                                                                 |        | mJ                |
| R <sub>th(j-s)</sub>               | per diode switch                                                             |                                              |                                                  |                                                                                    | 0.058  | K/W               |
| R <sub>th(j-r)</sub>               | per diode switch                                                             |                                              |                                                  |                                                                                    | 0.09   | K/W               |
| Driver                             |                                                                              |                                              |                                                  |                                                                                    |        |                   |
| V <sub>s</sub>                     | supply voltage non stabilized                                                |                                              | 13                                               | 24                                                                                 | 30     | V                 |
| I <sub>S0</sub>                    | bias current @V <sub>s</sub> =24V, f <sub>sw</sub> = 0, I <sub>AC</sub> = 0  |                                              |                                                  | 240                                                                                |        | mA                |
| I <sub>s</sub>                     | k <sub>1</sub> = 29 mA/kHz, k <sub>2</sub> = 0.00065 mA/A <sup>2</sup>       |                                              | = 240                                            | + k <sub>1</sub> * f <sub>sw</sub> + k <sub>2</sub> * I <sub>AC</sub> <sup>2</sup> |        | mA                |
| V <sub>IT+</sub>                   | input threshold voltage (HIGH)                                               |                                              | 12.3                                             |                                                                                    |        | V                 |
| V <sub>IT-</sub>                   | input threshold voltage (LOW)                                                |                                              |                                                  |                                                                                    | 4.6    | V                 |
| R <sub>IN</sub>                    | input resistance                                                             |                                              |                                                  | 10                                                                                 |        | kΩ                |
| C <sub>IN</sub>                    | input capacitance                                                            |                                              |                                                  | 1                                                                                  |        | nF                |
| t <sub>pRESET</sub>                | error memory reset time                                                      |                                              |                                                  | 0.0122                                                                             |        | ms                |
| t <sub>TD</sub>                    | top / bottom switch interlock time                                           |                                              |                                                  | 3                                                                                  |        | μs                |
| t <sub>jitter</sub>                | jitter clock time                                                            |                                              |                                                  | 125                                                                                |        | ns                |
| t <sub>SIS</sub>                   | short pulse suppression time                                                 |                                              |                                                  | 0.625                                                                              | 0.7    | μs                |
| I <sub>TRIPSC</sub>                | over current trip level                                                      |                                              | 1225                                             | 1250                                                                               | 1275   | A <sub>PEAK</sub> |
| T <sub>trip</sub>                  | over temperature trip level                                                  |                                              | 110                                              | 115                                                                                | 120    | °C                |
| V <sub>DCtrip</sub>                | over voltage trip level,                                                     |                                              |                                                  | not impl.                                                                          |        | V                 |
| t <sub>d(on)IO</sub>               | V <sub>CC</sub> = 1200 V<br>I <sub>C</sub> = 600 A<br>T <sub>j</sub> = 25 °C | input-output<br>turn-on<br>propagation time  |                                                  | 1.4                                                                                |        | μs                |
| t <sub>d(off)IO</sub>              |                                                                              | input-output<br>turn-off<br>propagation time |                                                  | 1.4                                                                                |        | μs                |
| System                             |                                                                              |                                              |                                                  |                                                                                    |        |                   |
| R <sub>th(r-a)</sub>               | flow rate=8l/min, T <sub>Fluid</sub> =50°C, water/<br>glycol ratio 50%:50%   |                                              |                                                  |                                                                                    | 0.0124 | K/W               |
| R <sub>CC+EE'</sub>                | terminals to chip, T <sub>s</sub> = 25 °C                                    |                                              |                                                  | 0.25                                                                               |        | mΩ                |
| L <sub>CE</sub>                    | commutation inductance                                                       |                                              |                                                  | 6                                                                                  |        | nH                |
| C <sub>CHC</sub>                   | per phase, AC-side                                                           |                                              |                                                  | 3.4                                                                                |        | nF                |
| I <sub>CES</sub> + I <sub>RD</sub> | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 1700 V, T <sub>j</sub> = 25 °C      |                                              |                                                  | 2.4                                                                                |        | mA                |
| M <sub>dc</sub>                    | DC terminals, SI Units                                                       |                                              | 6                                                |                                                                                    | 8      | Nm                |
| M <sub>ac</sub>                    | AC terminals, SI Units                                                       |                                              | 13                                               |                                                                                    | 15     | Nm                |
| w                                  | SKiiP System w/o heat sink                                                   |                                              |                                                  | 1.7                                                                                |        | kg                |
| w <sub>h</sub>                     | heat sink                                                                    |                                              |                                                  | 2.8                                                                                |        | kg                |



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

|                                                                                             |                                                                       |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| 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 | 2000m                                                                 |
| Maximum transient peak voltage between low voltage circuit and mains                        | 1600V                                                                 |
| Pollution degree acc. to IEC 60664-1 outside the moulded power section                      | 2                                                                     |
| Overvoltage cat. acc. to IEC 60664-1 for mains                                              | III                                                                   |
| Basic isolation                                                                             | between heat sink and mains;<br>between low voltage circuit and mains |
| Protection level acc. to IEC 60529                                                          | IP00                                                                  |

## Environmental conditions acc.to IEC 60721

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

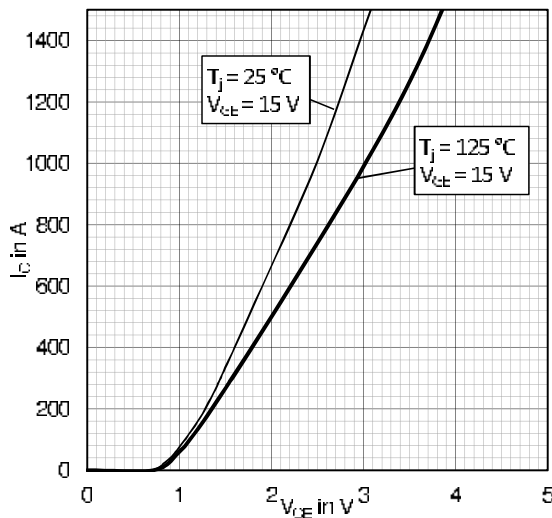


Fig. 1: Typical IGBT output characteristic

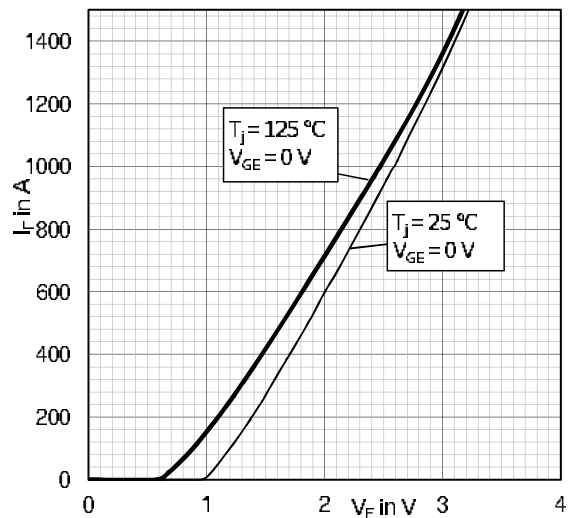


Fig. 2: Typical diode output characteristics

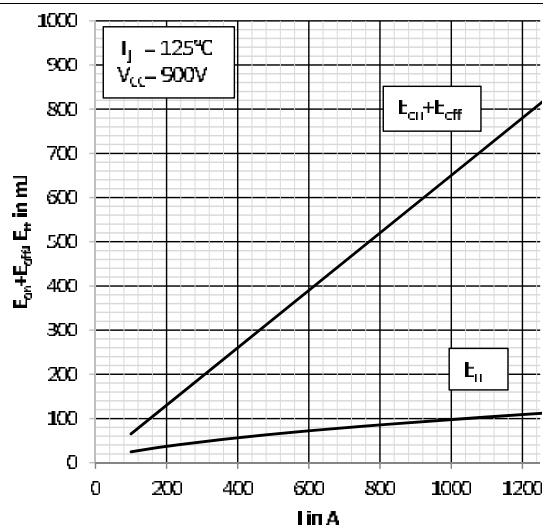


Fig. 3: Typical energy losses  $E = f(I_C, V_{CC})$

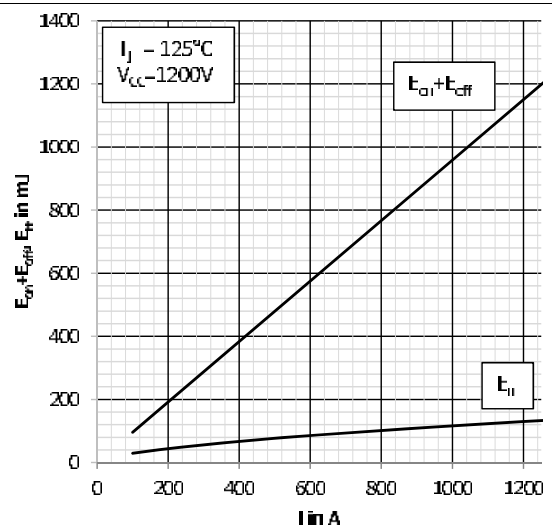


Fig. 4: Typical energy losses  $E = f(I_C, V_{CC})$

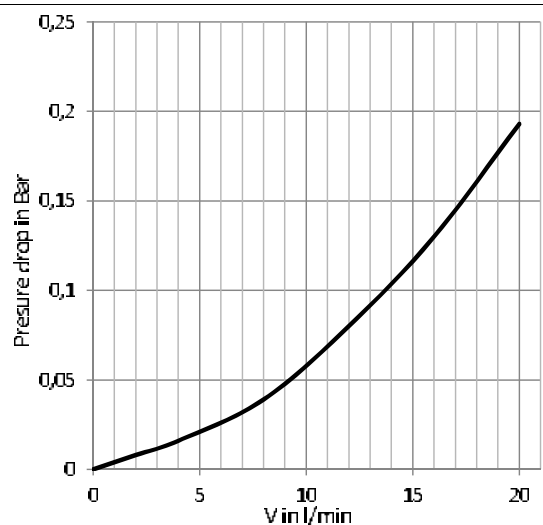


Fig. 5: Pressure drop  $\Delta p$  versus flow rate  $V$

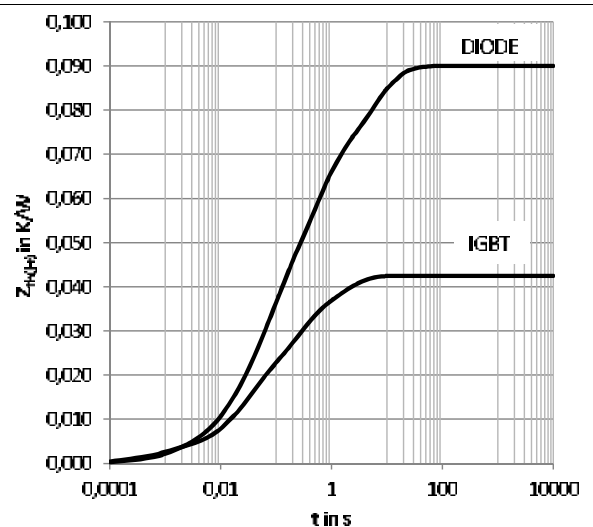
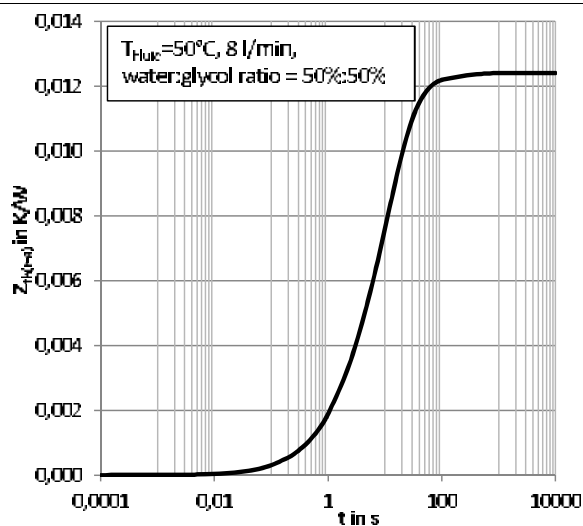


Fig. 6: Transient thermal impedance  $Z_{th}(j-r)$

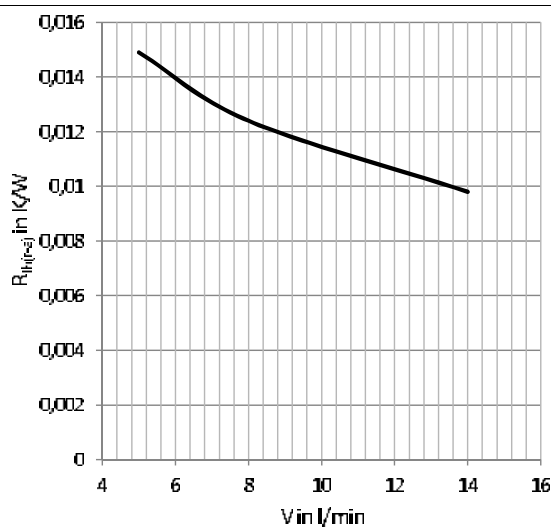

Fig. 7: Transient thermal impedance  $Z_{th(r-a)}$ 

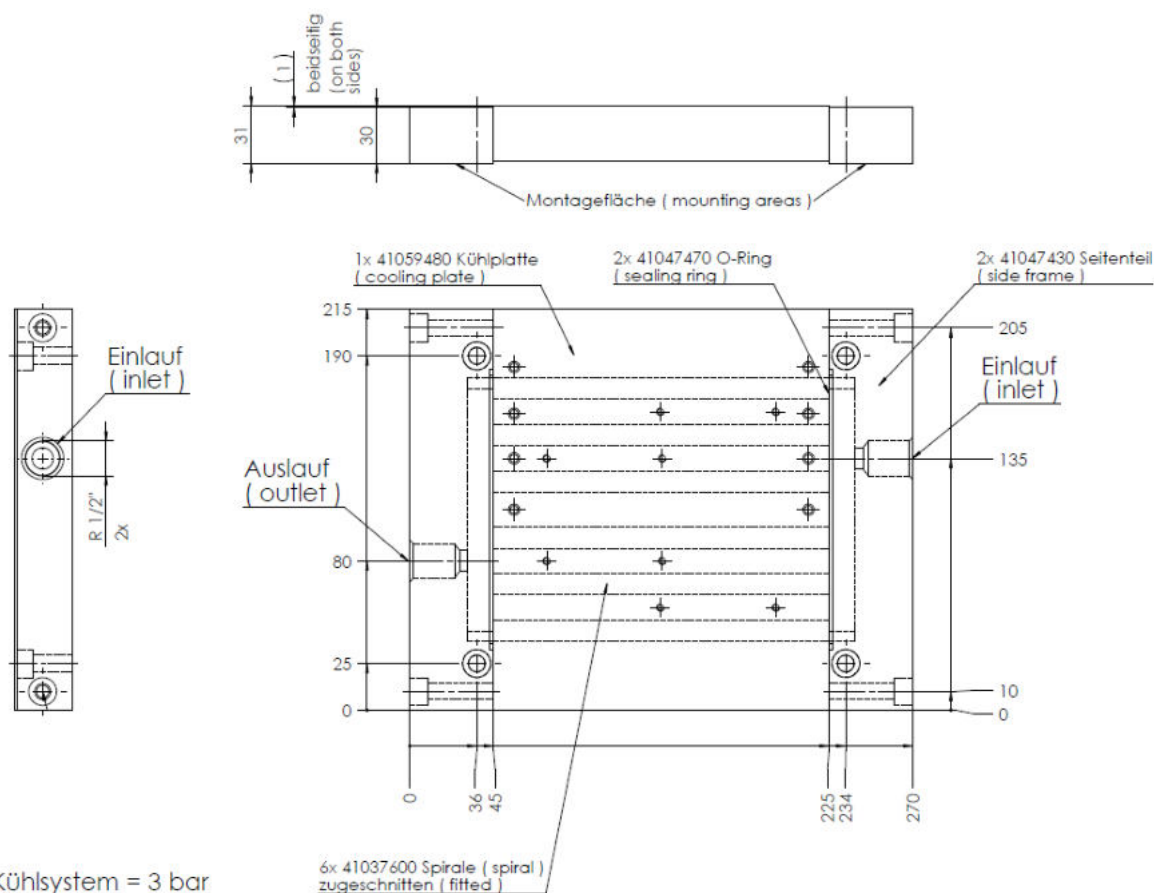
|                 | $R_{th} [K/W]$ |        |        |        |        |        |
|-----------------|----------------|--------|--------|--------|--------|--------|
|                 | 1              | 2      | 3      | 4      | 5      | 6      |
| $Z_{th(j-r)} I$ | 0,0027         | 0,0142 | 0,0151 | 0,0050 | 0,0055 | 0,0000 |
| $Z_{th(j-r)} D$ | 0,0022         | 0,0084 | 0,0259 | 0,0298 | 0,0189 | 0,0048 |
| $Z_{th(r-a)}$   | 0,0002         | 0,0016 | 0,0057 | 0,0046 | 0,0003 | 0,0000 |

|                 | $\tau [s]$ |        |        |        |        |        |
|-----------------|------------|--------|--------|--------|--------|--------|
|                 | 1          | 2      | 3      | 4      | 5      | 6      |
| $Z_{th(j-r)} I$ | 0,0007     | 0,0268 | 0,2165 | 1,0453 | 2,2456 | 1,0000 |
| $Z_{th(j-r)} D$ | 0,0013     | 0,0142 | 0,0676 | 0,4902 | 5,0713 | 14,977 |
| $Z_{th(r-a)}$   | 0,1382     | 1,4254 | 8,3077 | 20,093 | 189,77 | 1,0000 |

Fig. 8: Coefficients of thermal impedances

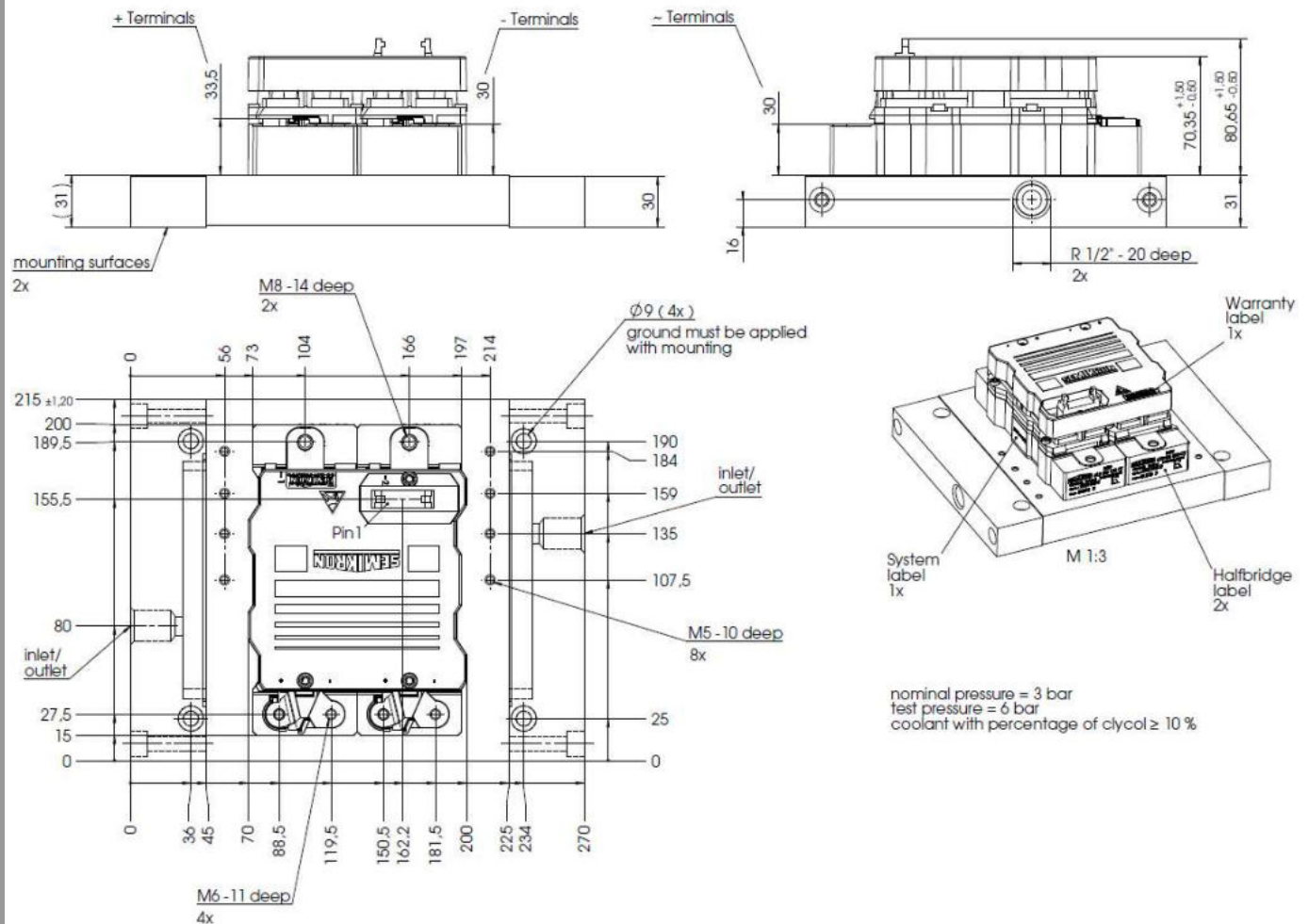

Fig. 9: Thermal resistance  $R_{th(r-a)}$  versus flow rate  $V$



Nennndruck/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 prestore  $\geq 10\%$

Heat sink



## 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.