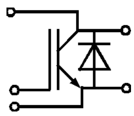
| Absolute Maximum Ratings | | | |
|---|---|---|---|
| Symbol | Conditions [1] | Values | Units |
| $V_{CES}$ | | 1200 | V |
| $V_{CGR}$ | $R_{GE}$ = 20 kΩ | 1200 | V |
| $I_C$ | $T_{case}$ = 25/85 °C | 600 / 400 | A |
| $I_{CM}$ | $T_{case}$ = 25/85 °C; $t_p$ = 1 ms | 1200 / 800 | A |
| $V_{GES}$ | | ± 20 | V |
| $P_{tot}$ | per IGBT, $T_{case}$ = 25 °C | 2750 | W |
| $T_j$, ($T_{stg}$) | | –40 ... +150 (125) | °C |
| $V_{isol}$ | AC, 1 min. | 2500 | V |
| humidity | DIN 40040 | Class F | |
| climate | DIN IEC 68 T.1 | 40/125/56 | |
| Inverse Diode | | | |
| $I_F = –I_C$ | $T_{case}$ = 25/80 °C | 390 / 260 | A |
| $I_{FM} = –I_{CM}$ | $T_{case}$ = 25/80 °C; $t_p$ = 1 ms | 1200 / 800 | A |
| $I_{FSM}$ | $t_p$ = 10 ms; sin.; $T_j$ = 150 °C | 2900 | A |
| $I^2t$ | $t_p$ = 10 ms; $T_j$ = 150 °C | 42000 | $A^2s$ |

| Characteristics | | | | | |
|---|---|---|---|---|---|
| Symbol | Conditions [1] | min. | typ. | max. | Units |
| $V_{(BR)CES}$ | $V_{GE}$ = 0, $I_C$ = 4 mA | ≥ $V_{CES}$ | – | – | V |
| $V_{GE(th)}$ | $V_{GE} = V_{CE}$, $I_C$ = 12 mA3 | 4,5 | 5,5 | 6,5 | V |
| $I_{CES}$ | $V_{GE}$ = 0, $V_{CE} = V_{CES}$; $T_j$ = 25 °C | – | 0,4 | 3 | mA |
| | $V_{GE}$ = 0, $V_{CE} = V_{CES}$; $T_j$ = 125 °C | – | 24 | – | mA |
| $I_{GES}$ | $V_{GE}$ = 20 V, $V_{CE}$ = 0 | – | – | 1 | µA |
| $V_{CEsat}$ | $I_C$ = 300 A; $V_{GE}$ = 15 V; $T_j$ = 25 (125) °C | – | 2,1(2,4) | 2,45(2,85) | V |
| $V_{CEsat}$ | $I_C$ = 400 A; $V_{GE}$ = 15 V; $T_j$ = 25 (125) °C | – | 2,5(3,0) | – | V |
| $g_{fs}$ | $V_{CE}$ = 20 V, $I_C$ = 300 A | 124 | – | – | S |
| $C_{CHC}$ | per IGBT | – | 1300 | 1500 | pF |
| $C_{ies}$ | $V_{GE}$ = 0, $V_{CE}$ = 25 V, f = 1 MHz | – | 22 | 30 | nF |
| $C_{oes}$ | | – | 3,3 | 4 | nF |
| $C_{res}$ | | – | 1,2 | 1,6 | nF |
| $L_{CE}$ | | – | – | 20 | nH |
| $t_{d(on)}$ | $V_{CC}$ = 600 V, $V_{GE}$ = –15 V / +15 V[3], $I_C$ = 300 A, ind. load, $R_{Gon} = R_{Goff}$ = 5 Ω, $T_j$ = 125 °C | – | 89 | – | ns |
| $t_r$ | | – | 77 | – | ns |
| $t_{d(off)}$ | | – | 690 | – | ns |
| $t_f$ | | – | 70 | – | ns |
| $E_{on}$ | | – | 36 | – | mWs |
| $E_{off}$ | | – | 42 | – | mWs |
| Inverse Diode [8] | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 300 A; $V_{GE}$ = 0 V; $T_j$ = 25 (125) °C | – | 2,0(1,8) | 2,5 | V |
| $V_F = V_{EC}$ | $I_F$ = 400 A; $V_{GE}$ = 0 V; $T_j$ = 25 (125) °C | – | 2,25(2,05) | – | V |
| $V_{TO}$ | $T_j$ = 125 °C | – | – | 1,2 | V |
| $r_t$ | $T_j$ = 125 °C | – | – | 3,5 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A; $T_j$ = 125 °C[2] | – | 154 | – | A |
| $Q_{rr}$ | $I_F$ = 300 A; $T_j$ = 125 °C[2] | – | 37 | – | µC |
| Thermal characteristics | | | | | |
| $R_{thjc}$ | per IGBT | – | – | 0,045 | °C/W |
| $R_{thjc}$ | per diode D | – | – | 0,125 | °C/W |
| $R_{thch}$ | per module | – | – | 0,038 | °C/W |

## SEMITRANS® M
## Low Loss IGBT Modules

## SKM 400 GA 124 D

**SEMITRANS 4**



**GA**

### Features

- MOS input (voltage controlled)
- N channel, homogeneous Silicon structure (NPT- Non punch-through IGBT)
- Low inductance case
- Very low tail current with low temperature dependance
- High short circuit capability, self limiting to 6 * $I_{cnom}$
- Latch-up free
- Fast & soft inverse CAL diodes [8]
- Isolated copper baseplate using DCB Direct Copper Bonding Technology without hard mould
- Large clearance (12 mm) and creepage distances (20 mm)

### Typical Applications

- Switching (not for linear use)
- Inverter drives
- UPS

[1] $T_{case}$ = 25 °C, unless otherwise specified
[2] $I_F = – I_C$, $V_R$ = 600 V, $–di_F/dt$ = 2000 A/µs, $V_{GE}$ = 0 V
[3] Use $V_{GEoff}$ = –5... –15 V
[8] CAL = Controlled Axial Lifetime Technology.

**Cases and mech. data**
**→ B 6 – 194**

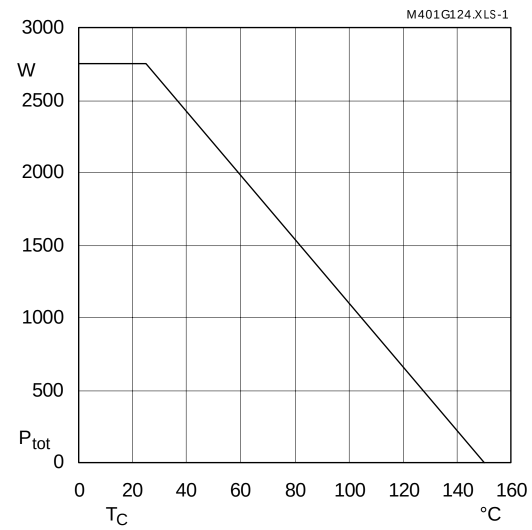



Fig. 1 Rated power dissipation $P_{tot} = f(T_C)$

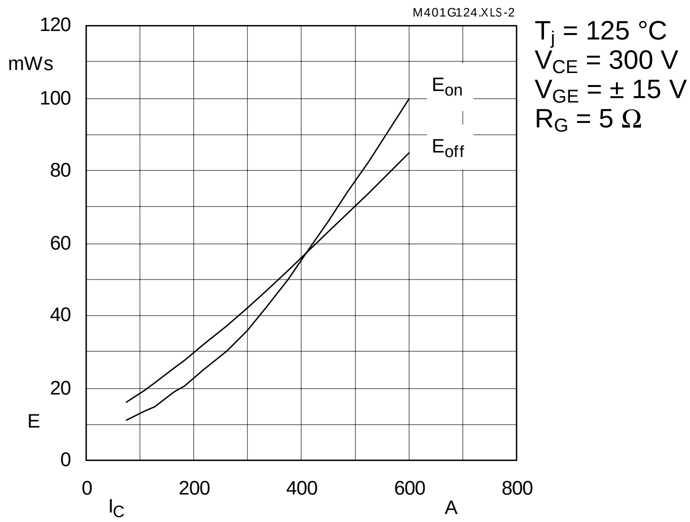



Fig. 2 Turn-on /-off energy = f ($I_C$)

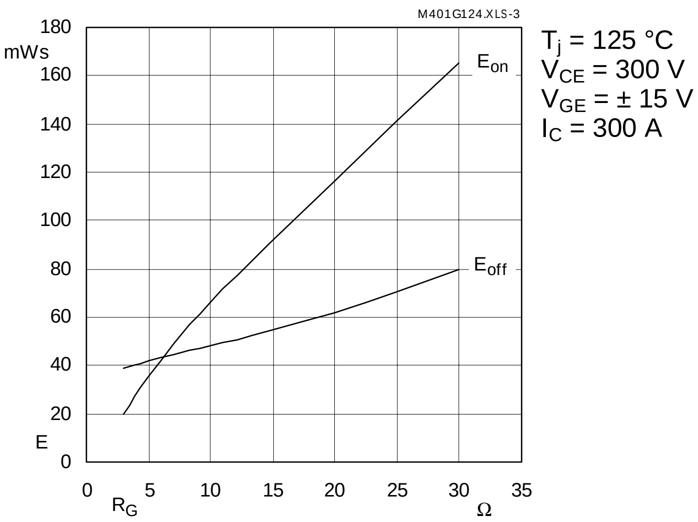



Fig. 3 Turn-on /-off energy = f ($R_G$)

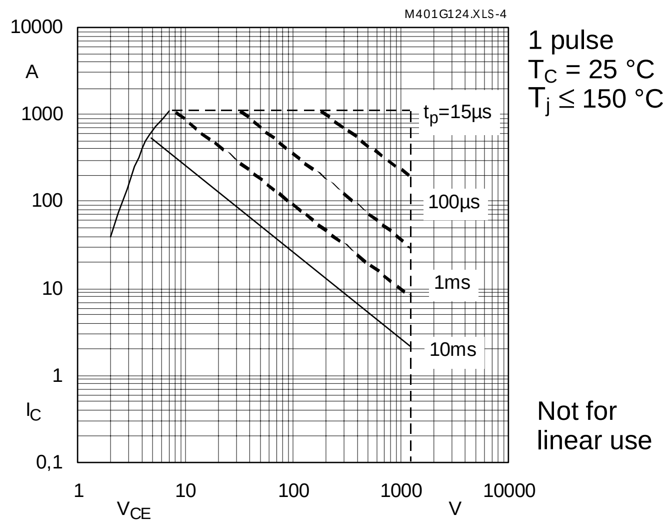



Fig. 4 Maximum safe operating area (SOA) $I_C = f(V_{CE})$

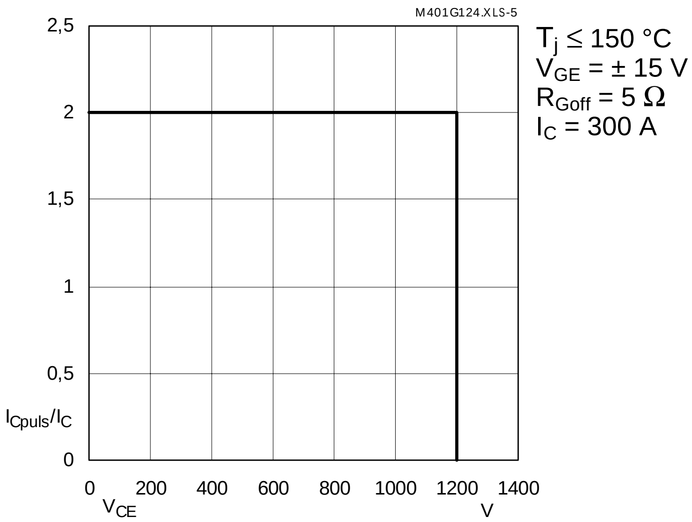



Fig. 5 Turn-off safe operating area (RBSOA)

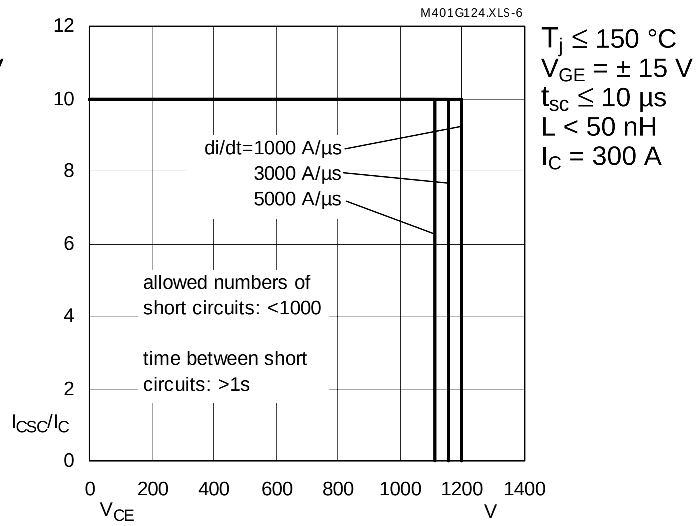



Fig. 6 Safe operating area at short circuit $I_C = f(V_{CE})$

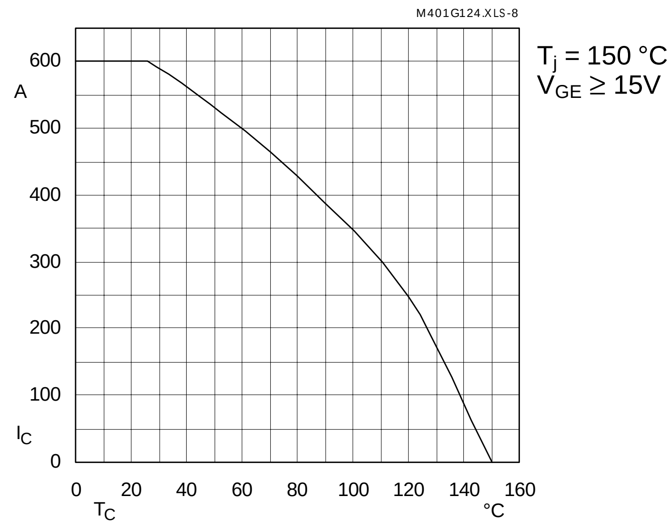



Fig. 8 Rated current vs. temperature $I_C = f(T_C)$

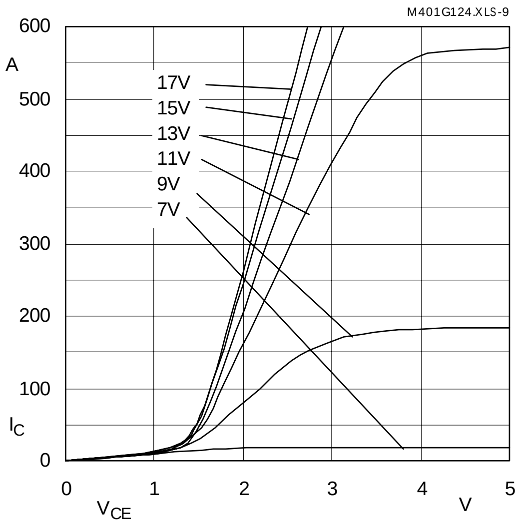



Fig. 9 Typ. output characteristic, $t_p$ = 250 µs; $T_j$ = 25 °C

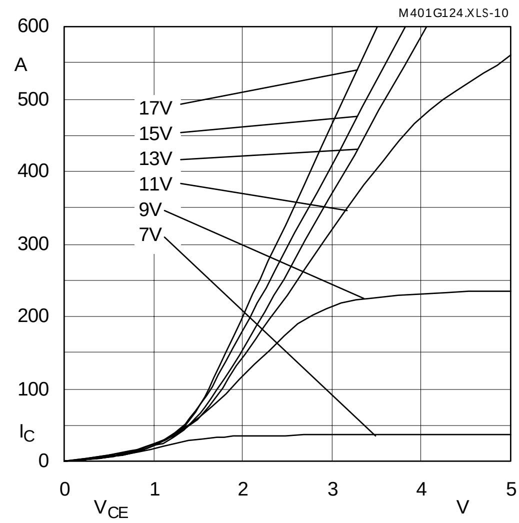



Fig. 10 Typ. output characteristic, $t_p$ = 250 µs; $T_j$ = 125 °C

$$P_{cond(t)} = V_{CEsat(t)} \cdot I_{C(t)}$$

$$V_{CEsat(t)} = V_{CE(TO)(Tj)} + r_{CE(Tj)} \cdot I_{C(t)}$$

$$V_{CE(TO)(Tj)} \leq 1{,}3 + 0{,}0005\ (T_j - 25)\ [V]$$

typ.: $r_{CE(Tj)} = 0{,}0027 + 0{,}000008\ (T_j - 25)\ [\Omega]$

max.: $r_{CE(Tj)} = 0{,}0038 + 0{,}000012\ (T_j - 25)\ [\Omega]$

valid for $V_{GE} = +\,15\,^{+2}_{-1}$ [V]; $I_C \geq 0{,}3\ I_{Cn}$

Fig. 11 Saturation characteristic (IGBT)
Calculation elements and equations

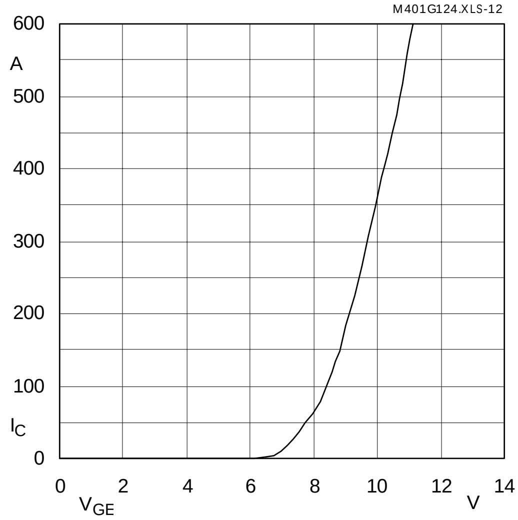



Fig. 12 Typ. transfer characteristic, $t_p$ = 250 µs; $V_{CE}$ = 20 V

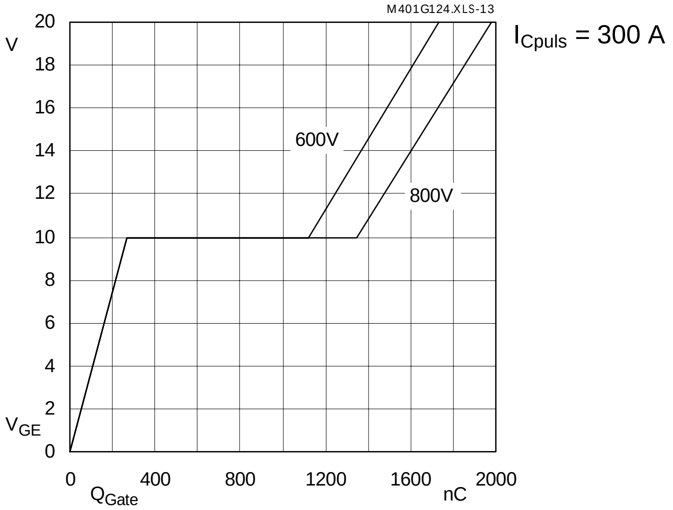



Fig. 13 Typ. gate charge characteristic

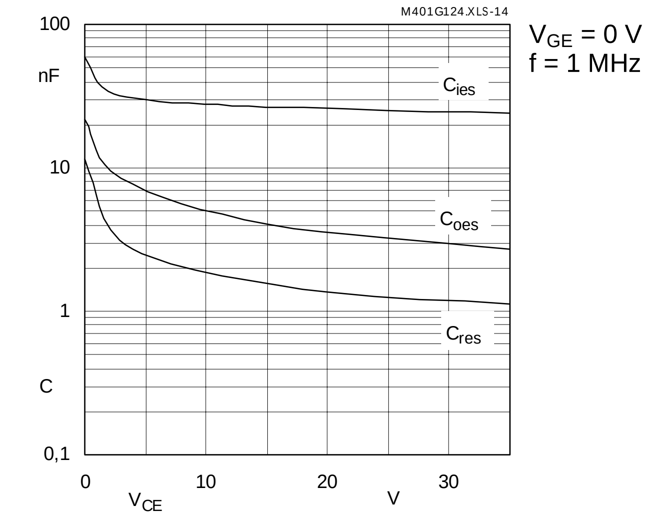



Fig. 14 Typ. capacitances vs.$V_{CE}$

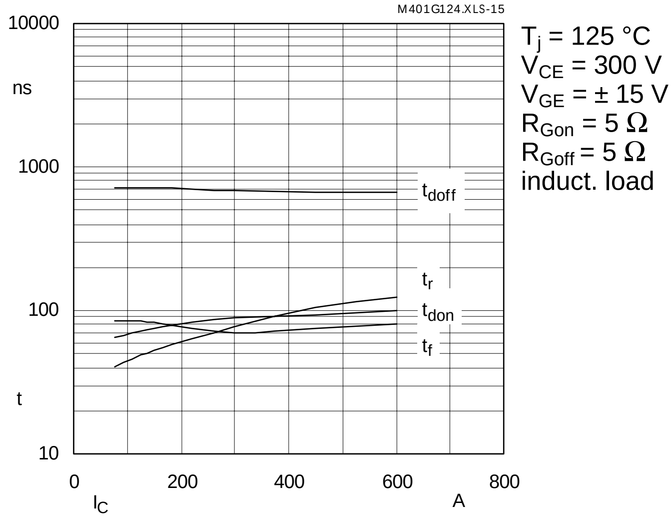



Fig. 15 Typ. switching times vs. $I_C$

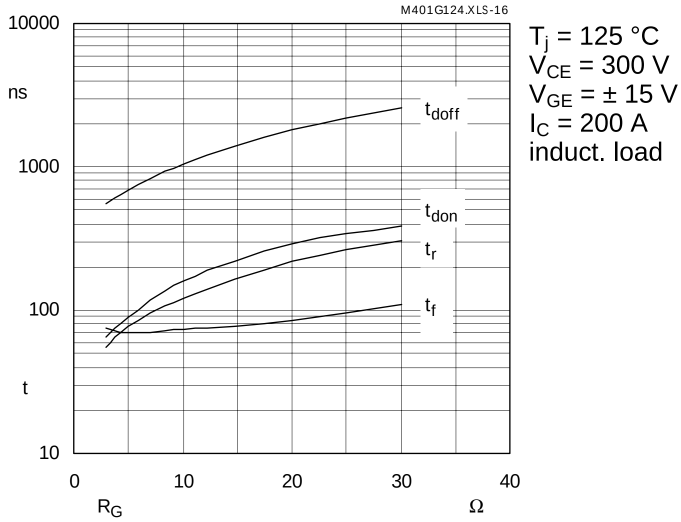



Fig. 16 Typ. switching times vs. gate resistor $R_G$

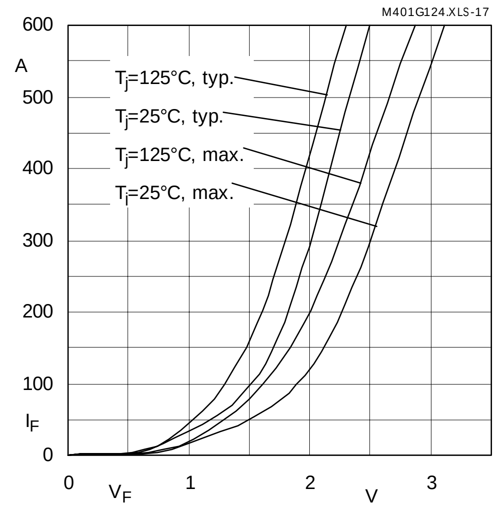



Fig. 17 Typ. CAL diode forward characteristic

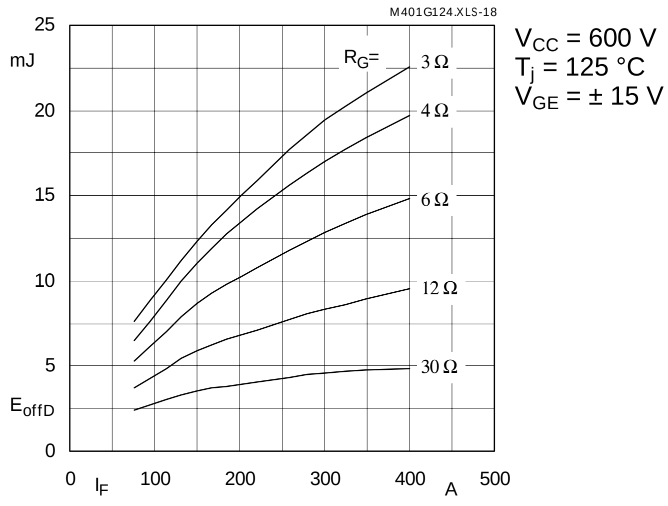



Fig. 18 Diode turn-off energy dissipation per pulse

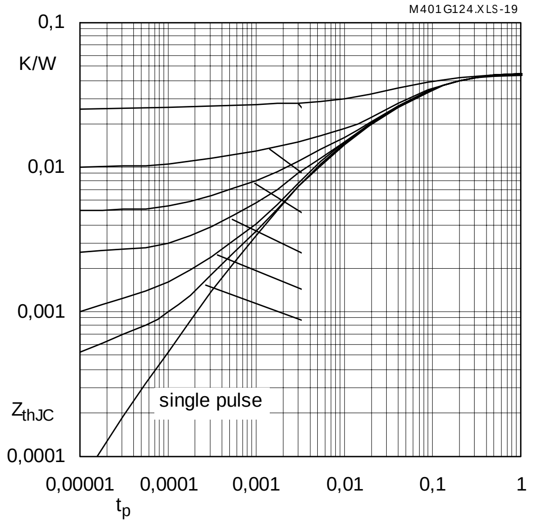



Fig. 19 Transient thermal impedance of IGBT $Z_{thJC} = f(t_p)$; $D = t_p / t_c = t_p \cdot f$

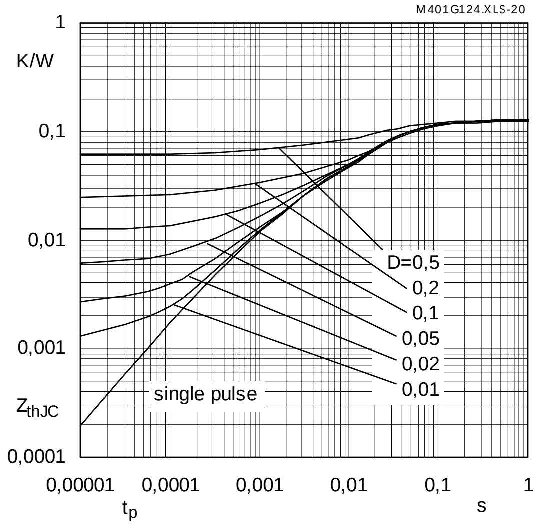



Fig. 20 Transient thermal impedance of inverse CAL diodes $Z_{thJC} = f(t_p)$; $D = t_p / t_c = t_p \cdot f$

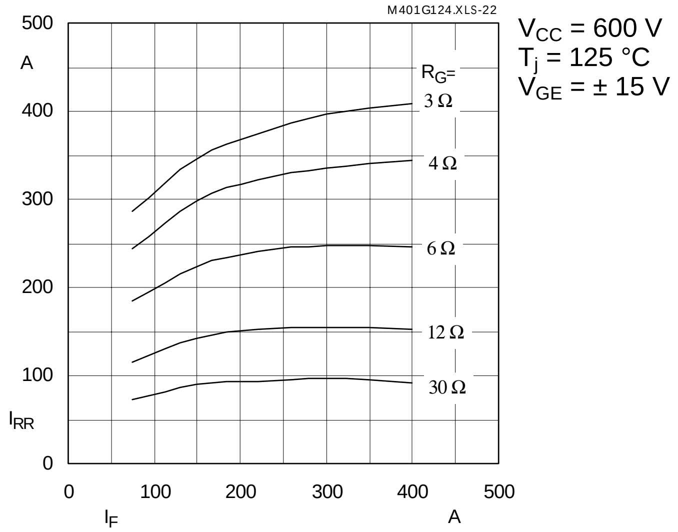



Fig. 22 Typ. CAL diode peak reverse recovery current $I_{RR} = f(I_F; R_G)$

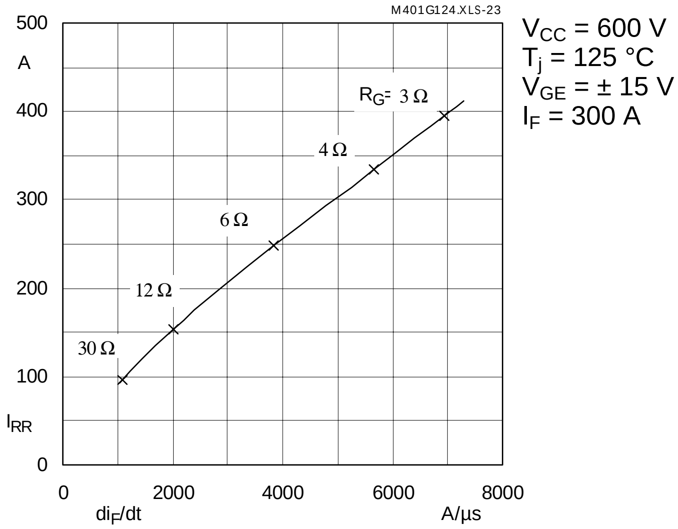



Fig. 23 Typ. CAL diode peak reverse recovery current $I_{RR} = f(di/dt)$

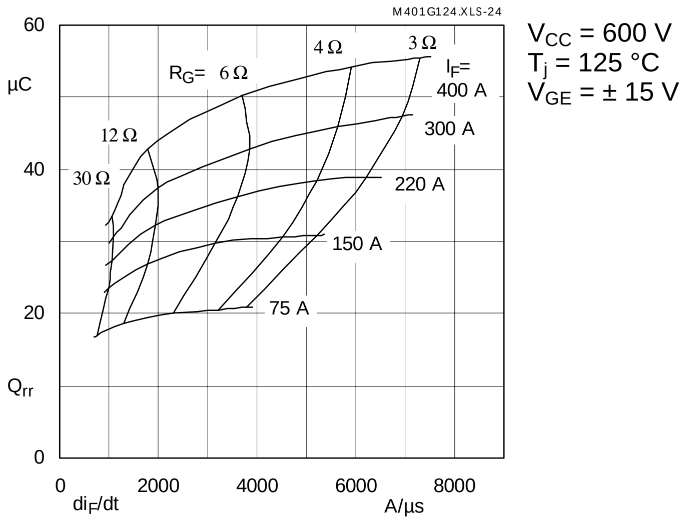
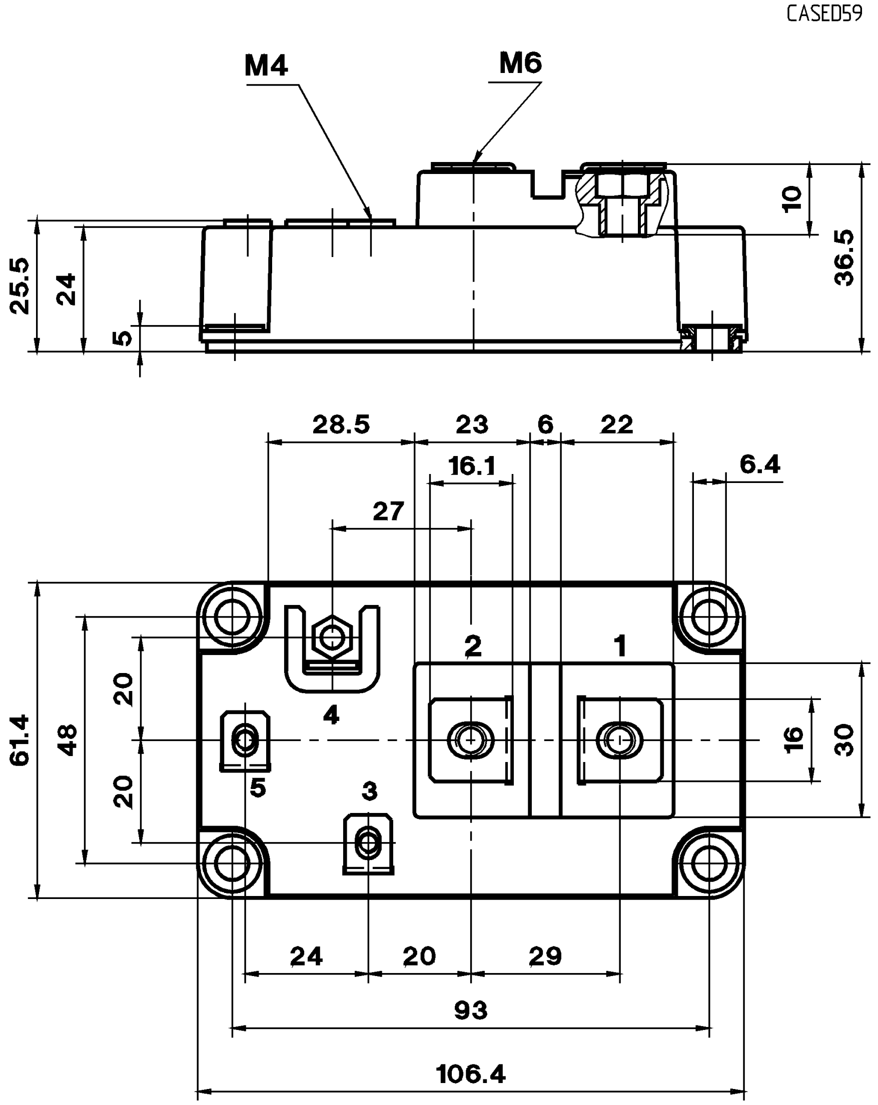


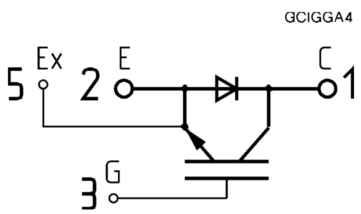

Fig. 24 Typ. CAL diode recovered charge

**SEMITRANS 4**

**Case D 59**

UL Recognized
File no. E 63 532




Dimensions in mm

Case outline and circuit diagram

| **Mechanical Data** | | | | | |
|---|---|---|---|---|---|
| **Symbol** | **Conditions** | **Values min.** | **typ.** | **max.** | **Units** |
| $M_1$ | to heatsink, SI Units (M6) | 3 | – | 5 | Nm |
| | to heatsink, US Units | 27 | – | 44 | lb.in. |
| $M_2$ | for terminals, SI Units (M6/M4) | 2,5/1,1 | – | 5/2 | Nm |
| | for terminals, US Units | 22/10 | – | 44/18 | lb.in. |
| a | | – | – | 5x9,81 | m/s$^2$ |
| w | | – | – | 330 | g |

**This is an electrostatic discharge sensitive device (ESDS).**
**Please observe the international standard IEC 747-1, Chapter IX.**

Three devices are supplied in one SEMIBOX B without mounting hardware, which can be ordered separately under Ident No. 33321100 (for 10 SEMITRANS 4)

Larger packing units of 12 or 20 pieces are used if suitable

Accessories → B 6 – 4

SEMIBOX → C – 1.