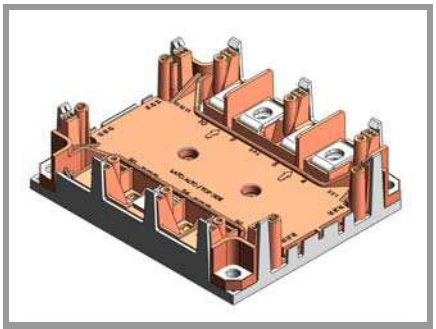
# SKiM301TMLI12E4B



SKiM® 4

## Trench IGBT Modules

**SKiM301TMLI12E4B**

### Features

- IGBT 4 Trench Gate Technology
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- Low inductance case
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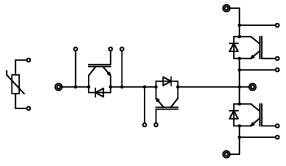


TMLI

**Absolute Maximum Ratings**

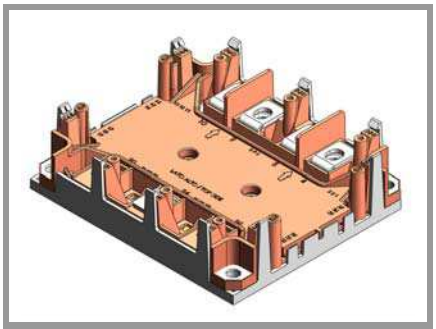
| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT 1** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $T_j$ = 150 °C | $T_s$ = 25 °C | 279 | A |
| | | $T_s$ = 70 °C | 213 | A |
| $I_C$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 311 | A |
| | | $T_s$ = 70 °C | 252 | A |
| $I_{Cnom}$ | | | 300 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3 x $I_{Cnom}$ | | 900 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 800 V<br>$V_{GE} \leq$ 15 V<br>$V_{CES} \leq$ 1200 V | $T_j$ = 150 °C | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |

**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT 2** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 650 | V |
| $I_C$ | $T_j$ = 150 °C | $T_s$ = 25 °C | 221 | A |
| | | $T_s$ = 70 °C | 164 | A |
| $I_C$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 248 | A |
| | | $T_s$ = 70 °C | 197 | A |
| $I_{Cnom}$ | | | 300 | A |
| $I_{CRM}$ | $I_{CRM}$ = 2 x $I_{Cnom}$ | | 600 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 360 V<br>$V_{GE} \leq$ 15 V<br>$V_{CES} \leq$ 650 V | $T_j$ = 150 °C | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |

**Absolute Maximum Ratings**

| Symbol | Conditions | Values | Unit |
|---|---|---|---|
| **Module** | | | |
| $I_{t(RMS)}$ | $T_{terminal}$ = 80 °C, | 400 | A |
| $T_{stg}$ | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50 Hz, t = 1 min | 2500 | V |



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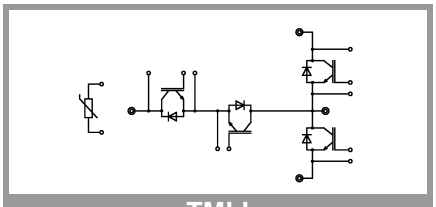
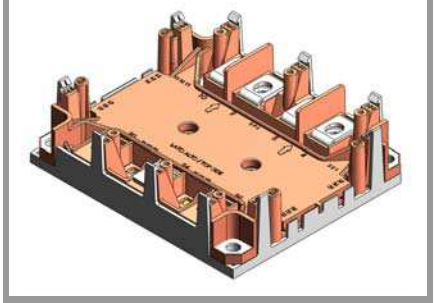


TMLI

| Absolute Maximum Ratings | | | | |
|---|---|---|---|---|
| **Symbol** | **Conditions** | | **Values** | **Unit** |
| **Diode 1** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 249 | A |
| | | $T_s$ = 70 °C | 196 | A |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 249 | A |
| | | $T_s$ = 70 °C | 196 | A |
| $I_{Fnom}$ | | | 300 | A |
| $I_{FRM}$ | $I_{FRM} = 3 \times I_{Fnom}$ | | 900 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 150 °C | | 1485 | A |
| $T_j$ | | | -40 ... 175 | °C |

| Absolute Maximum Ratings | | | | |
|---|---|---|---|---|
| **Symbol** | **Conditions** | | **Values** | **Unit** |
| **Diode 2** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 650 | V |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 266 | A |
| | | $T_s$ = 70 °C | 205 | A |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 266 | A |
| | | $T_s$ = 70 °C | 205 | A |
| $I_{Fnom}$ | | | 300 | A |
| $I_{FRM}$ | $I_{FRM} = 2xI_{Fnom}$ | | 600 | A |
| $I_{FSM}$ | 10 ms sin 180° | $T_j$ = 25 °C | 2160 | A |
| | | $T_j$ = 150 °C | 1980 | A |
| $T_j$ | | | -40 ... 175 | °C |



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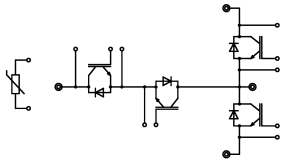

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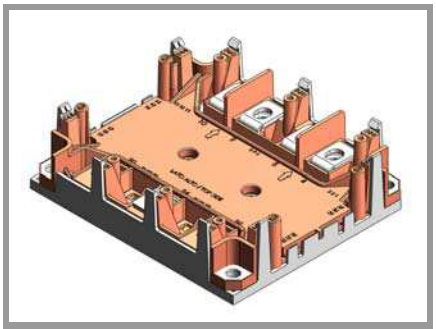
**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT 1** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 300 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 1.80 | 2.05 | V |
| | | $T_j$ = 150 °C | | 2.20 | 2.40 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 0.8 | 0.9 | V |
| | | $T_j$ = 150 °C | | 0.7 | 0.8 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 3.3 | 3.8 | mΩ |
| | | $T_j$ = 150 °C | | 5.0 | 5.3 | mΩ |
| $V_{GE(th)}$ | $V_{GE} = V_{CE}$ V, $I_C$ = 11.4 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V<br>$V_{CE}$ = 1200 V | $T_j$ = 25 °C | | | | mA |
| | | | | | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 18.45 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 1.215 | | nF |
| $C_{res}$ | | f = 1 MHz | | 1.035 | | nF |
| $Q_G$ | - 8 V...+ 15 V | | | 1695 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 2.50 | | Ω |
| $t_{d(on)}$ | $V_{CE}$ = 300 V<br>$I_C$ = 300 A<br>$R_{G\,on}$ = 2.7 Ω<br>$R_{G\,off}$ = 2.7 Ω<br>$di/dt_{on}$ = 5626 A/µs<br>$di/dt_{off}$ = 2636 A/µs<br>$V_{GE\,neg}$ = -15 V<br>$V_{GE\,pos}$ = 15 V | $T_j$ = 150 °C | | 217.9 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 69.43 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 6.62 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 355.5 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 91.3 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 19.37 | | mJ |
| $R_{th(j-s)}$ | per IGBT | | | 0.19 | | K/W |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT 2** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 300 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 1.55 | 1.95 | V |
| | | $T_j$ = 150 °C | | 1.75 | 2.2 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 0.9 | 1 | V |
| | | $T_j$ = 150 °C | | 0.82 | 0.9 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 2.2 | 3.2 | mΩ |
| | | $T_j$ = 150 °C | | 3.1 | 4.3 | mΩ |
| $V_{GE(th)}$ | $V_{GE} = V_{CE}$ V, $I_C$ = 8 mA | | 5.1 | 5.8 | 6.4 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V<br>$V_{CE}$ = 650 V | $T_j$ = 25 °C | | | | mA |
| | | $T_j$ = 150 °C | | | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 18.48 | | nF |
| $C_{oes}$ | | f = 1 MHz | | | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.548 | | nF |
| $Q_G$ | - 8 V...+ 15 V | | | | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 1.00 | | Ω |
| $t_{d(on)}$ | $V_{CE}$ = 300 V<br>$I_C$ = 300 A<br>$R_{G\,on}$ = 2.7 Ω<br>$R_{G\,off}$ = 2.7 Ω<br>$di/dt_{on}$ = 5566 A/µs<br>$di/dt_{off}$ = 1353 A/µs<br>$V_{GE\,neg}$ = -15 V<br>$V_{GE\,pos}$ = 15 V | $T_j$ = 150 °C | | 149.14 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 79.71 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 2.78 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 420 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 180 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 17.48 | | mJ |
| $R_{th(j-s)}$ | per IGBT | | | 0.3 | | K/W |



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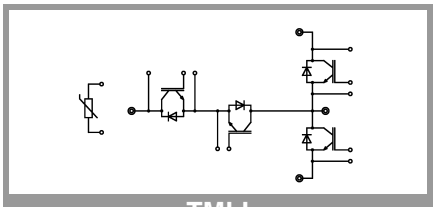


TMLI

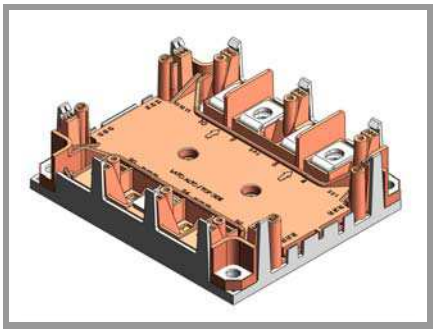
**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Diode 1** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 300 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 2.20 | 2.52 | V |
| | | $T_j$ = 150 °C | | 2.15 | 2.47 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | 1.1 | 1.3 | 1.5 | V |
| | | $T_j$ = 150 °C | 0.7 | 0.9 | 1.1 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | 2.7 | 3.0 | 3.4 | mΩ |
| | | $T_j$ = 150 °C | 3.5 | 4.2 | 4.6 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A | | | 132.43 | | A |
| $Q_{rr}$ | | | | 21.47 | | µC |
| $E_{rr}$ | $V_R$ = 300 V | | | 1.79 | | mJ |
| $R_{th(j-s)}$ | per DIODE | | | 0.29 | | K/W |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Diode 2** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 300 A | $T_j$ = 25 °C | | 1.4 | 1.80 | V |
| | chiplevel | $T_j$ = 150 °C | | 1.39 | 1.77 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | 0.95 | 1.04 | 1.236 | V |
| | | $T_j$ = 150 °C | | 0.85 | 0.99 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | 0.8 | 1.2 | 1.8 | mΩ |
| | | $T_j$ = 150 °C | | 1.8 | 2.6 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A | | | 126.64 | | A |
| $Q_{rr}$ | | | | 23.84 | | µC |
| $E_{rr}$ | $V_R$ = 300 V | | | 1.7 | | mJ |
| $R_{th(j-s)}$ | per DIODE | | | 0.35 | | K/W |



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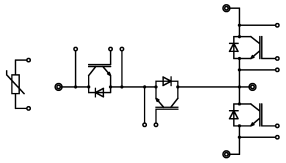


TMLI

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Module** | | | | | | |
| $L_{CE}$ | | | | 18 | | nH |
| $R_{CC'+EE'}$ | terminal-chip | $T_s$ = 25 °C | | 1.35 | | mΩ |
| | | $T_s$ = 125 °C | | 1.75 | | mΩ |
| $R_{th(c-s)}$ | per module | | | | | K/W |
| $M_s$ | to heat sink (M5) | | 2 | | 3 | Nm |
| $M_t$ | | to terminals M6 | 4 | | 5 | Nm |
| | | | | | | Nm |
| w | | | | 317 | | g |

**Characteristics**

| Symbol | Conditions | min. | typ. | max. | Unit |
|---|---|---|---|---|---|
| **Temperature Sensor** | | | | | |
| $R_{100}$ | $T_r$ = 100 °C, tolerance = 3 % | | 493 ± 5% | | Ω |
| $B_{100/125}$ | $R_{(T)}=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]$; T[K]; | | 3550 ±2% | | K |

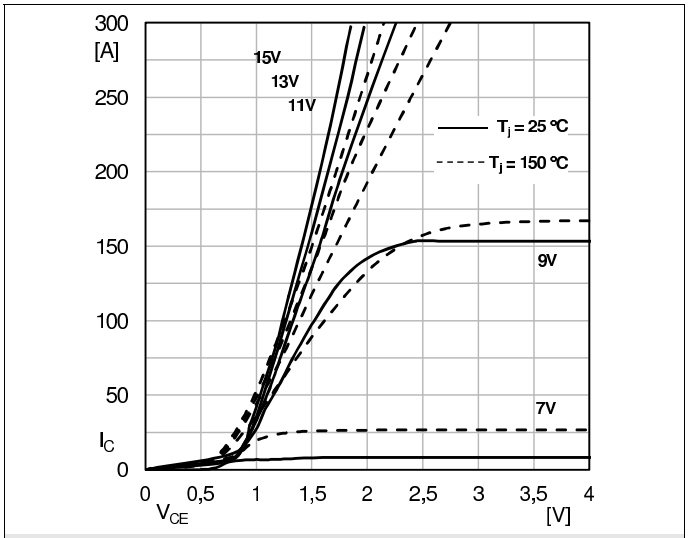



Fig. 1: Typ. output characteristic, inclusive $R_{CC'+EE'}$

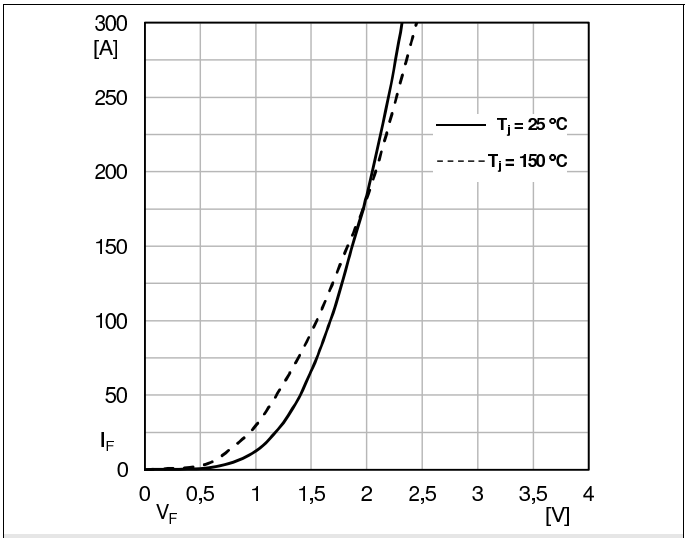



Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

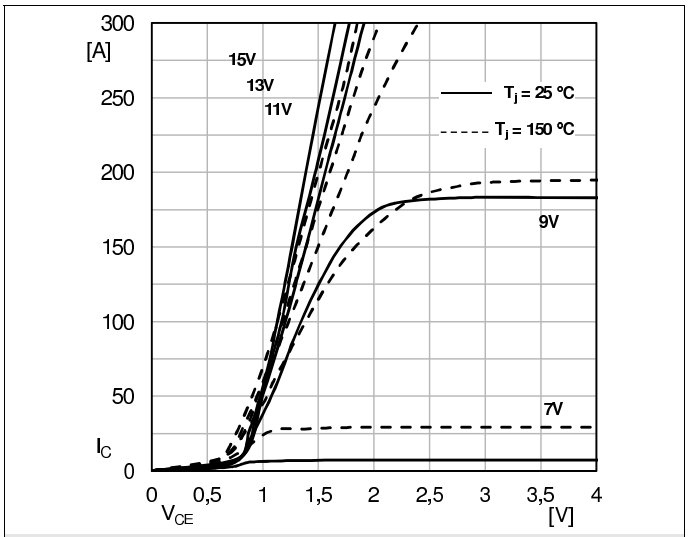



Fig. 3: Typ. turn-on /-off energy = f ($I_C$)

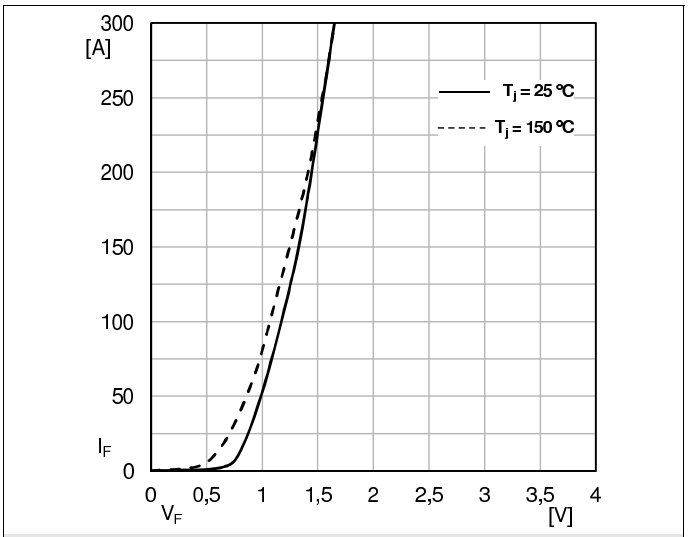



Fig. 4: Typ. turn-on /-off energy = f ($R_G$)

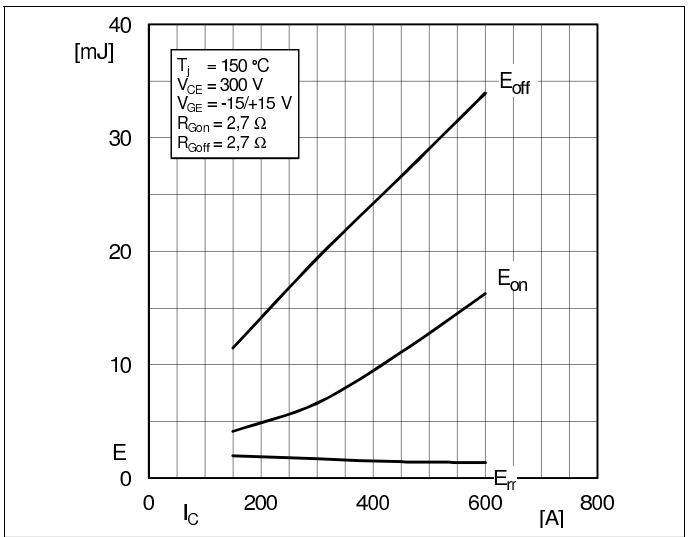



Fig. 5: Typ. transfer characteristic

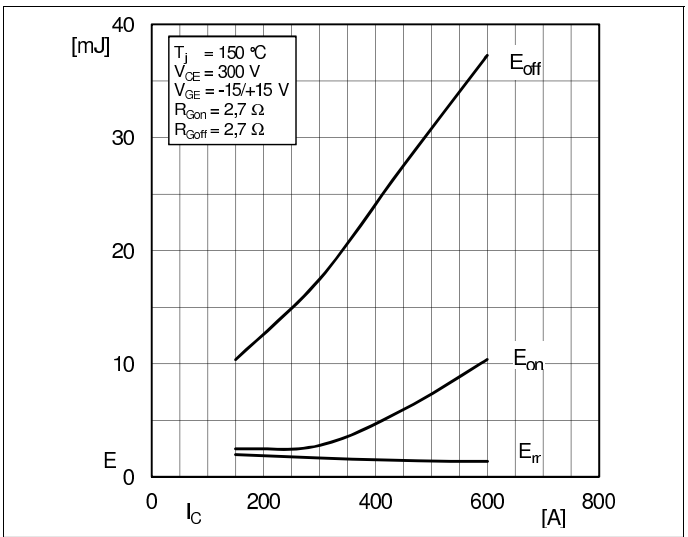



Fig. 6: Typ. gate charge characteristic

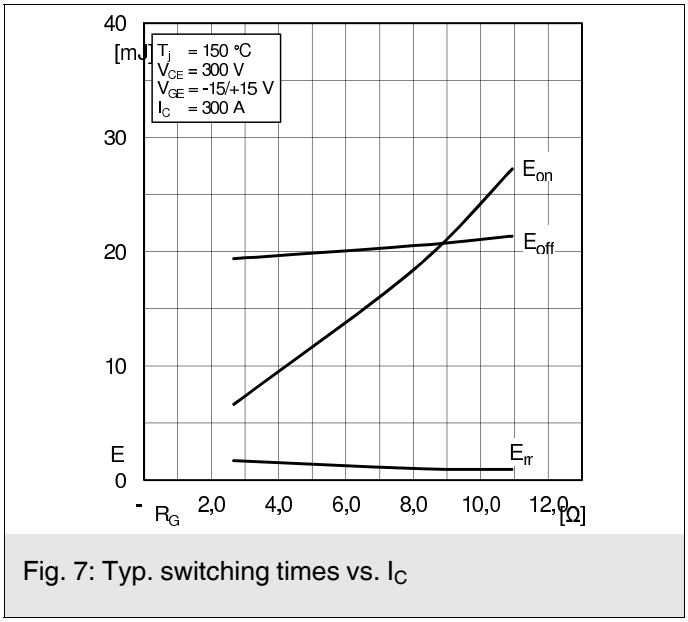



Fig. 7: Typ. switching times vs. $I_C$

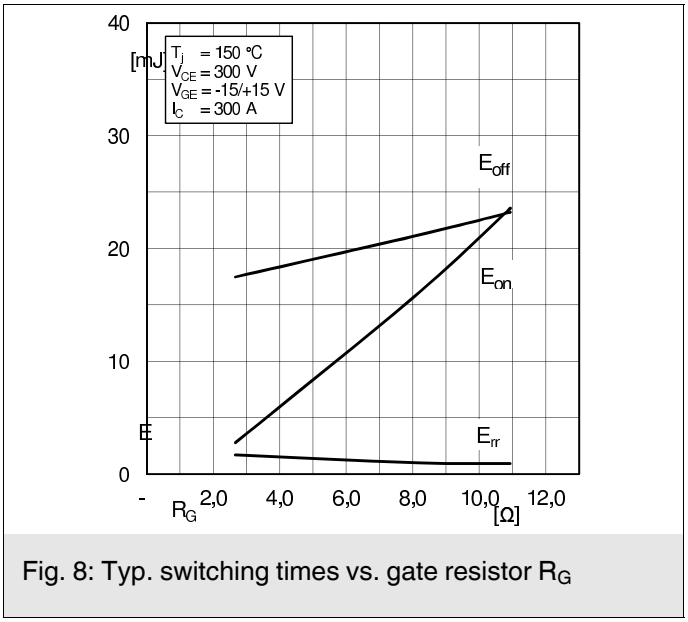



Fig. 8: Typ. switching times vs. gate resistor $R_G$

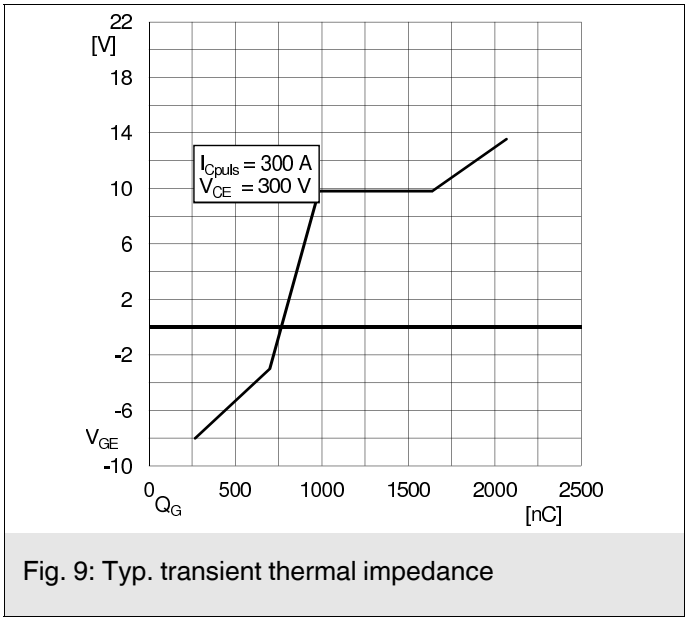



Fig. 9: Typ. transient thermal impedance

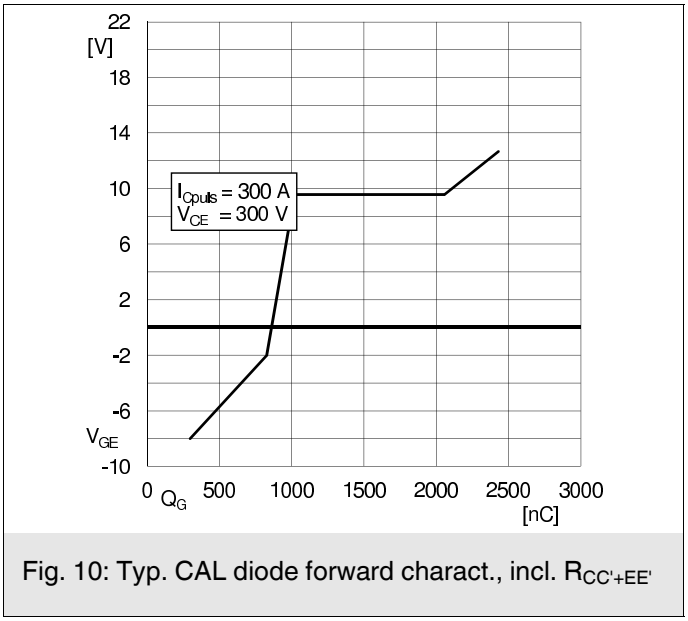



Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

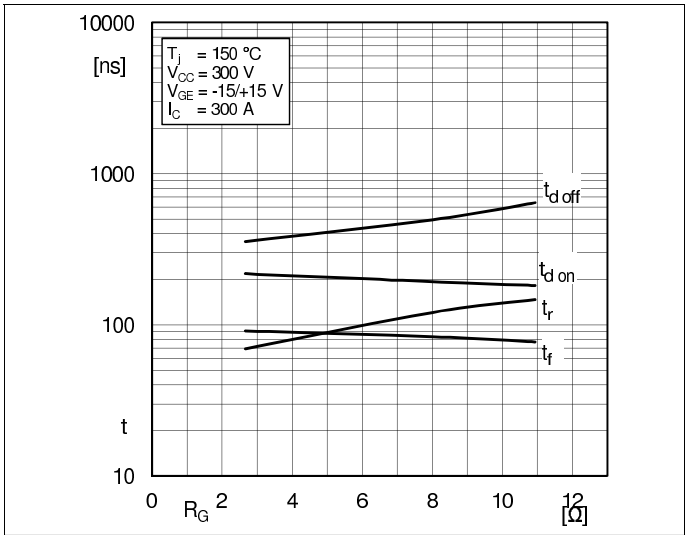



Fig. 11: Typ. diodes transient thermal impedance

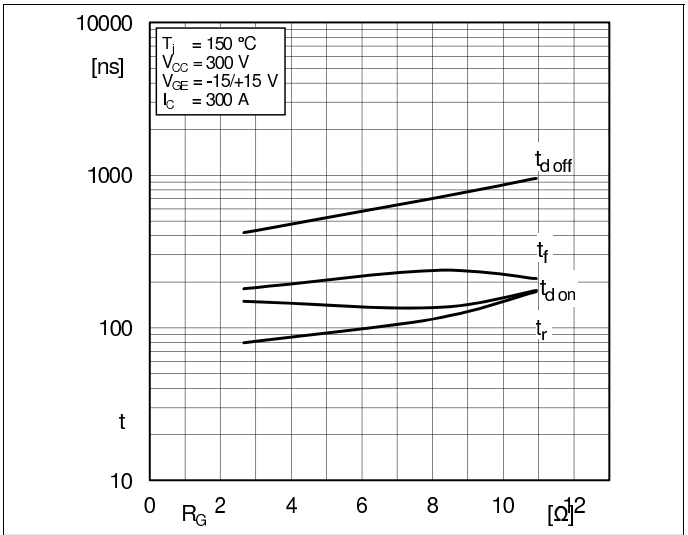
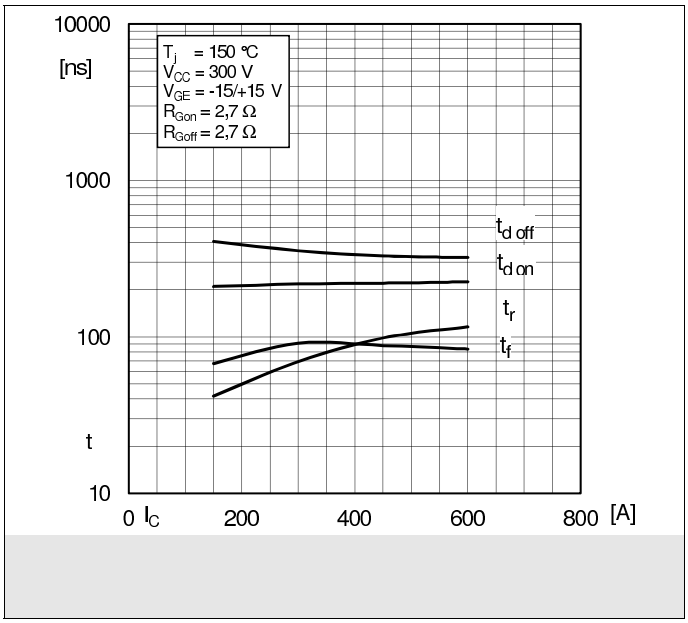
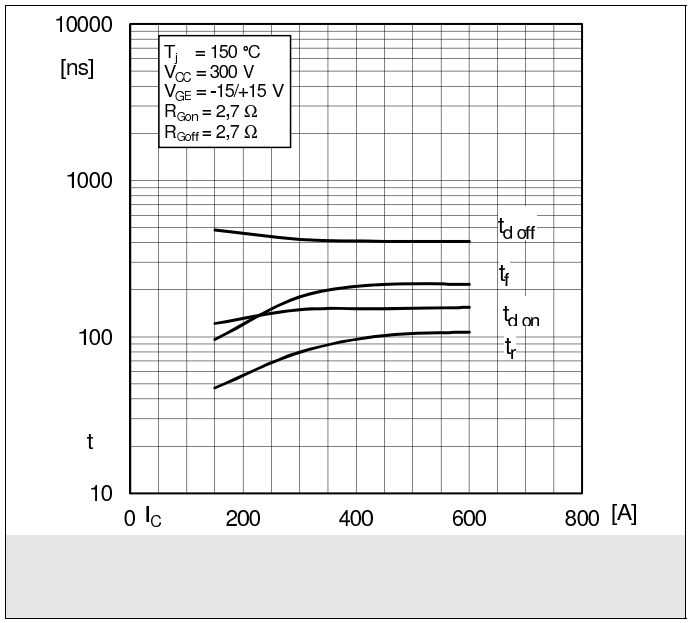
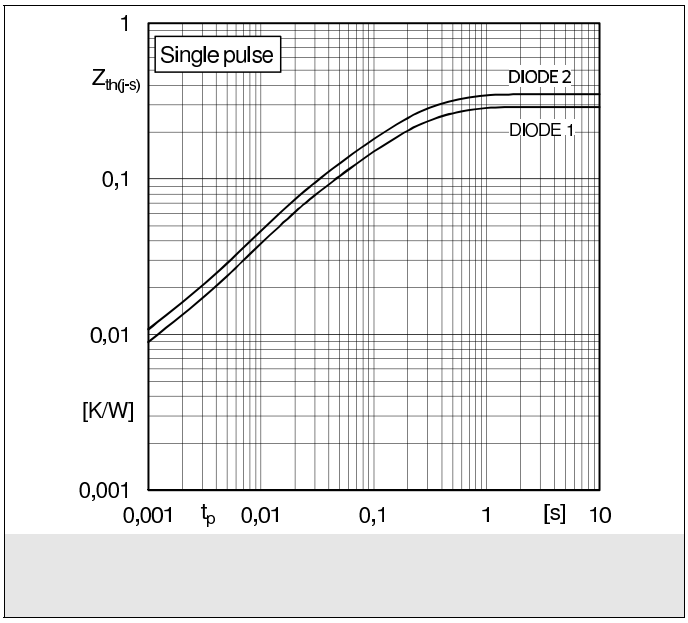
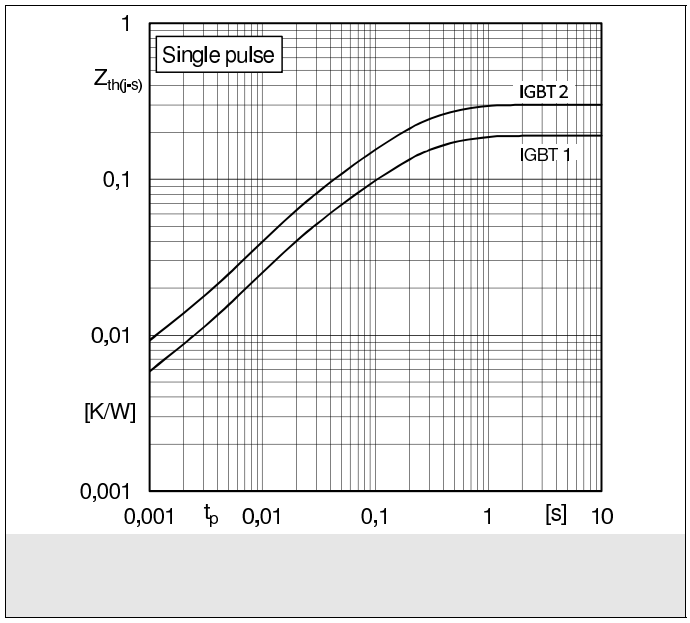



Fig. 12: Typ. IGBTs transient thermal impedance

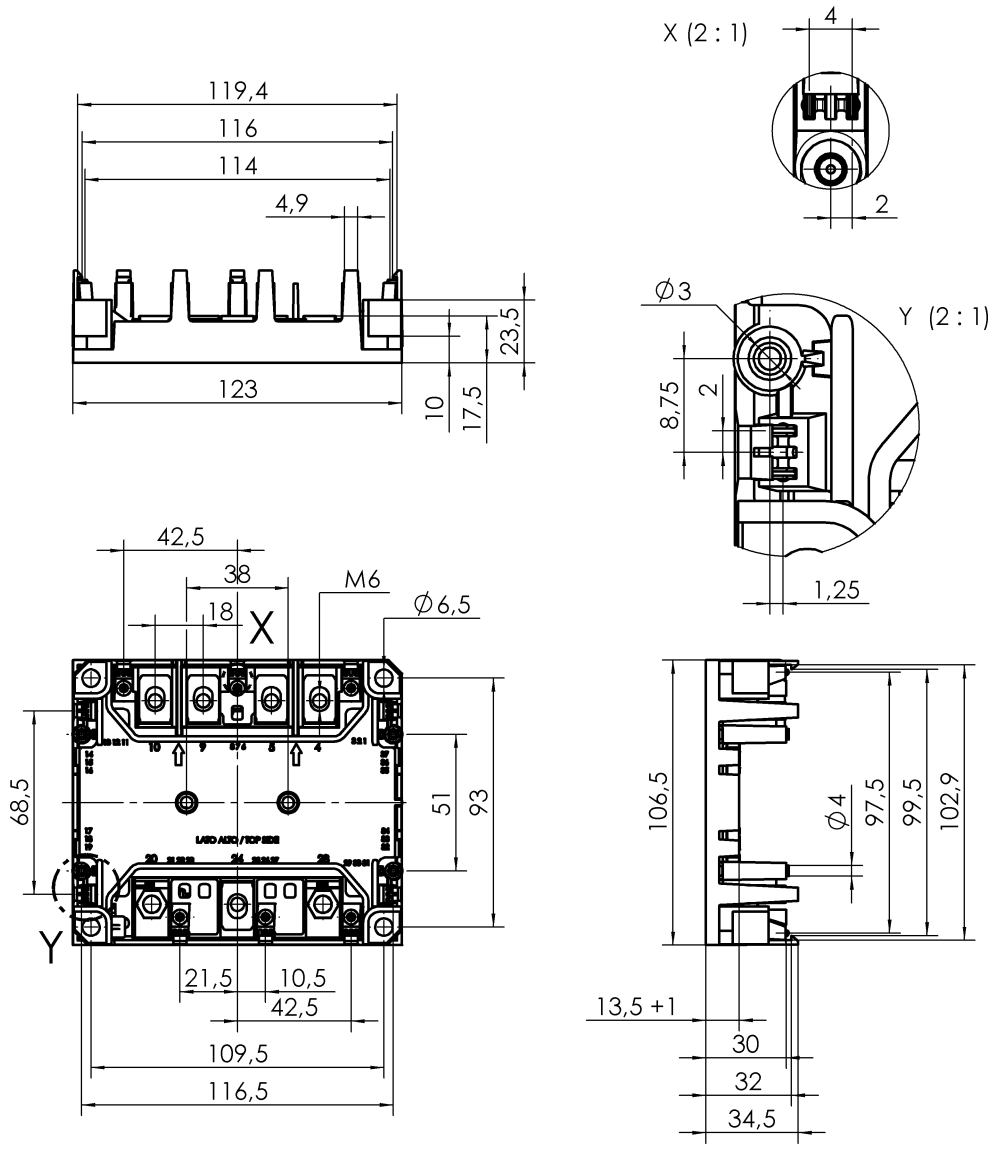

10000
[ns]
1000
100
t
10
$T_j$ = 150 °C
$V_{CC}$ = 300 V
$V_{GE}$ = -15/+15 V
$R_{Gon}$ = 2,7 Ω
$R_{Goff}$ = 2,7 Ω
$t_{d\,off}$
$t_{d\,on}$
$t_r$
$t_f$
0 $I_C$
200
400
600
800
[A]

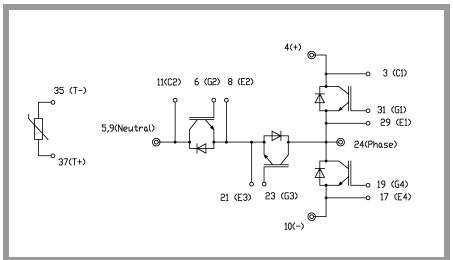

10000
[ns]
1000
100
t
10
$T_j$ = 150 °C
$V_{CC}$ = 300 V
$V_{GE}$ = -15/+15 V
$R_{Gon}$ = 2,7 Ω
$R_{Goff}$ = 2,7 Ω
$t_{d\,off}$
$t_f$
$t_{d\,on}$
$t_r$
0 $I_C$
200
400
600
800
[A]


1
$Z_{th(j-s)}$
0,1
0,01
[K/W]
0,001
Single pulse
DIODE 2
DIODE 1
0,001
$t_p$
0,01
0,1
1
[s]
10


1
$Z_{th(j-s)}$
0,1
0,01
[K/W]
0,001
Single pulse
IGBT 2
IGBT 1
0,001
$t_p$
0,01
0,1
1
[s]
10




**TMLI**

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.