Data Sheet, Doc. No. 5SYA 1413-03 05-2016

# 5SNA 0500J650300
# HiPak IGBT Module

$V_{CE}$ = 6500 V
$I_C$ = 500 A

Ultra low-loss, rugged SPT+ chip-set
Smooth switching SPT+ chip-set for good EMC
High insulation package
AlSiC base-plate for high power cycling capability
AlN substrate for low thermal resistance
Improved high reliability package
Recognized under UL1557, File E196689

## Maximum rated values [1)]

| Parameter | Symbol | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| Collector-emitter voltage | $V_{CES}$ | $V_{GE}$ = 0 V, $T_{vj}$ ≥ 25 °C | | 6500 | V |
| DC collector current | $I_C$ | $T_C$ = 85 °C, $T_{vj}$ = 125 °C | | 500 | A |
| Peak collector current | $I_{CM}$ | $t_p$ = 1 ms | | 1000 | A |
| Gate-emitter voltage | $V_{GES}$ | | -20 | 20 | V |
| Total power dissipation | $P_{tot}$ | $T_C$ = 25 °C, $T_{vj}$ = 125 °C | | 6250 | W |
| DC forward current | $I_F$ | | | 500 | A |
| Peak forward current | $I_{FRM}$ | $t_p$ = 1 ms | | 1000 | A |
| Surge current | $I_{FSM}$ | $V_R$ = 0 V, $T_{vj}$ = 125 °C,<br>$t_p$ = 10 ms, half-sinewave | | 5000 | A |
| IGBT short circuit SOA | $t_{psc}$ | $V_{CC}$ = 4400 V, $V_{CEM\ CHIP}$ ≤ 6500 V<br>$V_{GE}$ ≤ 15 V, $T_{vj}$ ≤ 125 °C | | 10 | µs |
| Isolation voltage | $V_{isol}$ | 1 min, f = 50 Hz | | 10200 | V |
| Junction temperature | $T_{vj}$ | | | 125 | °C |
| Junction operating temperature | $T_{vj(op)}$ | | -50 | 125 | °C |
| Case temperature | $T_C$ | | -50 | 125 | °C |
| Storage temperature | $T_{stg}$ | | -50 | 125 | °C |
| Mounting torques [2)] | $M_s$ | Base-heatsink, M6 screws | 4 | 6 | Nm |
| | $M_{t1}$ | Main terminals, M8 screws | 8 | 10 | |
| | $M_{t2}$ | Auxiliary terminals, M4 screws | 2 | 3 | |

[1)] Maximum rated values indicate limits beyond which damage to the device may occur per IEC 60747
[2)] For detailed mounting instructions refer to ABB Document No. 5SYA 2039

## IGBT characteristic values [3)]

| Parameter | Symbol | Conditions | | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| Collector (-emitter) breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$ = 0 V, $I_C$ = 10 mA, $T_{vj}$ = 25 °C | | 6500 | | | V |
| Collector-emitter [4)] saturation voltage | $V_{CE\ sat}$ | $I_C$ = 500 A, $V_{GE}$ = 15 V | $T_{vj}$ = 25 °C | | 2.9 | 3.3 | V |
| | | | $T_{vj}$ = 125 °C | | 3.9 | 4.5 | V |
| Collector cut-off current | $I_{CES}$ | $V_{CE}$ = 6500 V, $V_{GE}$ = 0 V | $T_{vj}$ = 25 °C | | | 8 | mA |
| | | | $T_{vj}$ = 125 °C | | 40 | 70 | mA |
| Gate leakage current | $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = ± 20 V, $T_{vj}$ = 125 °C | | -500 | | 500 | nA |
| Gate-emitter threshold voltage | $V_{GE(TO)}$ | $I_C$ = 160 mA, $V_{CE}$ = $V_{GE}$, $T_{vj}$ = 25 °C | | 5.5 | | 7.5 | V |
| Gate charge | $Q_{ge}$ | $I_C$ = 500 A, $V_{CE}$ = 3600 V, $V_{GE}$ = -15 V ..15 V | | | 5.3 | | µC |
| Input capacitance | $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, f = 1 MHz, $T_{vj}$ = 25 °C | | | 75.6 | | nF |
| Output capacitance | $C_{oes}$ | | | | 4.4 | | nF |
| Reverse transfer capacitance | $C_{res}$ | | | | 1.3 | | nF |
| Internal gate resistance | $R_{Gint}$ | | | | 1.3 | | Ω |
| Turn-on delay time | $t_{d(on)}$ | $V_{CC}$ = 3600 V, $I_C$ = 500 A, $R_G$ = 3.9 Ω, $C_{GE}$ = 150 nF, $V_{GE}$ = ±15 V, $L_\sigma$ = 280 nH, inductive load | $T_{vj}$ = 25 °C | | 780 | | ns |
| | | | $T_{vj}$ = 125 °C | | 710 | | ns |
| Rise time | $t_r$ | | $T_{vj}$ = 25 °C | | 200 | | ns |
| | | | $T_{vj}$ = 125 °C | | 240 | | ns |
| Turn-off delay time | $t_{d(off)}$ | $V_{CC}$ = 3600 V, $I_C$ = 500 A, $R_G$ = 22 Ω, $C_{GE}$ = 150 nF, $V_{GE}$ = ±15 V, $L_\sigma$ = 280 nH, inductive load | $T_{vj}$ = 25 °C | | 4750 | | ns |
| | | | $T_{vj}$ = 125 °C | | 5300 | | ns |
| Fall time | $t_f$ | | $T_{vj}$ = 25 °C | | 530 | | ns |
| | | | $T_{vj}$ = 125 °C | | 660 | | ns |
| Turn-on switching energy | $E_{on}$ | $V_{CC}$ = 3600 V, $I_C$ = 500 A, $R_G$ = 3.9 Ω, $C_{GE}$ = 150 nF, $V_{GE}$ = ±15 V, $L_\sigma$ = 280 nH, inductive load | $T_{vj}$ = 25 °C | | 2750 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 3950 | | mJ |
| Turn-off switching energy | $E_{off}$ | $V_{CC}$ = 3600 V, $I_C$ = 500 A, $R_G$ = 22 Ω, $C_{GE}$ = 150 nF, $V_{GE}$ = ±15 V, $L_\sigma$ = 280 nH, inductive load | Tvj = 25 °C | | 2700 | | mJ |
| | | | Tvj = 125 °C | | 3500 | | mJ |
| Short circuit current | $I_{SC}$ | $t_{psc}$ ≤ 10 µs, $V_{GE}$ = 15 V, $V_{CC}$ = 4400 V, $V_{CEM\ CHIP}$ ≤ 6500 V | Tvj = 125 °C | | 2250 | | A |

[3)] Characteristic values according to IEC 60747 - 9
[4)] Collector-emitter saturation voltage is given at chip level

## Diode characteristic values [5)]

| Parameter | Symbol | Conditions | | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| Forward voltage [6)] | $V_F$ | $I_F$ = 500 A | $T_{vj}$ = 25 °C | | 3.2 | 3.8 | V |
| | | | $T_{vj}$ = 125 °C | | 3.4 | 4.0 | V |
| Reverse recovery current | $I_{rr}$ | $V_{CC}$ = 3600 V, $I_F$ = 500 A, $V_{GE}$ = ±15 V, $R_G$ = 3.9 Ω, $C_{GE}$ = 150 nF, di/dt = 2 kA/µs $L_\sigma$ = 280 nH, inductive load | $T_{vj}$ = 25 °C | | 610 | | A |
| | | | $T_{vj}$ = 125 °C | | 650 | | A |
| Recovered charge | $Q_{rr}$ | | $T_{vj}$ = 25 °C | | 550 | | µC |
| | | | $T_{vj}$ = 125 °C | | 950 | | µC |
| Reverse recovery time | $t_{rr}$ | | $T_{vj}$ = 25 °C | | 1800 | | ns |
| | | | $T_{vj}$ = 125 °C | | 2800 | | ns |
| Reverse recovery energy | $E_{rec}$ | | $T_{vj}$ = 25 °C | | 900 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 1850 | | mJ |

[5)] Characteristic values according to IEC 60747 - 2
[6)] Forward voltage is given at chip level

## Package properties [7)]

| Parameter | Symbol | Conditions | | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| IGBT thermal resistance junction to case | $R_{th(j-c)IGBT}$ | | | | | 0.016 | K/W |
| Diode thermal resistance junction to case | $R_{th(j-c)DIODE}$ | | | | | 0.032 | K/W |
| IGBT thermal resistance [2)] case to heatsink | $R_{th(c-s)IGBT}$ | IGBT per switch, λ grease = 1W/m x K | | | 0.012 | | K/W |
| Diode thermal resistance [2)] case to heatsink | $R_{th(c-s)DIODE}$ | Diode per switch, λ grease = 1W/m x K | | | 0.024 | | K/W |
| Partial discharge extinction voltage | $V_e$ | f = 50 Hz, $Q_{PD} \leq$ 10 pC (acc. To IEC 61287) | | 5100 | | | V |
| Comparative tracking index | CTI | | | > 600 | | | |
| Module stray inductance | $L_{\sigma CE}$ | | | | 27 | | nH |
| Resistance, terminal-chip | $R_{CC'+EE'}$ | | $T_C$ = 25 °C | | 0.1 | | mΩ |
| | | | $T_C$ = 125 °C | | 0.15 | | |

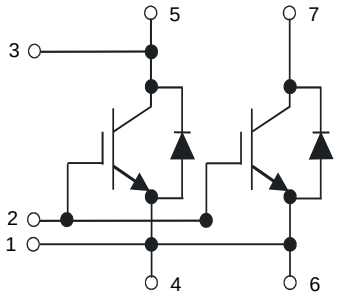
[2)] For detailed mounting instructions refer to ABB Document No. 5SYA 2039

## Mechanical properties [7)]

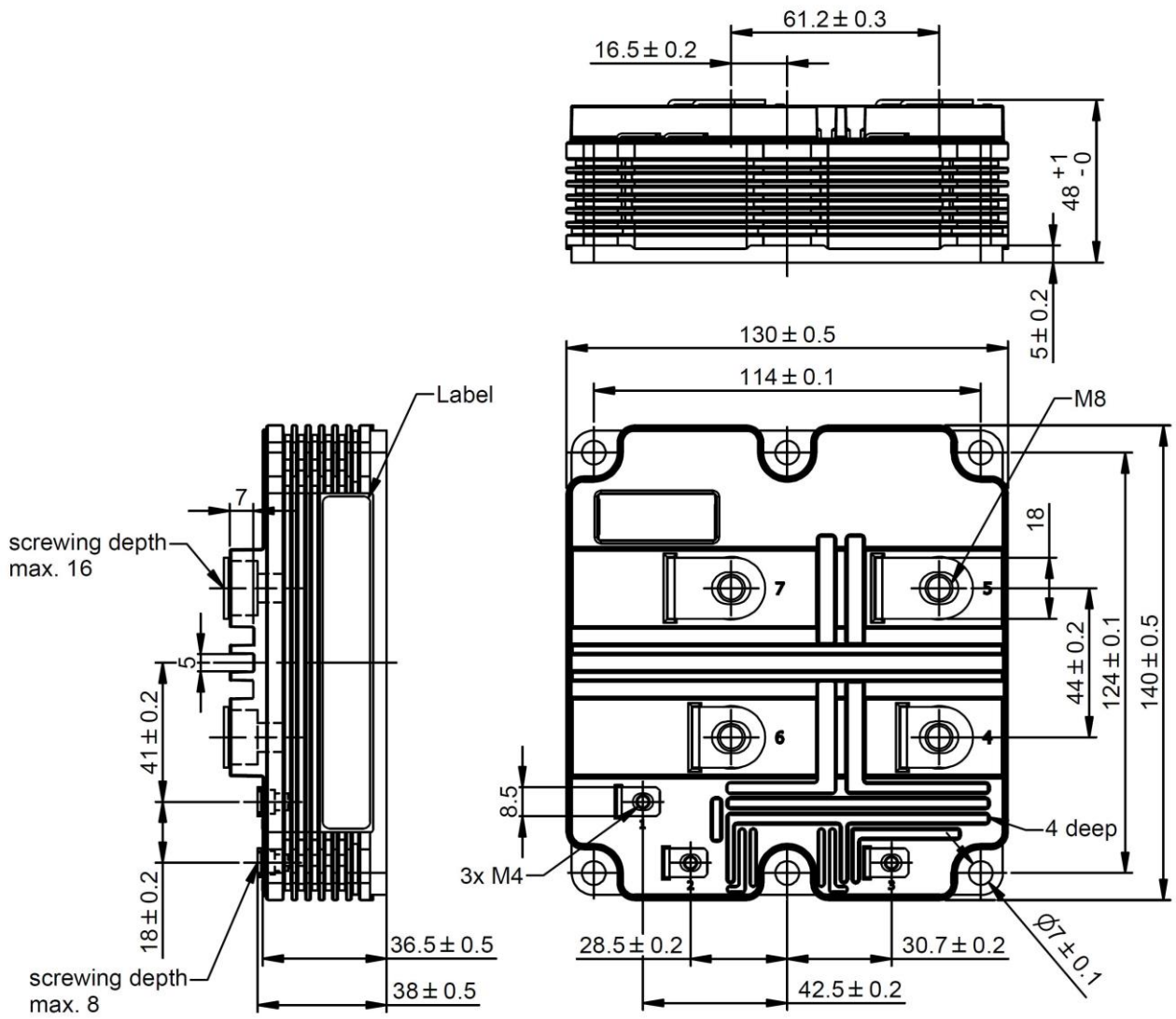
| Parameter | Symbol | Conditions | | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| Dimensions | L x W x H | Typical | | 130 x 140 x 48 | | | mm |
| Clearance distance in air | $d_a$ | according to IEC 60664-1 and EN 50124-1 | Term. to base: | 40 | | | mm |
| | | | Term. to term: | 26 | | | |
| Surface creepage distance | $d_s$ | according to IEC 60664-1 and EN 50124-1 | Term. to base: | 64 | | | mm |
| | | | Term. to term: | 56 | | | |
| Mass | m | | | | 1010 | | g |

[7)] Package and mechanical properties according to IEC 60747 - 15

## Electrical configuration




## Outline drawing [2)]




**Note: all dimensions are shown in millimeters**
[2)] For detailed mounting instructions refer to ABB Document No. 5SYA 2039

This is an electrostatic sensitive device, please observe the international standard IEC 60747-1, chap. IX.
This product has been designed and qualified for Industrial Level.

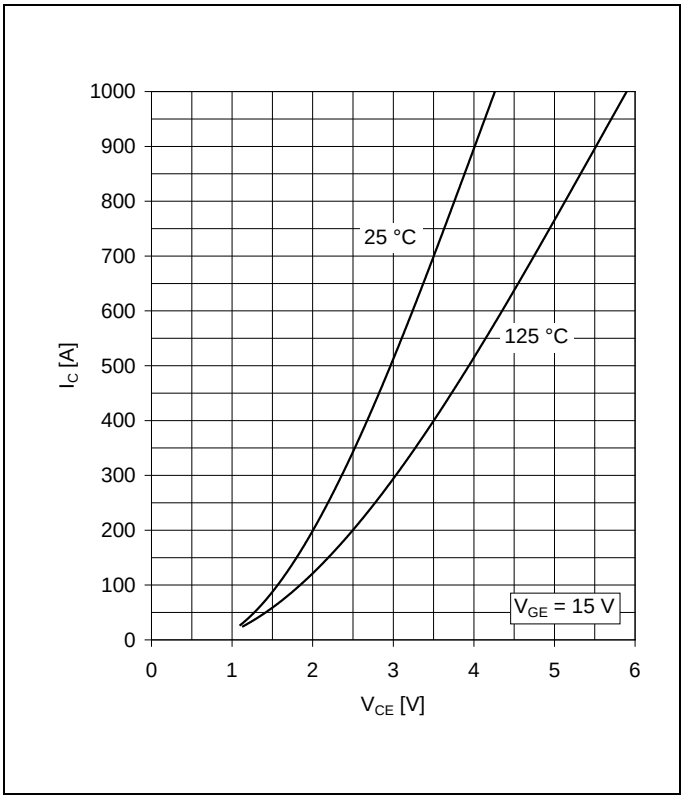



**Fig. 1** Typical on-state characteristics, chip level

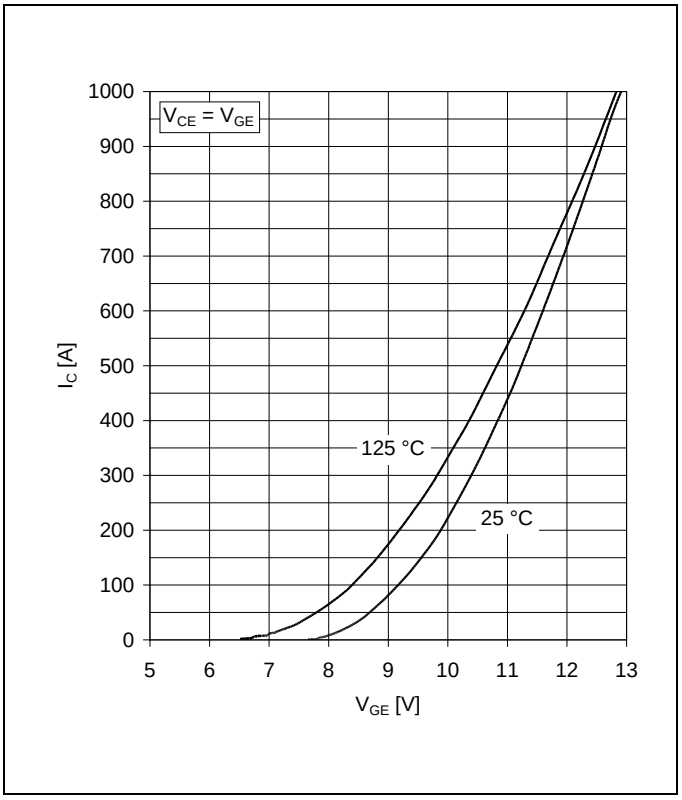



**Fig. 2** Typical transfer characteristics, chip level

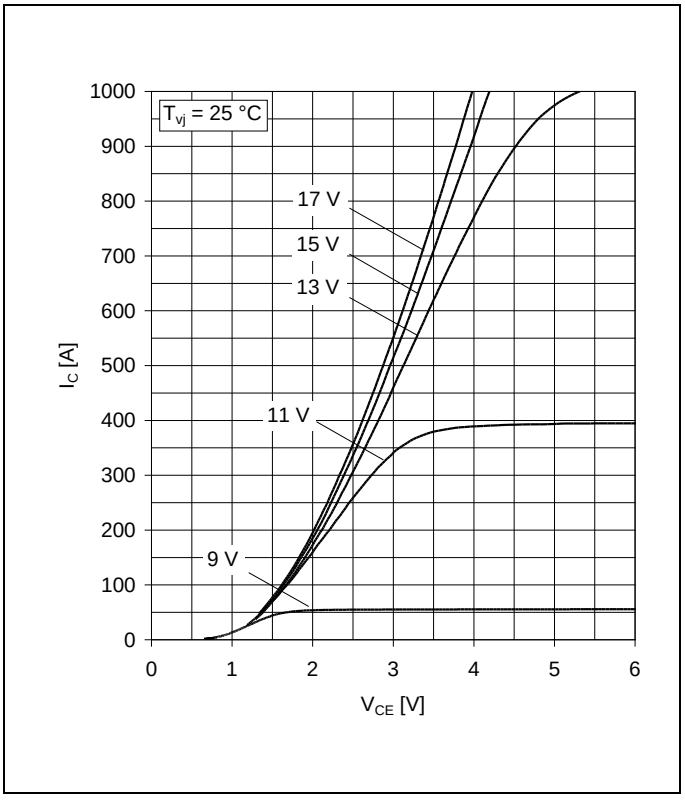



**Fig. 3** Typical output characteristics, chip level

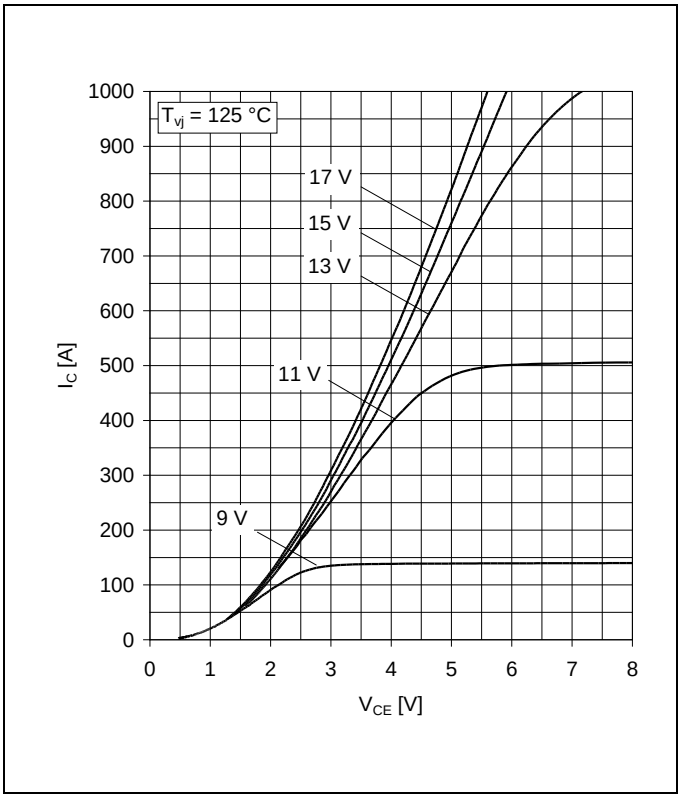



**Fig. 4** Typical output characteristics, chip level

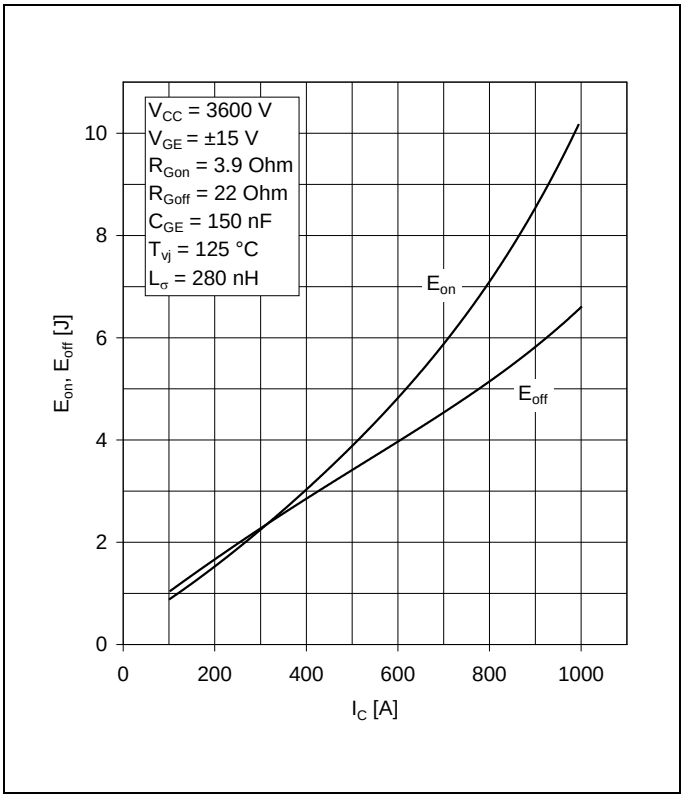



**Fig. 5** Typical switching energies per pulse vs. collector current

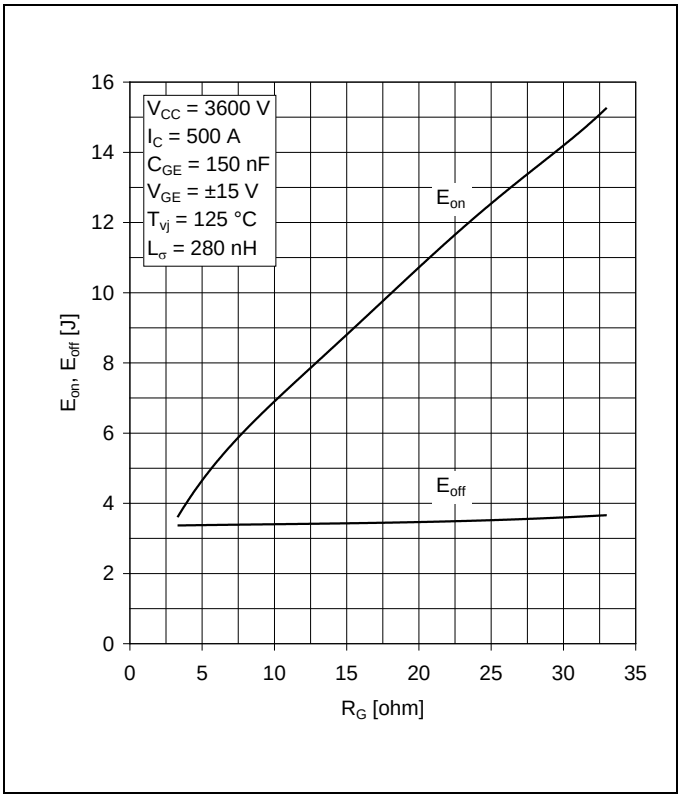



**Fig. 6** Typical switching energies per pulse vs. gate resistor

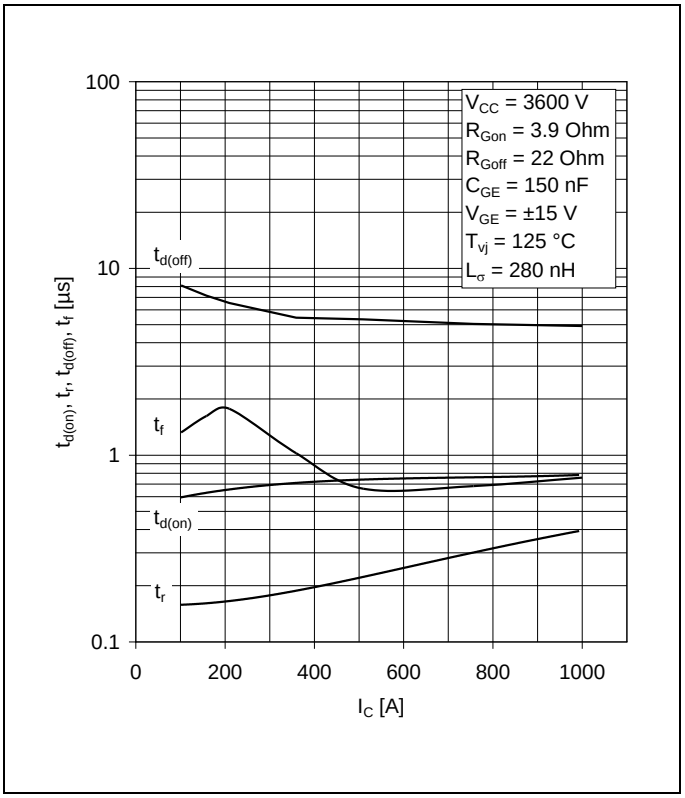



**Fig. 7** Typical switching times vs. collector current

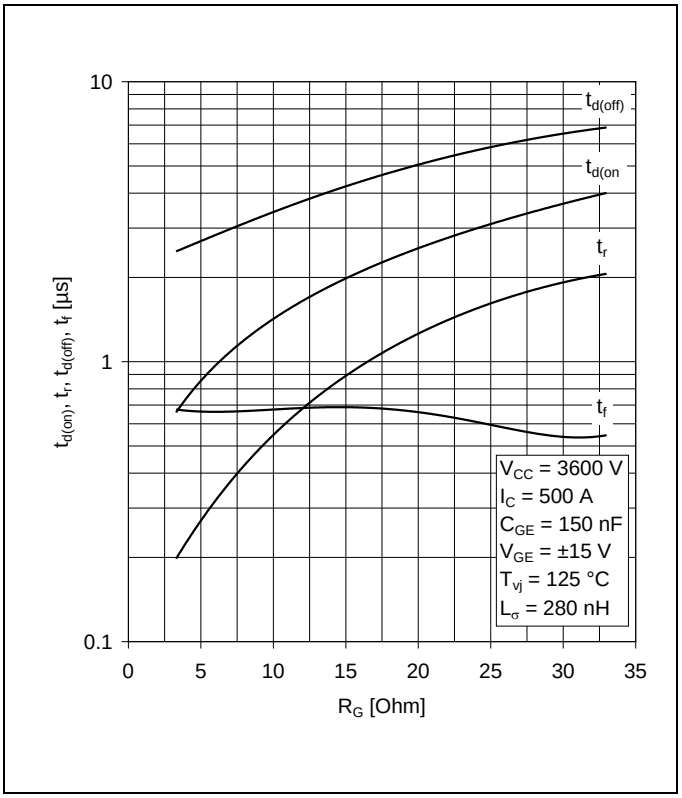



**Fig. 8** Typical switching times vs. gate resistor

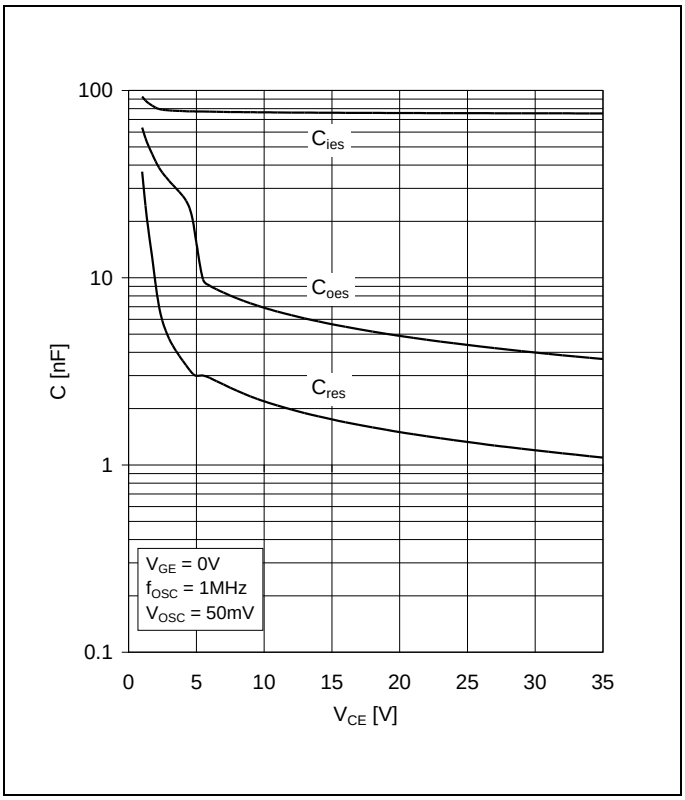



**Fig. 9** Typical capacitances vs. collector-emitter voltage

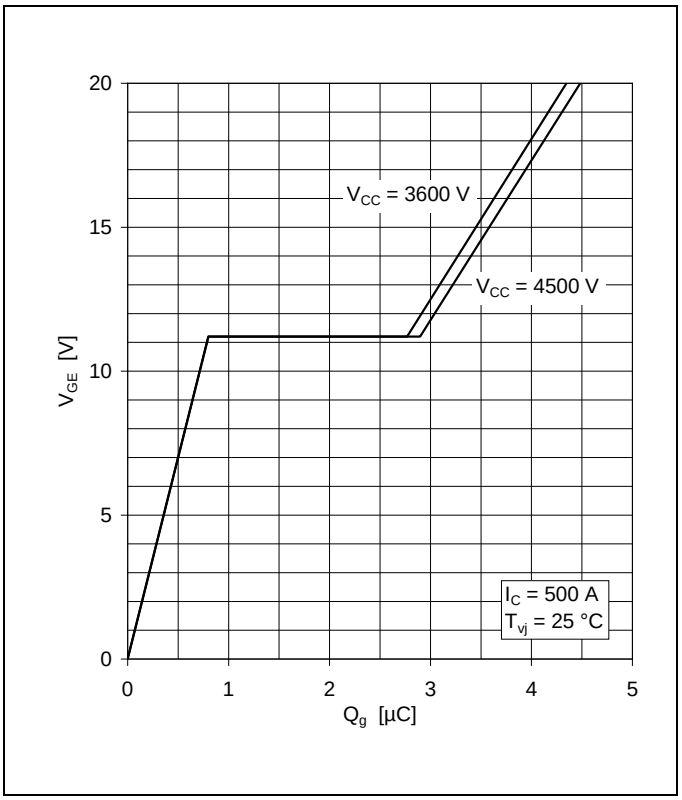



**Fig. 10** Typical gate charge characteristics

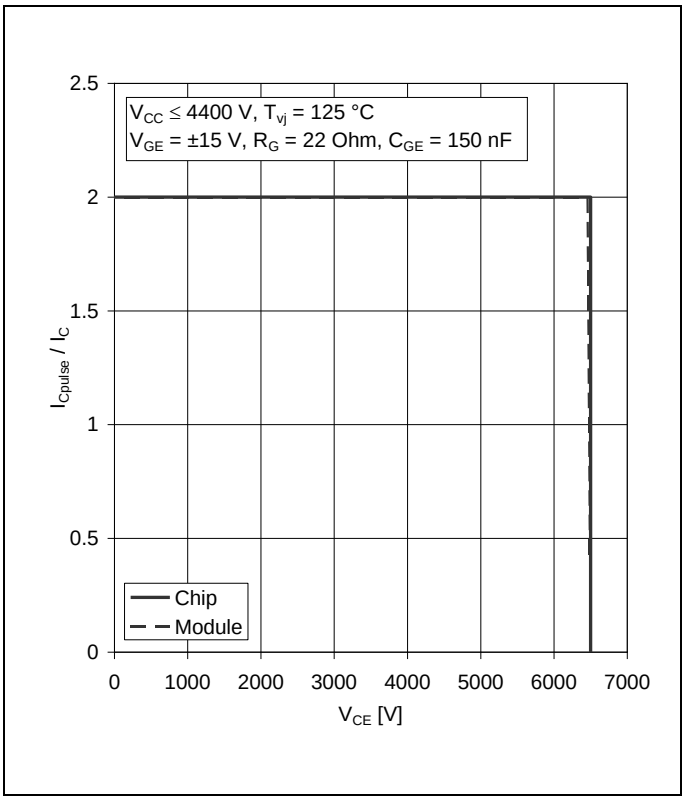



**Fig. 11** Turn-off safe operating area (RBSOA)

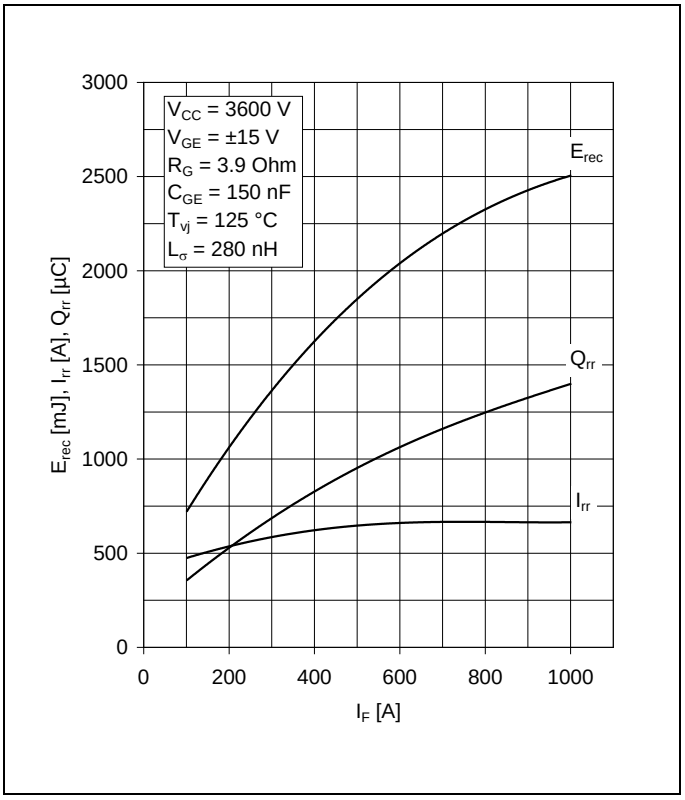



**Fig. 12** Typical reverse recovery characteristics vs. forward current

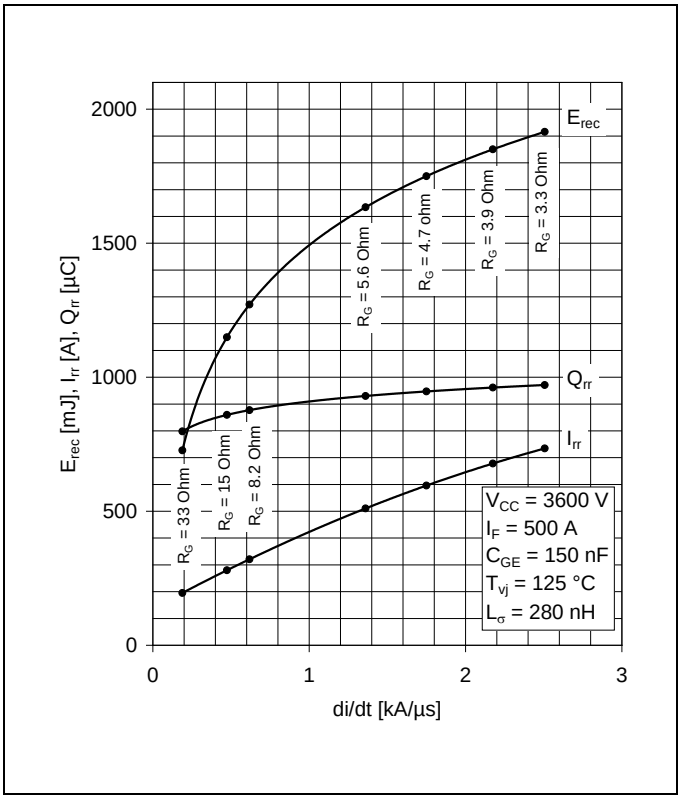



**Fig. 13** Typical reverse recovery characteristics vs. di/dt

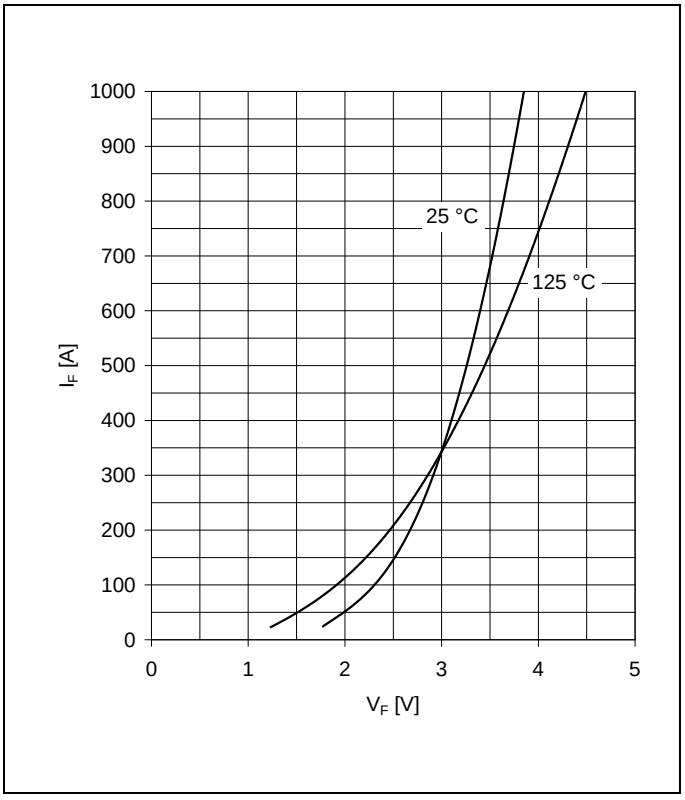



**Fig. 14** Typicial diode forward characteristics chip level

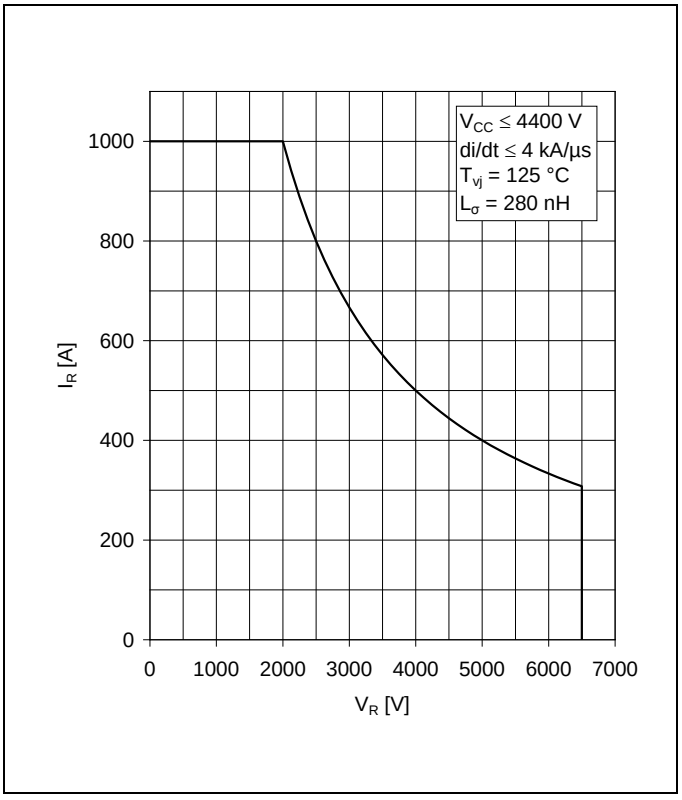
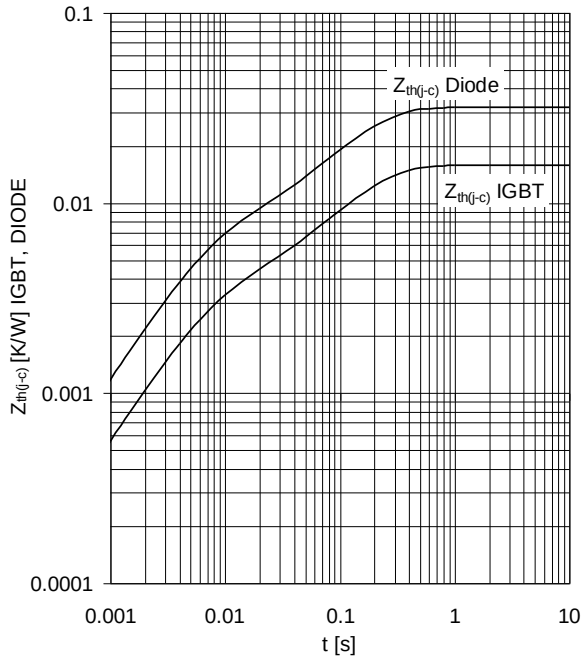



**Fig. 15** Safe operating area diode (SOA)




Analytical function for transient thermal impedance:

$$Z_{th\,(j\text{-}c)}(t) = \sum_{i=1}^{n} R_i\,(1 - e^{-t/\tau_i})$$

| | i | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| IGBT | Ri(K/kW) | 12.75 | 2.99 | | | |
| | τi(ms) | 151 | 5.84 | | | |
| DIODE | Ri(K/kW) | 25.5 | 6.3 | | | |
| | τi(ms) | 144 | 5.83 | | | |

**Fig. 16** Thermal impedance vs. time

5SNA 0500J650300 | **Doc. No.** 5SYA 1413-03 05-2016

**Related documents:**

5SYA 2042 Failure rates of HiPak modules due to cosmic rays
5SYA 2043 Load – cycle capability of HiPaks
5SYA 2045 Thermal runaway during blocking
5SYA 2053 Applying IGBT
5SYA 2058 Surge currents for IGBT diodes
5SZK 9111 Specification of environmental class for HiPak Storage
5SZK 9112 Specification of environmental class for HiPak Transportation
5SZK 9113 Specification of environmental class for HiPak Operation (Industry)
5SZK 9120 Specification of environmental class for HiPak

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