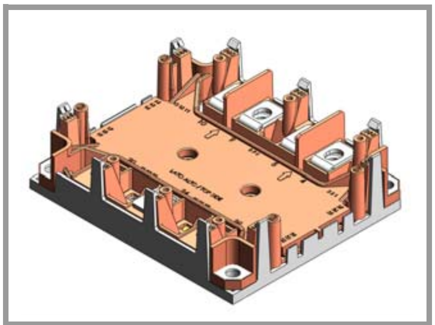


SKiM® 4

Trench IGBT Modules

**SKiM601TMLI12E4B**

### Features

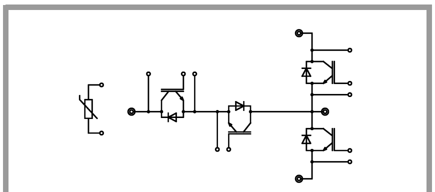
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c$ = $T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



TMLI

**Absolute Maximum Ratings**

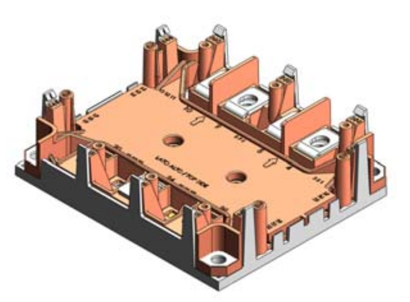
| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT 1** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $T_j$ = 150 °C | $T_s$ = 25 °C | 473 | A |
| | | $T_s$ = 70 °C | 358 | A |
| $I_C$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 529 | A |
| | | $T_s$ = 70 °C | 425 | A |
| $I_{Cnom}$ | | | 600 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3 x $I_{Cnom}$ | | 1800 | 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 | 389 | A |
| | | $T_s$ = 70 °C | 285 | A |
| $I_C$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 440 | A |
| | | $T_s$ = 70 °C | 345 | A |
| $I_{Cnom}$ | | | 600 | A |
| $I_{CRM}$ | $I_{CRM}$ = 2 x $I_{Cnom}$ | | 1200 | 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 |



**SKiM® 4**

## Trench IGBT Modules

**SKiM601TMLI12E4B**

### Features

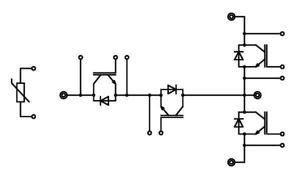
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c$ = $T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



TMLI

**Absolute Maximum Ratings**

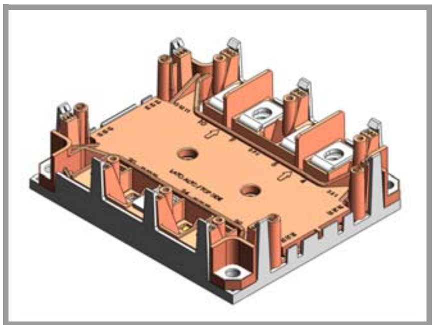
| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **Diode 1** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 150 °C | $T_s$ = 25 °C | 438 | A |
| | | $T_s$ = 70 °C | 322 | A |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 495 | A |
| | | $T_s$ = 70 °C | 389 | A |
| $I_{Fnom}$ | | | 600 | A |
| $I_{FRM}$ | $I_{FRM}$ = 3 x $I_{Fnom}$ | | 1800 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 150 °C | | 3240 | A |
| $T_j$ | | | -40 ... 175 | °C |

**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **Diode 2** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 650 | V |
| $I_F$ | $T_j$ = 150 °C | $T_s$ = 25 °C | 462 | A |
| | | $T_s$ = 70 °C | 330 | A |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 527 | A |
| | | $T_s$ = 70 °C | 406 | A |
| $I_{Fnom}$ | | | 600 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 1200 | A |
| $I_{FSM}$ | 10 ms sin 180° | $T_j$ = 25 °C | 3969 | A |
| | | $T_j$ = 150 °C | 3483 | A |
| $T_j$ | | | -40 ... 175 | °C |


© by SEMIKRON

# SKiM601TMLI12E4B



SKiM® 4

## Trench IGBT Modules

**SKiM601TMLI12E4B**

### Features

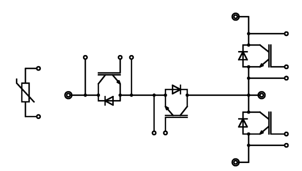
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c$ = $T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



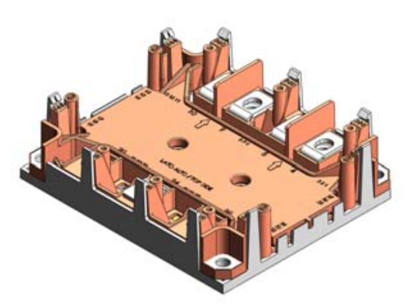
TMLI

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT 1** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 600 A, $V_{GE}$ = 15 V, 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, chiplevel | $T_j$ = 25 °C | | 1.7 | 1.9 | mΩ |
| | | $T_j$ = 150 °C | | 2.5 | 2.7 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$ V, $I_C$ = 24 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V | $T_j$ = 25 °C | | 0.8 | 2.4 | mA |
| | | | | | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | f = 1 MHz | | 37.2 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 2.32 | | nF |
| $C_{res}$ | | f = 1 MHz | | 2.04 | | nF |
| $Q_G$ | - 8 V...+ 15 V | | | 3750 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 1.3 | | Ω |
| $t_{d(on)}$ | $V_{CE}$ = 300 V, $I_C$ = 600 A, $R_{G\,on}$ = 2 Ω, $R_{G\,off}$ = 2 Ω, $di/dt_{on}$ = 2584 A/µs, $di/dt_{off}$ = 2673 A/µs, $V_{GE\,neg}$ = -15 V, $V_{GE\,pos}$ = 15 V | $T_j$ = 150 °C | | 261 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 231 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 11.44 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 585 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 182 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 44.88 | | mJ |
| $R_{th(j-s)}$ | per IGBT | | | 0.125 | | K/W |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT 2** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 600 A, $V_{GE}$ = 15 V, chiplevel | $T_j$ = 25 °C | | 1.55 | 1.95 | V |
| | | $T_j$ = 150 °C | | 1.75 | 2.1 | 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, chiplevel | $T_j$ = 25 °C | | 1.1 | 1.6 | mΩ |
| | | $T_j$ = 150 °C | | 1.6 | 2 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$ V, $I_C$ = 12 mA | | 5.1 | 5.8 | 6.4 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V | $T_j$ = 25 °C | | 0.45 | 1.35 | mA |
| | | $T_j$ = 150 °C | | | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | f = 1 MHz | | 37.005 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 2.307 | | nF |
| $C_{res}$ | | f = 1 MHz | | 1.098 | | nF |
| $Q_G$ | - 8 V...+ 15 V | | | 5002.2 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 0.7 | | Ω |
| $t_{d(on)}$ | $V_{CE}$ = 300 V, $I_C$ = 600 A, $R_{G\,on}$ = 2 Ω, $R_{G\,off}$ = 2 Ω, $di/dt_{on}$ = 2648 A/µs, $di/dt_{off}$ = 3097 A/µs, $V_{GE\,neg}$ = -15 V, $V_{GE\,pos}$ = 15 V | $T_j$ = 150 °C | | 121 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 232 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 6.05 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 599 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 156 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 44 | | mJ |
| $R_{th(j-s)}$ | | | | 0.19 | | K/W |



SKiM® 4

Trench IGBT Modules

**SKiM601TMLI12E4B**

### Features

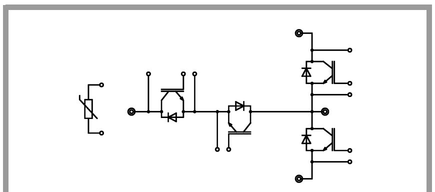
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c = T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



TMLI

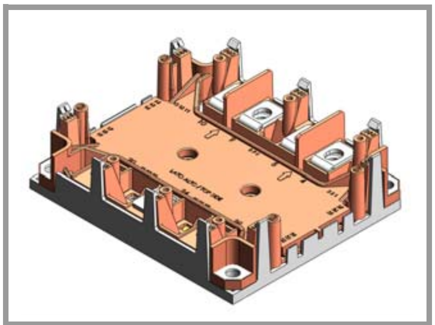
**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Diode 1** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 600 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 2.14 | 2.46 | V |
| | | $T_j$ = 150 °C | | 2.07 | 2.38 | 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 | 1.1 | 1.4 | 1.6 | mΩ |
| | | $T_j$ = 150 °C | 1.8 | 2 | 2.1 | mΩ |
| $I_{RRM}$ | $I_F$ = 600 A | | | 251 | | A |
| $Q_{rr}$ | | | | 21.9 | | µC |
| $E_{rr}$ | $V_R$ = 300 V | | | 4.37 | | mJ |
| $R_{th(j-s)}$ | per DIODE | | | 0.15 | | K/W |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Diode 2** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 600 A<br>chiplevel | $T_j$ = 25 °C | | 1.39 | 1.80 | V |
| | | $T_j$ = 150 °C | | 1.38 | 1.76 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | 0.95 | 1 | 1.2 | V |
| | | $T_j$ = 150 °C | | 0.9 | 1 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | 0.4 | 0.6 | 0.9 | mΩ |
| | | $T_j$ = 150 °C | | 0.9 | 1.3 | mΩ |
| $I_{RRM}$ | $I_F$ = 600 A | | | 247 | | A |
| $Q_{rr}$ | | | | 25.2 | | µC |
| $E_{rr}$ | $V_R$ = 300 V | | | 2.64 | | mJ |
| $R_{th(j-s)}$ | per DIODE | | | 0.18 | | K/W |

 © by SEMIKRON



SKiM® 4

| 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 |
| $M_s$ | 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 |

## Trench IGBT Modules

**SKiM601TMLI12E4B**

### Features

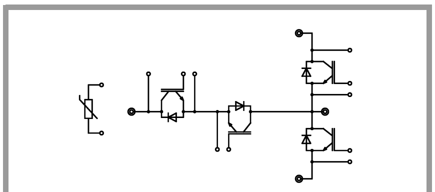
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c$ = $T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



TMLI

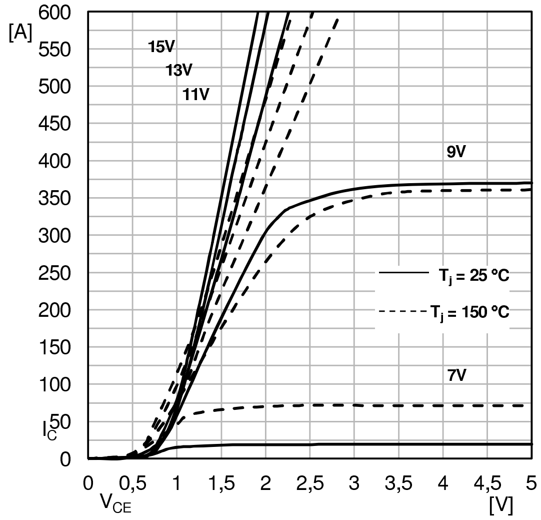



Fig. 1: Typ. IGBT 1 output characteristic, incl. $R_{CC'+ EE'}$

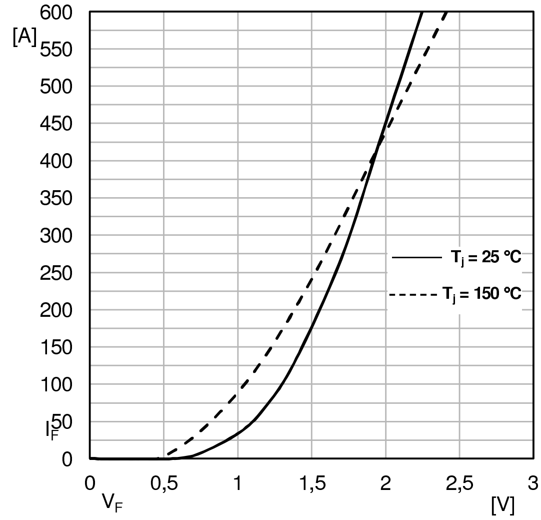



Fig. 2: Typ. Diode 1 output characteristics

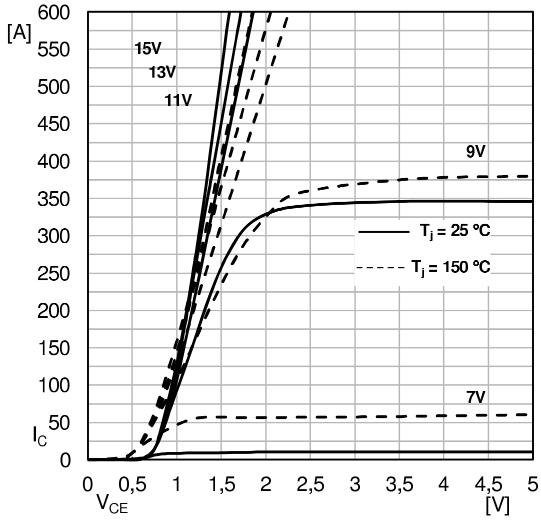



Fig. 3: Typ. IGBT 2 output characteristic, inclusive $R_{CC'+ EE'}$

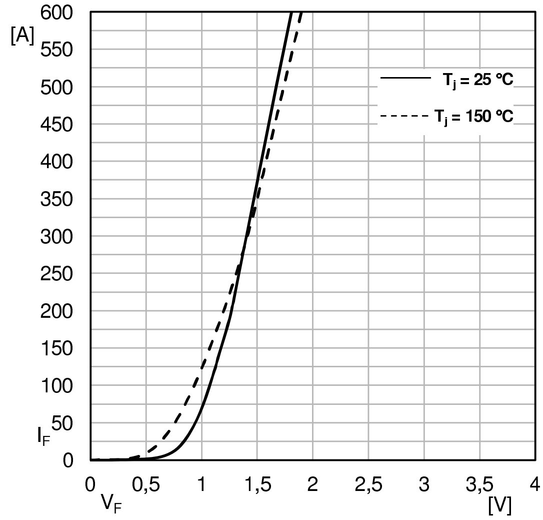



Fig.4: Typ. Diode 2 output characteristic

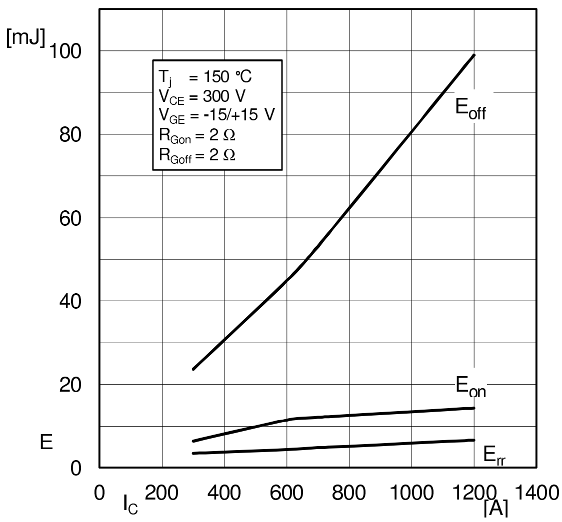



Fig. 5: Typ. IGBT 1 and Diode 2 turn-on /-off energy = f ($I_C$)

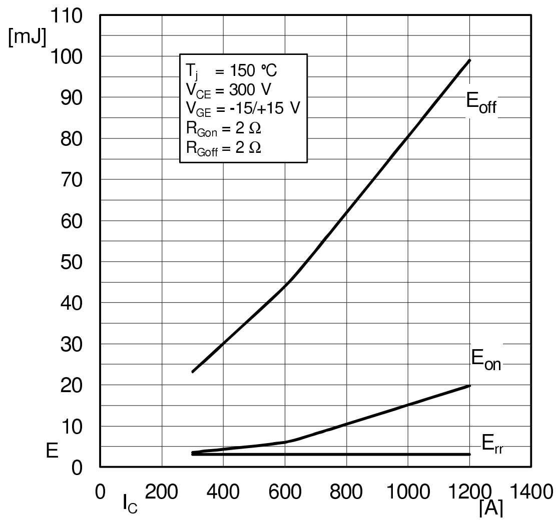



Fig. 6: Typ. IGBT 2 and Diode 1 turn-on /-off energy = f ($I_C$)

 © by SEMIKRON

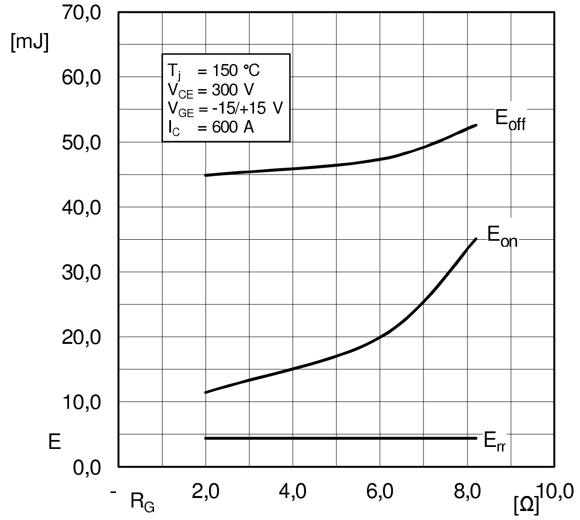



Fig. 7: Typ. IGBT 1 and Diode 2 turn-on /-off energy = f ($R_G$)

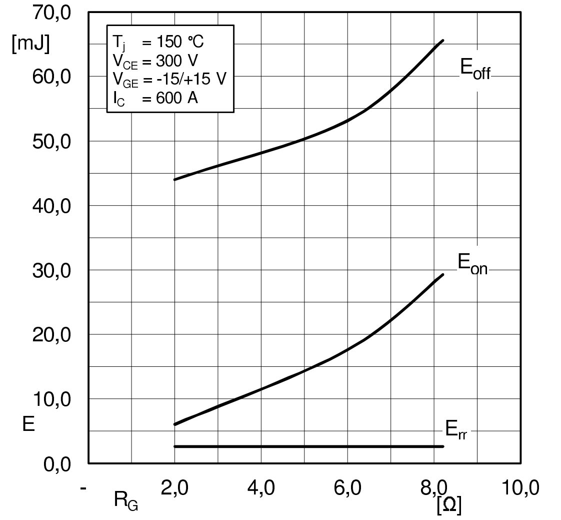



Fig. 8: Typ. IGBT 2 and Diode 1 turn-on /-off energy = f ($R_G$)

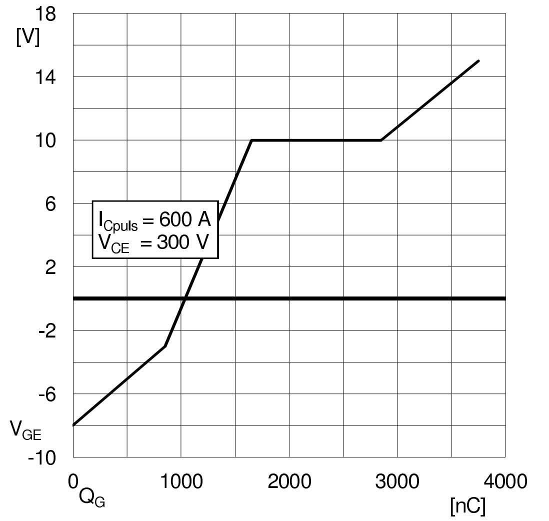



Fig. 9: Typ. IGBT 1 gate charge characteristic

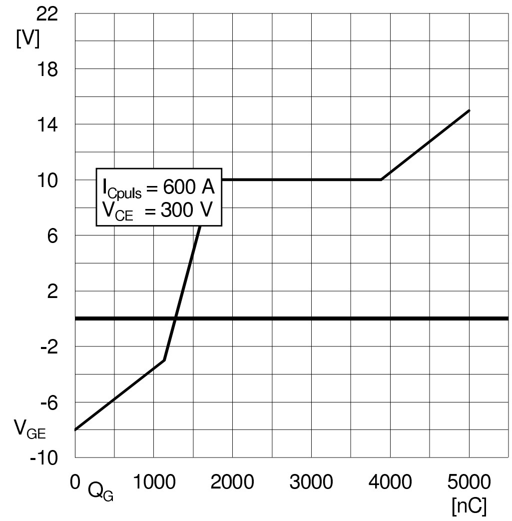



Fig. 10: Typ. IGBT 2 gate charge characteristic

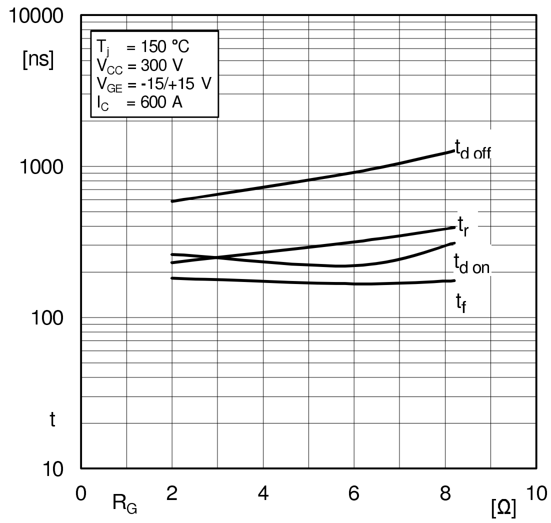



Fig. 11: Typ. IGBT 1 switching times vs. gate resistor $R_G$

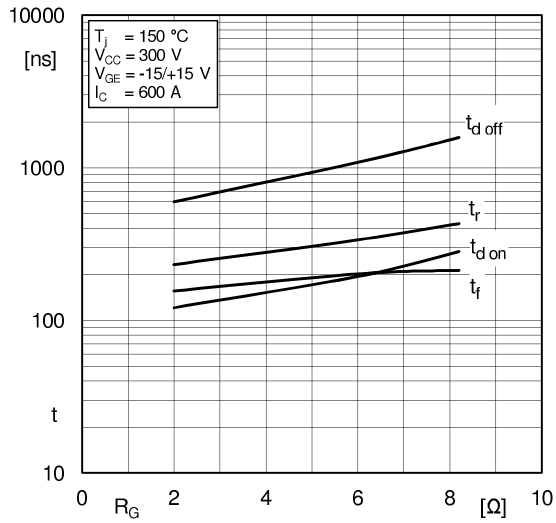



Fig. 12: Typ. IGBT 2 switching times vs. gate resistor $R_G$

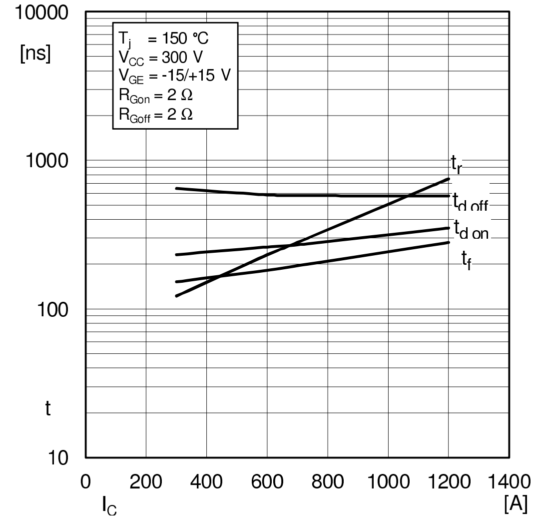



Fig. 13: Typ. IGBT 1 switching times vs. $I_C$

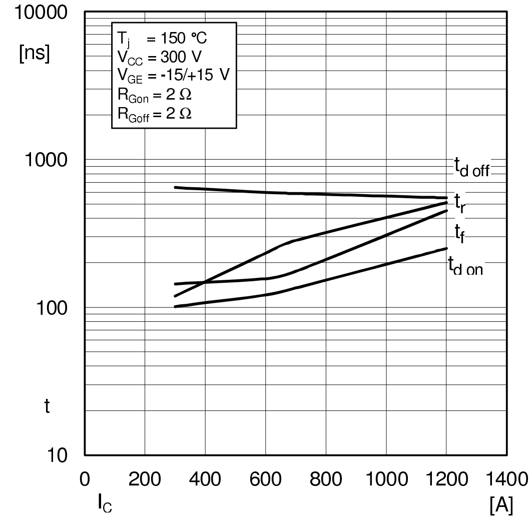



Fig. 14: Typ. IGBT 2 switching times vs. $I_C$

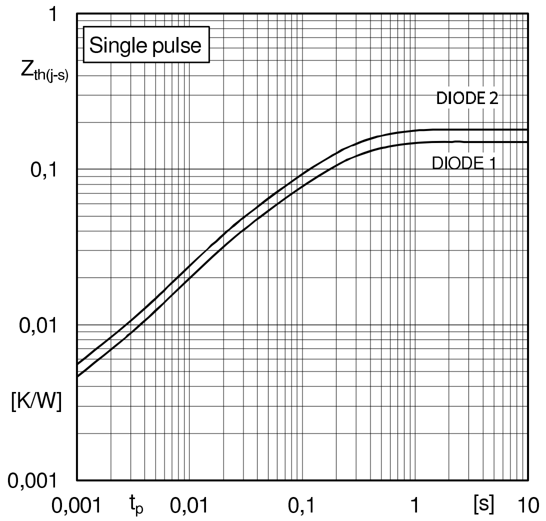



Fig.15: Typ. DIODEs transient thermal impedance

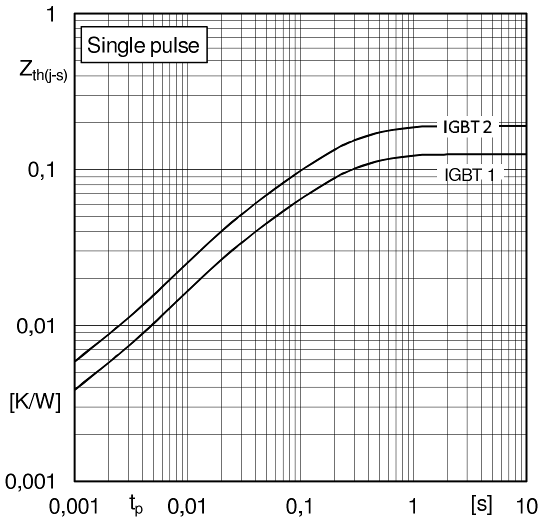
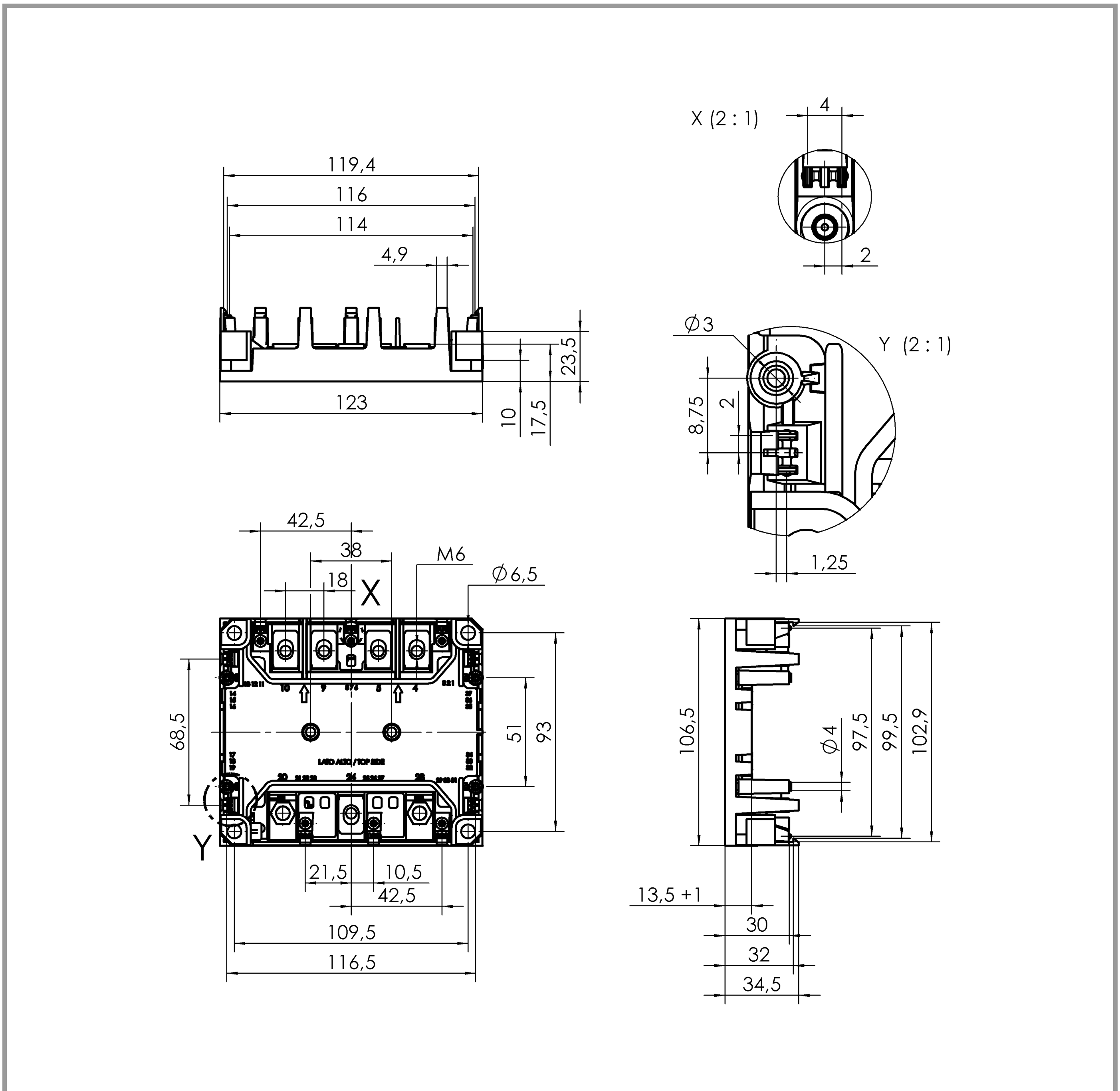
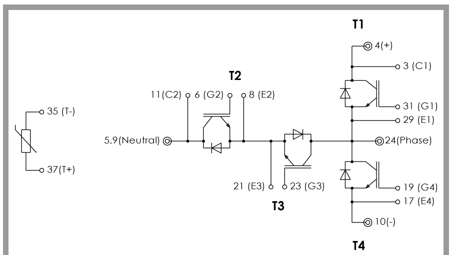



Fig. 16: Typ. IGBTs transient thermal impedance


© by SEMIKRON




**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.