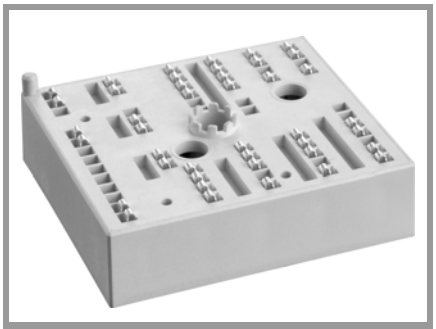


MiniSKiiP® 2

Converter-Inverter-Brake (CIB)

**SKiiP 23NAB12T4V1**

### Features*

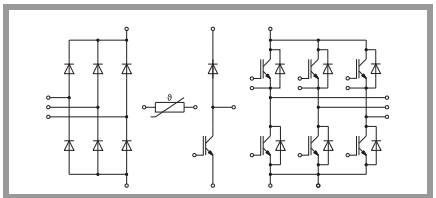
- Trench 4 IGBTs
- Robust and soft switching freewheeling diodes in CAL technology
- Highly reliable spring contacts for electrical connections
- UL recognized: File no. E63532

### Typical Applications

- Inverter up to 14 kVA
- Typical motor power 7,5 kW

### Remarks

- Max. case temperature limited to $T_C$=125°C
- Product reliability results valid for $T_j$≤150°C (recommended $T_{j,op}$=-40...+150°C)
- MiniSKiiP "Technical Explanations" and "Mounting Instructions" are part of the data sheet. Please refer to both documents for further information



NAB

| Absolute Maximum Ratings | | | | |
|---|---|---|---|---|
| **Symbol** | **Conditions** | | **Values** | **Unit** |
| **Inverter - IGBT** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 37 | A |
| | | $T_s$ = 70 °C | 30 | A |
| $I_C$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 41 | A |
| | | $T_s$ = 70 °C | 34 | A |
| $I_{Cnom}$ | | | 25 | A |
| $I_{CRM}$ | | | 75 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 800 V $V_{GE}$ ≤ 15 V $V_{CES}$ ≤ 1200 V | $T_j$ = 150 °C | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |
| **Chopper - IGBT** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 37 | A |
| | | $T_s$ = 70 °C | 30 | A |
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| | | $T_s$ = 70 °C | 34 | A |
| $I_{Cnom}$ | | | 25 | A |
| $I_{CRM}$ | | | 75 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
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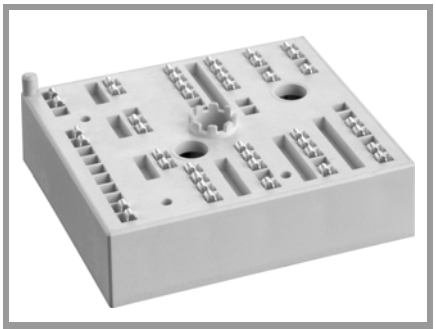
| $T_j$ | | | -40 ... 175 | °C |
| **Inverse - Diode** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 32 | A |
| | | $T_s$ = 70 °C | 26 | A |
| $I_F$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 35 | A |
| | | $T_s$ = 70 °C | 28 | A |
| $I_{FRM}$ | | | 75 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 150 °C | | 100 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Freewheeling - Diode** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 32 | A |
| | | $T_s$ = 70 °C | 26 | A |
| $I_F$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 35 | A |
| | | $T_s$ = 70 °C | 28 | A |
| $I_{FRM}$ | | | 75 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 150 °C | | 100 | A |
| $T_j$ | | | -40 ... 175 | °C |



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**SKiiP 23NAB12T4V1**

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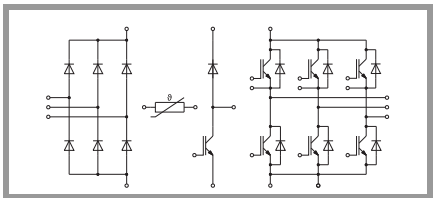

NAB

| Absolute Maximum Ratings | | | | |
|---|---|---|---|---|
| **Symbol** | **Conditions** | | **Values** | **Unit** |
| **Rectifier - Diode** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1600 | V |
| $I_F$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 150 °C | $T_s$ = 25 °C | 52 | A |
| | | $T_s$ = 70 °C | 39 | A |
| $I_F$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 150 °C | $T_s$ = 25 °C | 58 | A |
| | | $T_s$ = 70 °C | 44 | A |
| $I_{FSM}$ | $t_p$ = 10 ms sin 180° | $T_j$ = 25 °C | 370 | A |
| | | $T_j$ = 150 °C | 270 | A |
| $i^2t$ | $t_p$ = 10 ms sin 180° | $T_j$ = 25 °C | 685 | $A^2s$ |
| | | $T_j$ = 150 °C | 365 | $A^2s$ |
| $T_j$ | | | -40 ... 150 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | $T_{terminal}$ = 80 °C, 20 A per spring | | 40 | A |
| $T_{stg}$ | module without TIM | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50 Hz, 1 min | | 2500 | V |

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **Inverter - IGBT** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 25 A $V_{GE}$ = 15 V chiplevel | $T_j$ = 25 °C | | 1.85 | 2.10 | V |
| | | $T_j$ = 150 °C | | 2.25 | 2.45 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 0.80 | 0.90 | V |
| | | $T_j$ = 150 °C | | 0.70 | 0.80 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V chiplevel | $T_j$ = 25 °C | | 42 | 48 | mΩ |
| | | $T_j$ = 150 °C | | 62 | 66 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 1 mA | | 5.3 | 5.8 | 6.3 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 1 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V $V_{GE}$ = 0 V | f = 1 MHz | | 1.45 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 0.12 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.05 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 142 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 0 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 600 V $I_C$ = 25 A $R_{G\ on}$ = 24 Ω $R_{G\ off}$ = 24 Ω | $T_j$ = 150 °C | | 28 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 40 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 2.65 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 295 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 68 | | ns |
| $E_{off}$ | $V_{GE}$ = +15/-15 V | $T_j$ = 150 °C | | 2.3 | | mJ |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=0.8 W/(mK) | | | 1.2 | | K/W |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=2.5 W/(mK) | | | 1 | | K/W |

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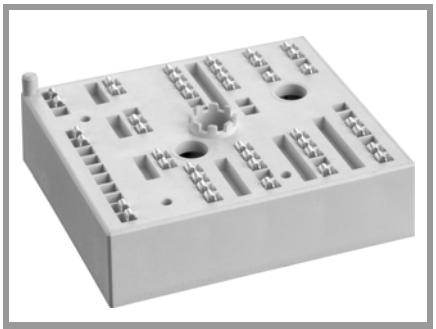

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**SKiiP 23NAB12T4V1**

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- Typical motor power 7,5 kW

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- Max. case temperature limited to $T_C$=125°C
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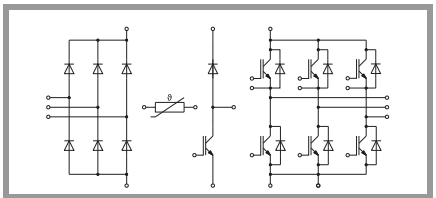
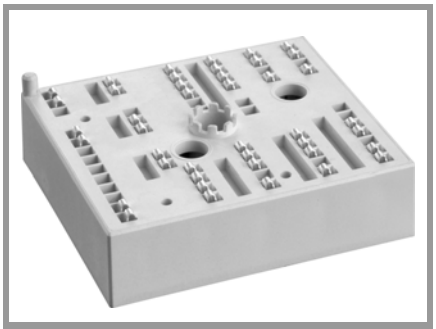


NAB

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **Chopper - IGBT** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 25 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 1.85 | 2.10 | V |
| | | $T_j$ = 150 °C | | 2.25 | 2.45 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 0.80 | 0.90 | V |
| | | $T_j$ = 150 °C | | 0.70 | 0.80 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 42 | 48 | mΩ |
| | | $T_j$ = 150 °C | | 62 | 66 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 1 mA | | 5.3 | 5.8 | 6.3 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 1 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 1.45 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 0.12 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.05 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 142 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 0 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 600 V<br>$I_C$ = 25 A<br>$R_{G\ on}$ = 24 Ω<br>$R_{G\ off}$ = 24 Ω | $T_j$ = 150 °C | | 28 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 40 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 2.65 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 295 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 68 | | ns |
| $E_{off}$ | $V_{GE}$ = +15/-15 V | $T_j$ = 150 °C | | 2.3 | | mJ |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=0.8 W/(mK) | | | 1.2 | | K/W |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=2.5 W/(mK) | | | 1 | | K/W |
| **Inverse - Diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 25 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.41 | 2.74 | V |
| | | $T_j$ = 150 °C | | 2.45 | 2.79 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.30 | 1.50 | V |
| | | $T_j$ = 150 °C | | 0.90 | 1.10 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 44 | 50 | mΩ |
| | | $T_j$ = 150 °C | | 62 | 68 | mΩ |
| $I_{RRM}$ | $I_F$ = 25 A<br>$di/dt_{off}$ = 850 A/µs<br>$V_{GE}$ = -15 V<br>$V_{CC}$ = 600 V | $T_j$ = 150 °C | | 24 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 3.7 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 1.6 | | mJ |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=0.8 W/(mK) | | | 1.52 | | K/W |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=2.5 W/(mK) | | | 1.29 | | K/W |
| **Freewheeling - Diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 25 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.41 | 2.74 | V |
| | | $T_j$ = 150 °C | | 2.45 | 2.79 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.30 | 1.50 | V |
| | | $T_j$ = 150 °C | | 0.90 | 1.10 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 44 | 50 | mΩ |
| | | $T_j$ = 150 °C | | 62 | 68 | mΩ |
| $I_{RRM}$ | $I_F$ = 25 A<br>$di/dt_{off}$ = 850 A/µs<br>$V_{GE}$ = -15 V<br>$V_{CC}$ = 600 V | $T_j$ = 150 °C | | 24 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 3.7 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 1.6 | | mJ |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=0.8 W/(mK) | | | 1.52 | | K/W |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=2.5 W/(mK) | | | 1.29 | | K/W |



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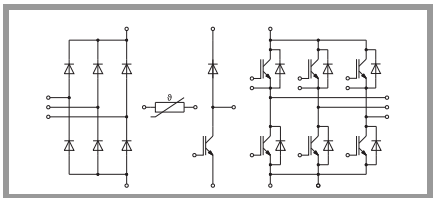

NAB

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **Rectifier - Diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 13 A chiplevel | $T_j$ = 25 °C | | 1.00 | 1.21 | V |
| | | $T_j$ = 125 °C | | 0.90 | 1.10 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 0.88 | 0.98 | V |
| | | $T_j$ = 125 °C | | 0.73 | 0.83 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 9.2 | 18 | mΩ |
| | | $T_j$ = 125 °C | | 13 | 21 | mΩ |
| $I_R$ | $T_j$ = 145 °C, $V_{RRM}$ | | | | 1.1 | mA |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=0.8 W/(mK) | | | 1.25 | | K/W |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=2.5 W/(mK) | | | 1.06 | | K/W |
| **Module** | | | | | | |
| $M_s$ | to heat sink | | 2 | | 2.5 | Nm |
| w | | | | 55 | | g |
| $L_{CE}$ | | | | - | | nH |
| **Temperature Sensor** | | | | | | |
| $R_{100}$ | $T_r$=100°C ($R_{25}$=1000Ω) | | | 1670 ± 3% | | Ω |
| $R_{(T)}$ | $R_{(T)}$=1000Ω[1+A(T-25°C)+B(T-25°C)$^2$], A = 7.635*10$^{-3}$°C$^{-1}$, B = 1.731*10$^{-5}$°C$^{-2}$ | | | | | |

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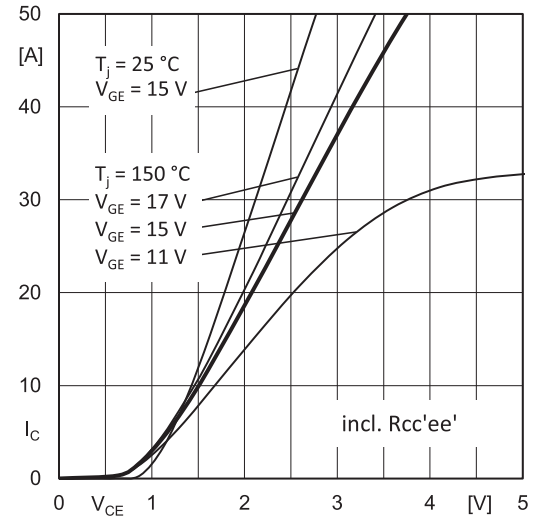


Fig. 1: Typ. output characteristic

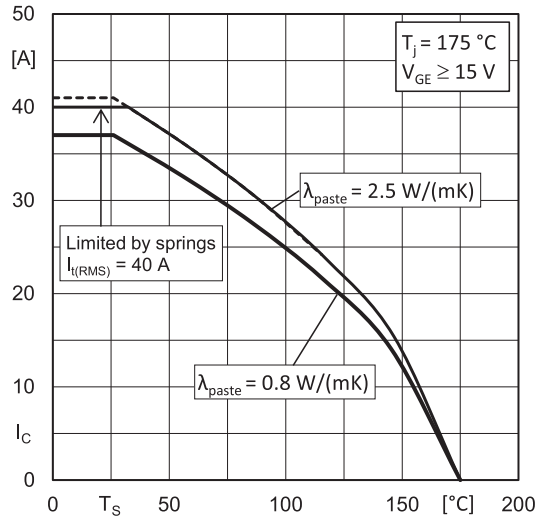


Fig. 2: Typ. rated current vs. temperature $I_C = f(T_S)$

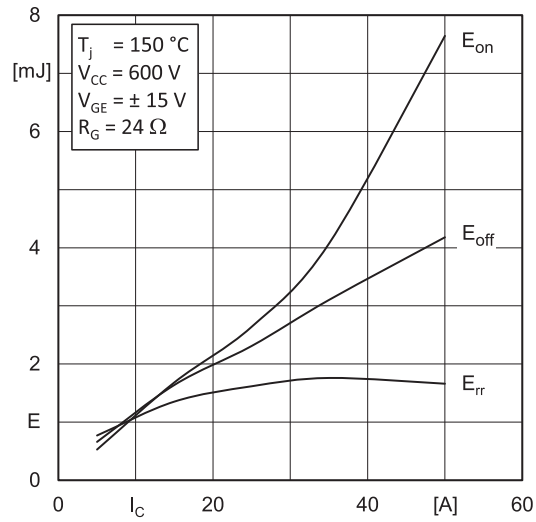


Fig. 3: Typ. turn-on /-off energy = f ($I_C$)

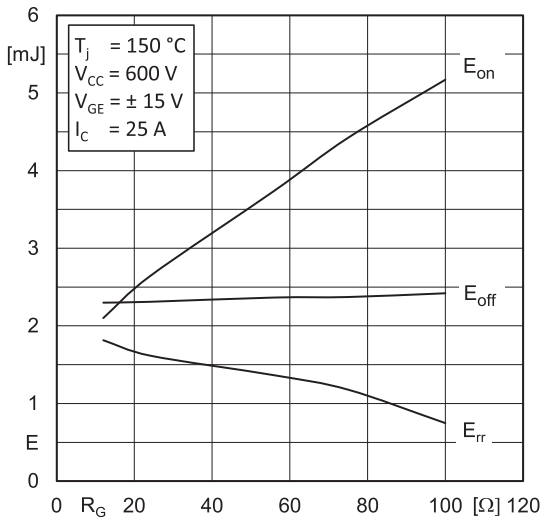


Fig. 4: Typ. turn-on /-off energy = f ($R_G$)

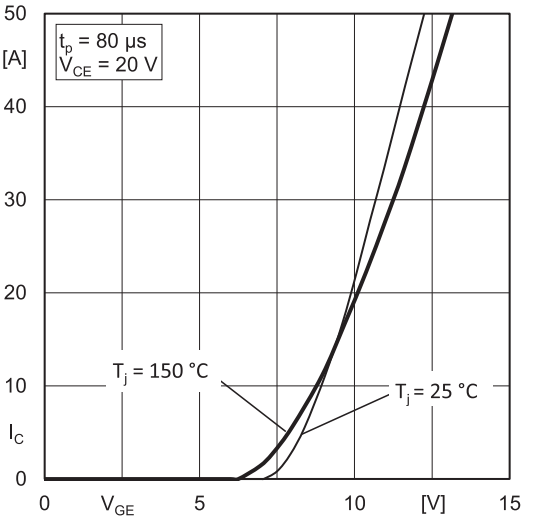


Fig. 5: Typ. transfer characteristic

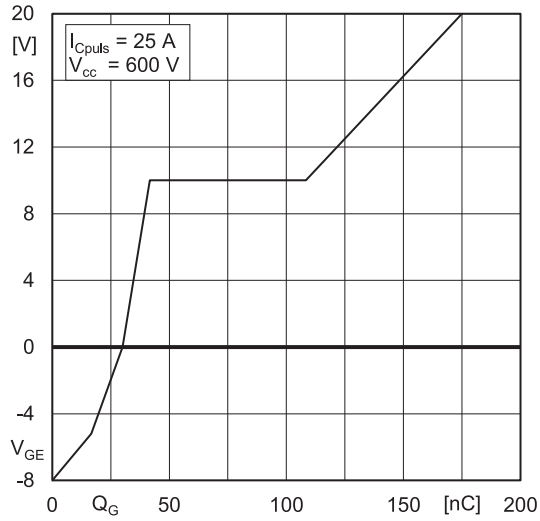


Fig. 6: Typ. gate charge characteristic

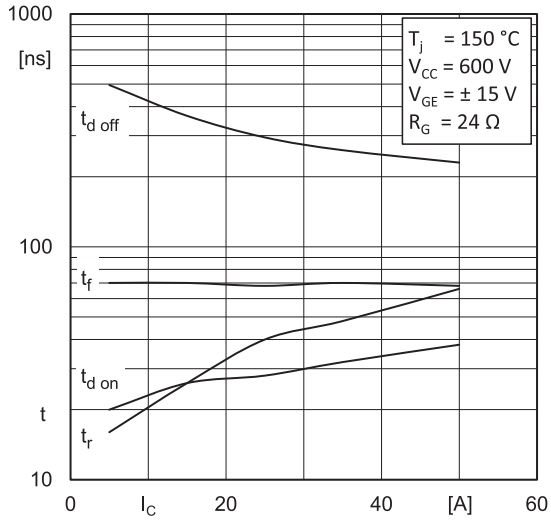


Fig. 7: Typ. switching times vs. $I_C$

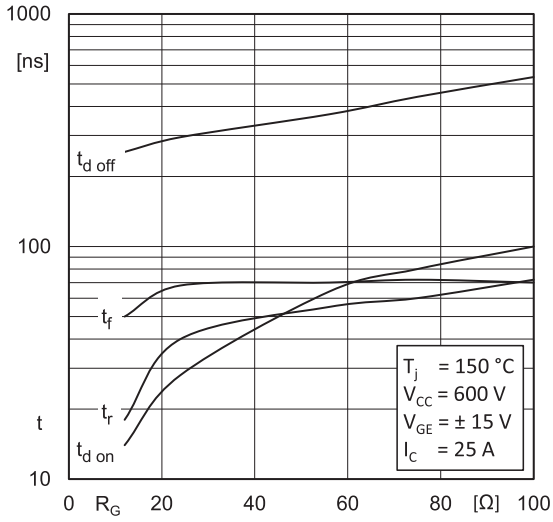


Fig. 8: Typ. switching times vs. gate resistor $R_G$

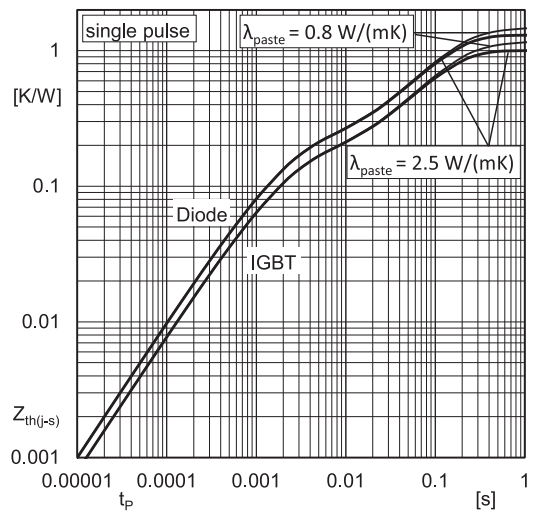


Fig. 9: Typ. transient thermal impedance

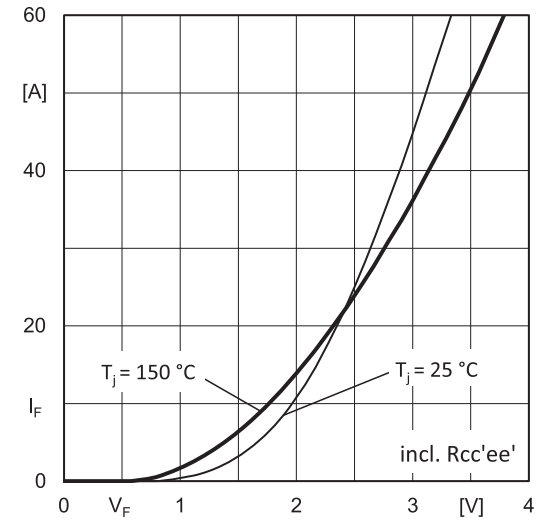


Fig. 10: Typ. CAL diode forward characteristic

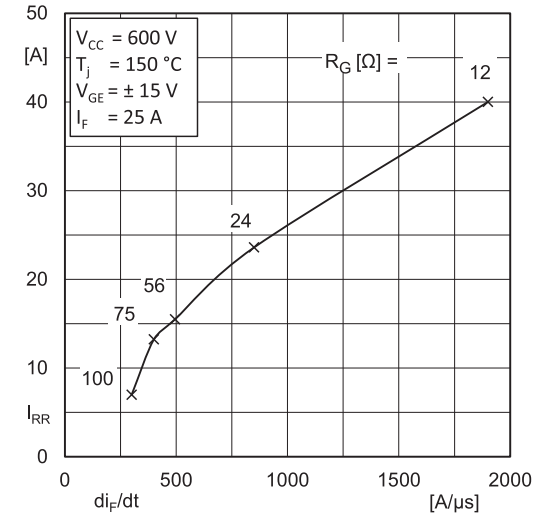


Fig. 11: Typ. CAL diode peak reverse recovery current

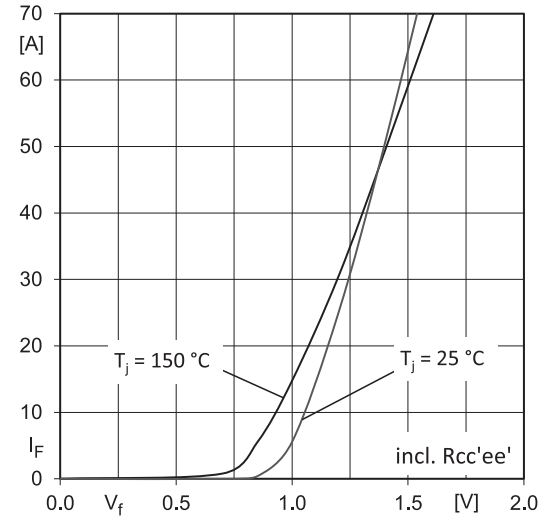


Fig. 12: Typ. input bridge forward characteristic

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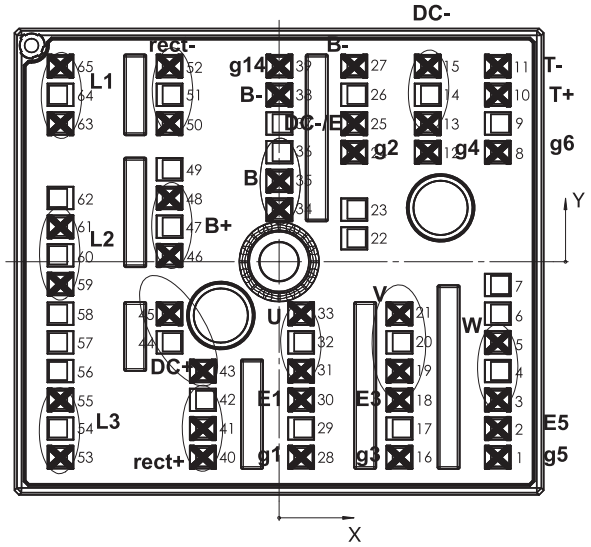
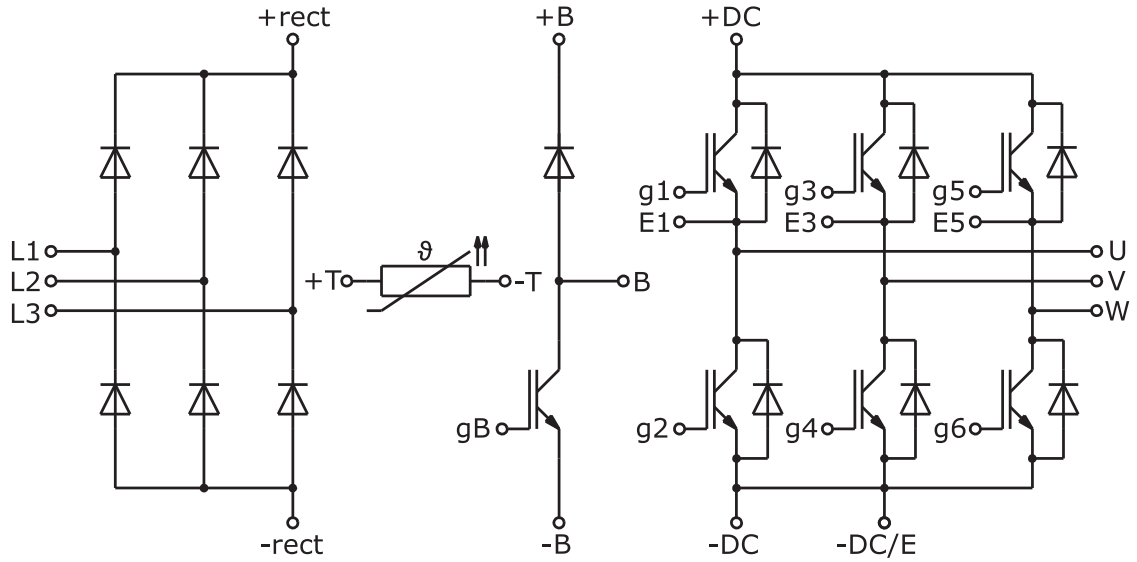
| Pin out | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pin* | *X* | *Y* | *Function* | *Pin* | *X* | *Y* | *Function* | *Pin* | *X* | *Y* | *Function* |
| 1 | 24,38 | -21,80 | g5 | 23 | 8,38 | 5,80 | | 45 | -12,23 | -5,80 | DC+ |
| 2 | 24,38 | -18,60 | E5 | 24 | 8,38 | 12,20 | g2 | 46 | -12,23 | 0,70 | B+ |
| 3 | 24,38 | -15,40 | W | 25 | 8,38 | 15,40 | DC-/E | 47 | -12,23 | 3,90 | |
| 4 | 24,38 | -12,20 | | 26 | 8,38 | 18,60 | | 48 | -12,23 | 7,10 | B+ |
| 5 | 24,38 | -9,00 | W | 27 | 8,38 | 21,80 | B- | 49 | -12,23 | 10,30 | |
| 6 | 24,38 | -5,80 | | 28 | 2,46 | -21,80 | g1 | 50 | -12,23 | 15,40 | rect- |
| 7 | 24,38 | -2,60 | | 29 | 2,46 | -18,60 | | 51 | -12,23 | 18,60 | |
| 8 | 24,38 | 12,20 | g6 | 30 | 2,46 | -15,40 | E1 | 52 | -12,23 | 21,80 | rect- |
| 9 | 24,38 | 15,40 | | 31 | 2,46 | -12,20 | U | 53 | -24,38 | -21,80 | L3 |
| 10 | 24,38 | 18,60 | T+ | 32 | 2,46 | -9,00 | | 54 | -24,38 | -18,60 | |
| 11 | 24,38 | 21,80 | T- | 33 | 2,46 | -5,80 | U | 55 | -24,38 | -15,40 | L3 |
| 12 | 16,58 | 12,20 | g4 | 34 | 0,03 | 5,80 | B | 56 | -24,38 | -12,20 | |
| 13 | 16,58 | 15,40 | DC- | 35 | 0,03 | 9,00 | B | 57 | -24,38 | -9,00 | |
| 14 | 16,58 | 18,60 | | 36 | 0,03 | 12,20 | | 58 | -24,38 | -5,80 | |
| 15 | 16,58 | 21,80 | DC- | 37 | 0,03 | 15,40 | | 59 | -24,38 | -2,50 | L2 |
| 16 | 13,42 | -21,80 | g3 | 38 | 0,03 | 18,60 | B- | 60 | -24,38 | 0,70 | |
| 17 | 13,42 | -18,60 | | 39 | 0,03 | 21,80 | g14 | 61 | -24,38 | 3,90 | L2 |
| 18 | 13,42 | -15,40 | E3 | 40 | -8,51 | -21,80 | rect+ | 62 | -24,38 | 7,10 | |
| 19 | 13,42 | -12,20 | V | 41 | -8,51 | -18,60 | rect+ | 63 | -24,38 | 15,40 | L1 |
| 20 | 13,42 | -9,00 | | 42 | -8,51 | -15,40 | | 64 | -24,38 | 18,60 | |
| 21 | 13,42 | -5,80 | V | 43 | -8,51 | -12,20 | DC+ | 65 | -24,38 | 21,80 | L1 |
| 22 | 8,38 | 2,60 | | 44 | -12,23 | -9,00 | | | | | |

all values in mm




Pinout and Dimensions




Pinout

This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

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