

# 5SNA 3000K452300

## StakPak IGBT Module

$V_{CE} = 4500 \text{ V}$

$I_C = 3000 \text{ A}$

Remains in low impedance state for up to 1 minute after failure\*

Low-loss, rugged SPT+ chip-set

Smooth switching SPT+ chip-set for good EMC

High tolerance to uneven mounting pressure

Explosion resistant package



### Maximum rated values <sup>1)</sup>

| Parameter                       | Symbol       | Conditions                                                                                                                          | min | max   | Unit          |
|---------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------|-----|-------|---------------|
| Collector-emitter voltage       | $V_{CES}$    | $V_{GE} = 0 \text{ V}$ , $T_{vj} \geq 25 \text{ °C}$                                                                                |     | 4500  | V             |
| DC collector current            | $I_C$        | $T_C = 90 \text{ °C}$ , $T_{vj} = 125 \text{ °C}$                                                                                   |     | 3000  | A             |
| Peak collector current          | $I_{CM}$     | $t_p = 1 \text{ ms}$                                                                                                                |     | 6000  | A             |
| Gate-emitter voltage            | $V_{GES}$    |                                                                                                                                     | -20 | 20    | V             |
| Total power dissipation         | $P_{tot}$    | $T_C = 25 \text{ °C}$ , $T_{vj} = 125 \text{ °C}$                                                                                   |     | 31200 | W             |
| DC forward current              | $I_F$        |                                                                                                                                     |     | 3000  | A             |
| Peak forward current            | $I_{FRM}$    | $t_p = 1 \text{ ms}$                                                                                                                |     | 6000  | A             |
| Surge current                   | $I_{FSM}$    | $V_R = 0 \text{ V}$ , $T_{vj} = 125 \text{ °C}$ ,<br>$t_p = 10 \text{ ms}$ , half-sinewave                                          |     | 21000 | A             |
| IGBT short circuit SOA          | $t_{psc}$    | $V_{CC} = 3400 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 4500 \text{ V}$<br>$V_{GE} \leq 15 \text{ V}$ , $T_{vj} \leq 125 \text{ °C}$ |     | 10    | $\mu\text{s}$ |
| Junction temperature            | $T_{vj}$     |                                                                                                                                     | -50 | 150   | °C            |
| Junction operating temperature  | $T_{vj(op)}$ |                                                                                                                                     | -50 | 125   | °C            |
| Case temperature                | $T_C$        |                                                                                                                                     | -50 | 125   | °C            |
| Storage temperature             | $T_{stg}$    |                                                                                                                                     | -50 | 70    | °C            |
| Mounting force <sup>2) 3)</sup> | $F_M$        |                                                                                                                                     | 90  | 130   | kN            |

<sup>1)</sup> Maximum rated values indicate limits beyond which damage to the device may occur per IEC 60747

<sup>2)</sup> For detailed mounting instructions refer to ABB document no. 5SYA 2037-02

<sup>3)</sup> All electrical characteristics are valid only when the module is clamped

\* Functionality is load profile dependent and is to be agreed upon

## IGBT characteristic values <sup>4)</sup>

| Parameter                                          | Symbol               | Conditions                                                                                                                                                                                           | min                                     | typ   | max  | Unit          |
|----------------------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------|------|---------------|
| Collector (-emitter) breakdown voltage             | $V_{(BR)CES}$        | $V_{GE} = 0 \text{ V}$ , $I_C = 10 \text{ mA}$ , $T_{vj} = 25 \text{ }^{\circ}\text{C}$                                                                                                              | 4500                                    |       |      | V             |
| Collector-emitter <sup>5)</sup> saturation voltage | $V_{CE \text{ sat}}$ | $I_C = 3000 \text{ A}$ , $V_{GE} = 15 \text{ V}$                                                                                                                                                     | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 2.85  | 3.15 | V             |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 3.65  | 3.95 | V             |
| Collector cut-off current                          | $I_{CES}$            | $V_{CE} = 4500 \text{ V}$ , $V_{GE} = 0 \text{ V}$                                                                                                                                                   | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  |       | 1.5  | mA            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 75    | 150  | mA            |
| Gate leakage current                               | $I_{GES}$            | $V_{CE} = 0 \text{ V}$ , $V_{GE} = \pm 20 \text{ V}$ , $T_{vj} = 25 \text{ }^{\circ}\text{C}$                                                                                                        | -500                                    |       | 500  | nA            |
| Gate-emitter threshold voltage                     | $V_{GE(th)}$         | $I_C = 480 \text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25 \text{ }^{\circ}\text{C}$                                                                                                                  | 5.3                                     |       | 7.3  | V             |
| Gate charge                                        | $Q_G$                | $I_C = 3000 \text{ A}$ , $V_{CE} = 2800 \text{ V}$ , $V_{GE} = -15 \text{ V} \dots 15 \text{ V}$                                                                                                     |                                         | 14.4  |      | $\mu\text{C}$ |
| Input capacitance                                  | $C_{ies}$            | $V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_{vj} = 25 \text{ }^{\circ}\text{C}$                                                                                      |                                         | 279   |      | nF            |
| Output capacitance                                 | $C_{oes}$            |                                                                                                                                                                                                      |                                         | 20.1  |      | nF            |
| Reverse transfer capacitance                       | $C_{res}$            |                                                                                                                                                                                                      |                                         | 5.55  |      | nF            |
| Internal gate resistor                             | $R_{Gint}$           |                                                                                                                                                                                                      |                                         | 0.11  |      | $\Omega$      |
| Turn-on delay time                                 | $t_{d(on)}$          | $V_{CC} = 2800 \text{ V}$ , $I_C = 3000 \text{ A}$ ,<br>$R_G = 1.5 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ ,<br>$V_{GE} = \pm 15 \text{ V}$ ,<br>$L_{\sigma} = 130 \text{ nH}$ , inductive load | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 760   |      | ns            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 650   |      | ns            |
| Rise time                                          | $t_r$                |                                                                                                                                                                                                      | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 560   |      | ns            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 530   |      | ns            |
| Turn-off delay time                                | $t_{d(off)}$         | $V_{CC} = 2800 \text{ V}$ , $I_C = 3000 \text{ A}$ ,<br>$R_G = 6.8 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ ,<br>$V_{GE} = \pm 15 \text{ V}$ ,<br>$L_{\sigma} = 130 \text{ nH}$ , inductive load | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 4630  |      | ns            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 5130  |      | ns            |
| Fall time                                          | $t_f$                |                                                                                                                                                                                                      | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 690   |      | ns            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 750   |      | ns            |
| Turn-on switching energy                           | $E_{on}$             | $V_{CC} = 2800 \text{ V}$ , $I_C = 3000 \text{ A}$ ,<br>$R_G = 1.5 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ ,<br>$V_{GE} = \pm 15 \text{ V}$ ,<br>$L_{\sigma} = 130 \text{ nH}$ , inductive load | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 12800 |      | mJ            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 15500 |      | mJ            |
| Turn-off switching energy                          | $E_{off}$            | $V_{CC} = 2800 \text{ V}$ , $I_C = 3000 \text{ A}$ ,<br>$R_G = 6.8 \text{ } \Omega$ , $C_{GE} = 330 \text{ nF}$ ,<br>$V_{GE} = \pm 15 \text{ V}$ ,<br>$L_{\sigma} = 130 \text{ nH}$ , inductive load | $T_{vj} = 25 \text{ }^{\circ}\text{C}$  | 12100 |      | mJ            |
|                                                    |                      |                                                                                                                                                                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 15100 |      | mJ            |
| Short circuit current                              | $I_{SC}$             | $t_{psc} \leq 10 \text{ } \mu\text{s}$ , $V_{GE} = 15 \text{ V}$ ,<br>$V_{CC} = 3400 \text{ V}$ ,<br>$V_{CEM \text{ CHIP}} \leq 4500 \text{ V}$                                                      | $T_{vj} = 125 \text{ }^{\circ}\text{C}$ | 11800 |      | A             |

<sup>4)</sup> Characteristic values according to IEC 60747 - 9

<sup>5)</sup> Collector-emitter saturation voltage is given at chip level

## Diode characteristic values <sup>6)</sup>

| Parameter                     | Symbol           | Conditions                                                                                                                                                                                          | min                      | typ  | max | Unit |  |
|-------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------|-----|------|--|
| Forward voltage <sup>7)</sup> | V <sub>F</sub>   | I <sub>F</sub> = 3000 A                                                                                                                                                                             | T <sub>vj</sub> = 25 °C  | 2.6  | 2.9 | V    |  |
|                               |                  |                                                                                                                                                                                                     | T <sub>vj</sub> = 125 °C | 3.0  | 3.4 | V    |  |
| Peak reverse recovery current | I <sub>RM</sub>  | V <sub>CC</sub> = 2800 V, I <sub>F</sub> = 3000 A,<br>V <sub>GE</sub> = ±15 V,<br>R <sub>G</sub> = 1.5 Ω, C <sub>GE</sub> = 330 nF,<br>di/dt = 5.1 kA/μs<br>L <sub>σ</sub> = 130 nH, inductive load | T <sub>vj</sub> = 25 °C  | 2200 |     | A    |  |
|                               |                  |                                                                                                                                                                                                     | T <sub>vj</sub> = 125 °C | 2550 |     | A    |  |
| Recovered charge              | Q <sub>r</sub>   |                                                                                                                                                                                                     | T <sub>vj</sub> = 25 °C  | 2700 |     | μC   |  |
|                               |                  |                                                                                                                                                                                                     | T <sub>vj</sub> = 125 °C | 4000 |     | μC   |  |
| Reverse recovery time         | t <sub>rr</sub>  |                                                                                                                                                                                                     | T <sub>vj</sub> = 25 °C  | 2500 |     | ns   |  |
|                               |                  |                                                                                                                                                                                                     | T <sub>vj</sub> = 125 °C | 2850 |     | ns   |  |
| Reverse recovery energy       | E <sub>rec</sub> |                                                                                                                                                                                                     | T <sub>vj</sub> = 25 °C  | 4100 |     | mJ   |  |
|                               |                  |                                                                                                                                                                                                     | T <sub>vj</sub> = 125 °C | 6700 |     | mJ   |  |

<sup>6)</sup> Characteristic values according to IEC 60747 - 2

<sup>7)</sup> Forward voltage is given at chip level

## Package properties

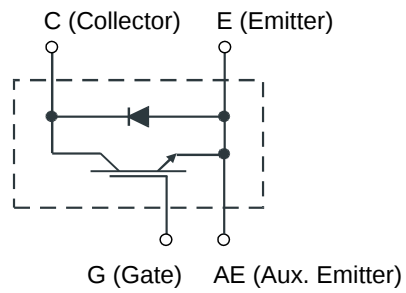
| Parameter                                               | Symbol             | Conditions                                                                                                                                   | min | typ    | max    | Unit |
|---------------------------------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|--------|------|
| IGBT thermal resistance junction to case                | $R_{th(j-c)IGBT}$  |                                                                                                                                              |     |        | 0.0032 | K/W  |
| Diode thermal resistance junction to case               | $R_{th(j-c)DIODE}$ |                                                                                                                                              |     |        | 0.0061 | K/W  |
| IGBT thermal resistance <sup>2)</sup> case to heatsink  | $R_{th(c-h)IGBT}$  | Heatsink flatness :<br>Complete module area < 100 $\mu\text{m}$<br>Each submodule area < 20 $\mu\text{m}$<br>Roughness : < 1.6 $\mu\text{m}$ |     | 0.0007 |        | K/W  |
| Diode thermal resistance <sup>2)</sup> case to heatsink | $R_{th(c-h)DIODE}$ |                                                                                                                                              |     | 0.0015 |        | K/W  |
| Comparative tracking index                              | CTI                |                                                                                                                                              | 600 |        |        |      |

<sup>2)</sup> for detailed mounting instructions refer to ABB Document No. 5SYA 2037-02

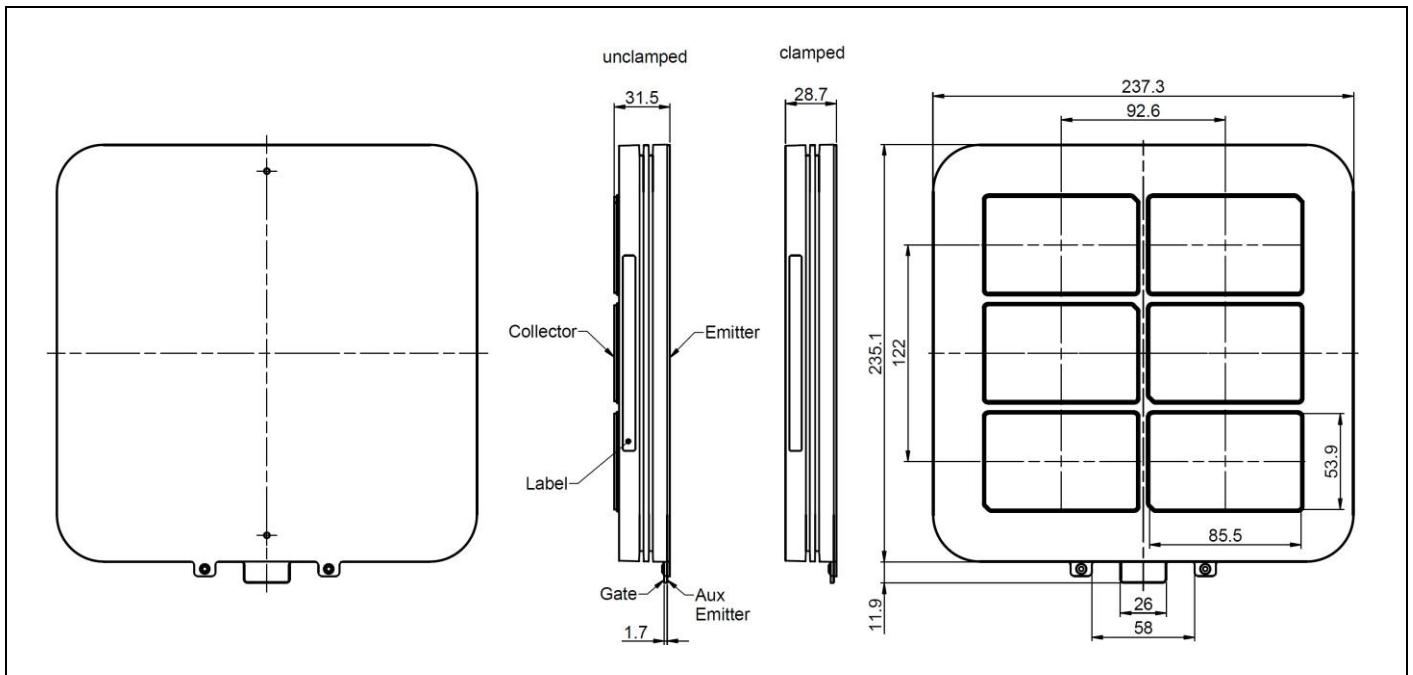
## Mechanical properties

| Parameter                 | Symbol         | Conditions                              |                  | min                    | typ  | max | Unit |
|---------------------------|----------------|-----------------------------------------|------------------|------------------------|------|-----|------|
| Dimensions                | L x W x H      | Typical                                 | device clamped   | 246.95 x 237.3 x 28.75 |      |     | mm   |
|                           |                |                                         | device unclamped | 246.95 x 237.3 x 31.5  |      |     |      |
| Clearance distance in air | d <sub>a</sub> | according to IEC 60664-1 and EN 50124-1 |                  | 23                     |      |     | mm   |
| Surface creepage distance | d <sub>s</sub> | according to IEC 60664-1 and EN 50124-1 |                  | 40                     |      |     | mm   |
| Mass                      | m              |                                         |                  |                        | 4300 |     | g    |

## Electrical configuration



## Outline drawing <sup>2)</sup>



Note: all dimensions are shown in millimeters

<sup>2)</sup> 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. VIII.  
This product has been designed and qualified for Industrial Level.

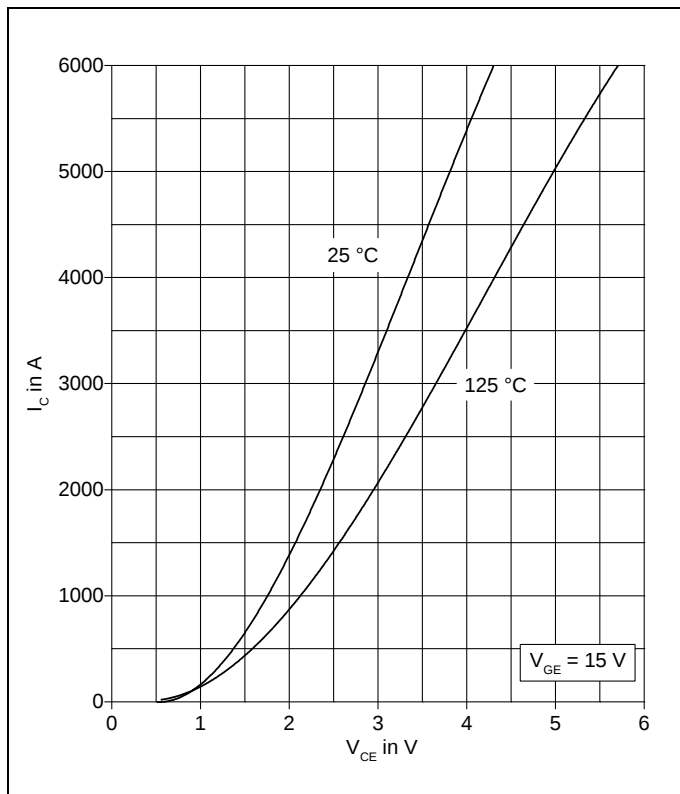


Fig. 1 Typical on-state characteristics, chip level

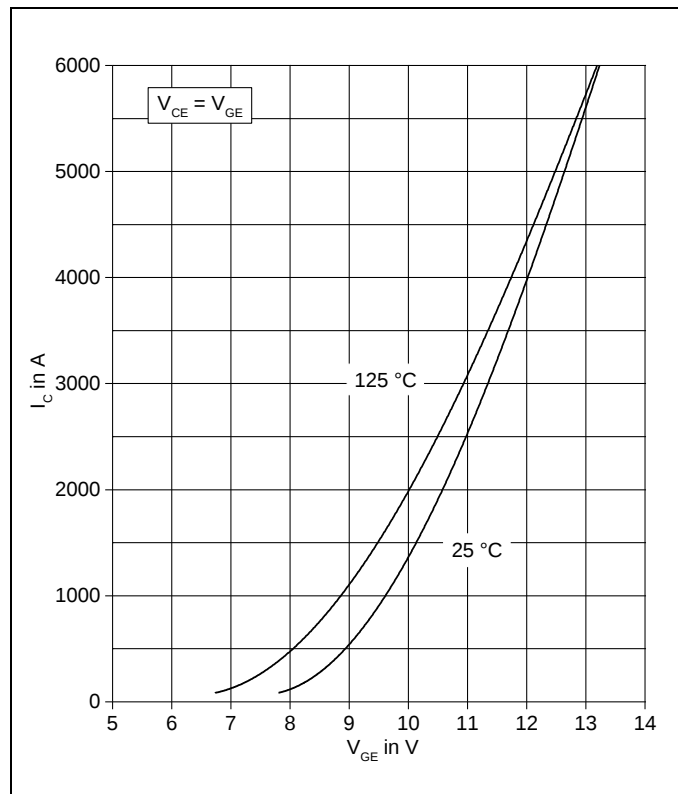


Fig. 2 Typical transfer characteristics, chip level

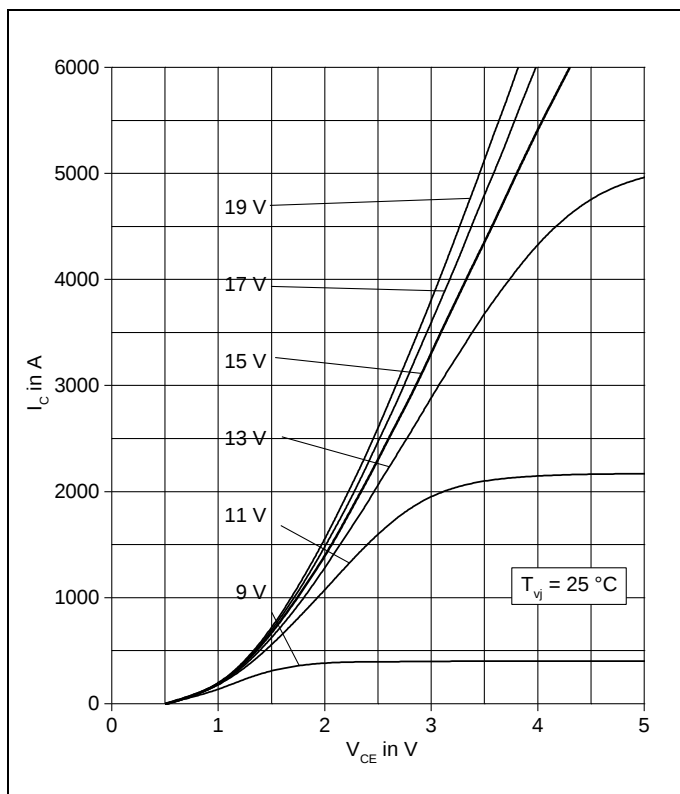


Fig. 3 Typical output characteristics, chip level

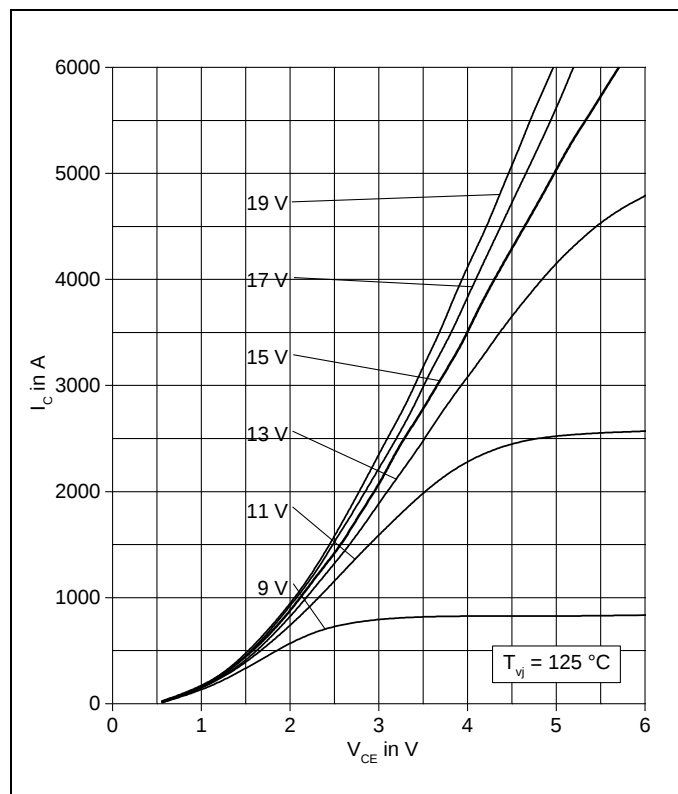


Fig. 4 Typical output characteristics, chip level

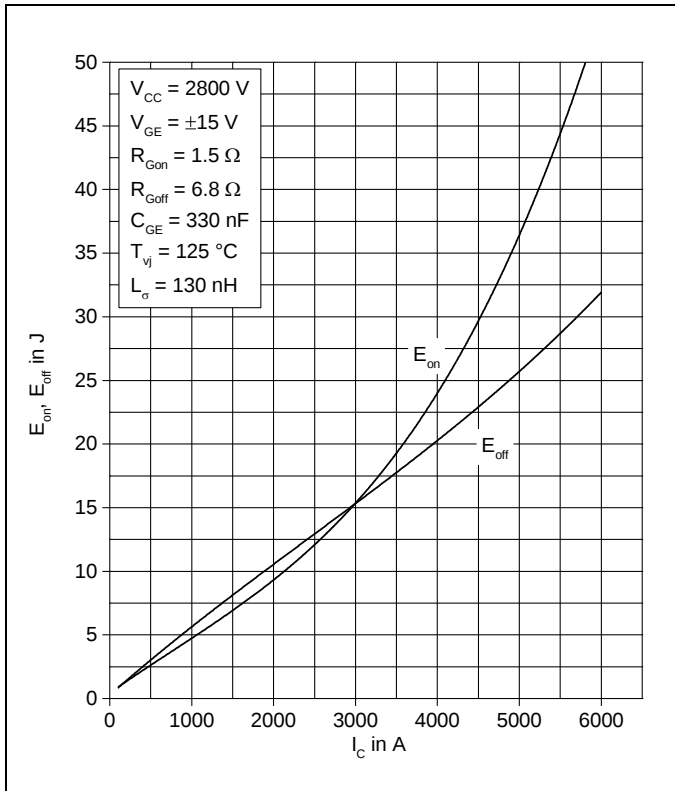


Fig. 5 Typical switching energies per pulse vs. collector current

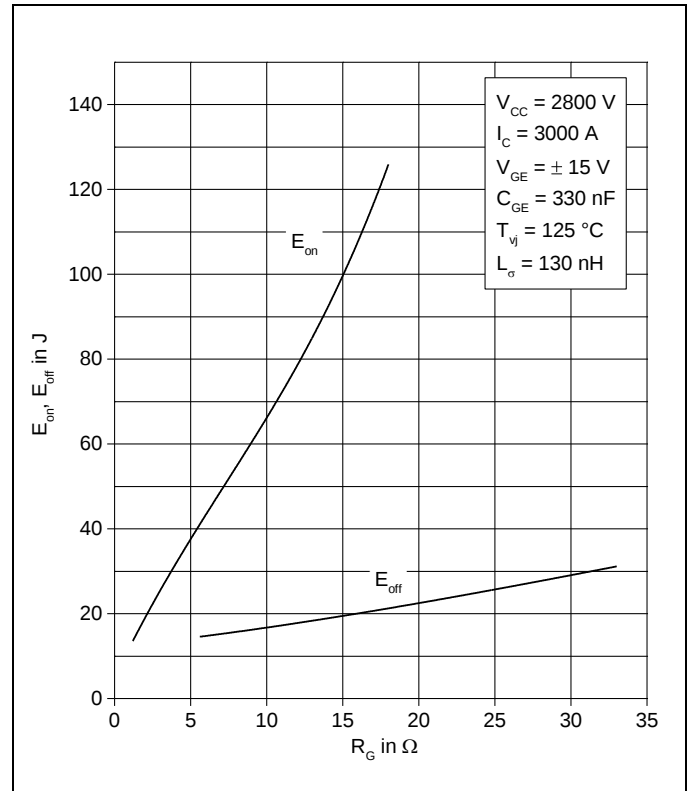


Fig. 6 Typical switching energies per pulse vs. gate resistor

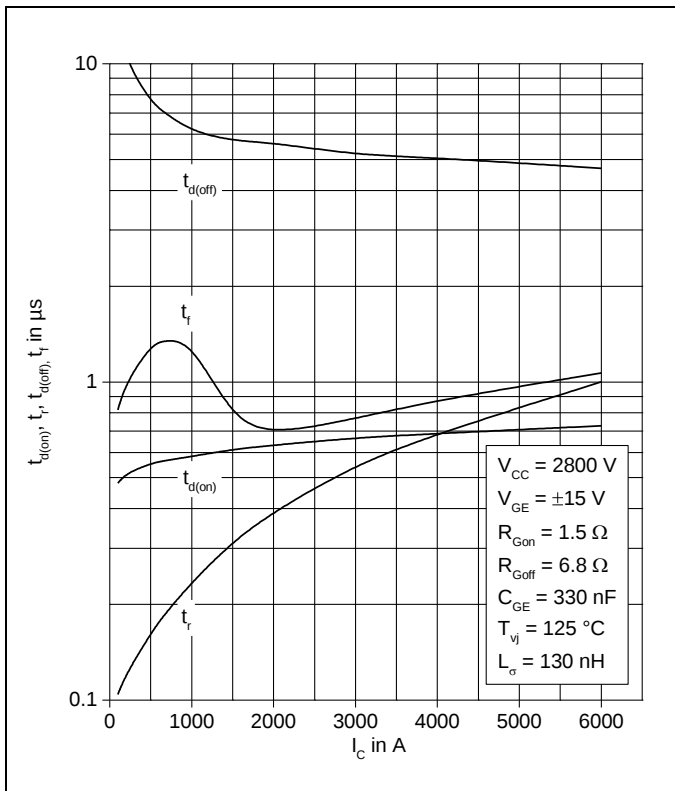


Fig. 7 Typical switching times vs. collector current

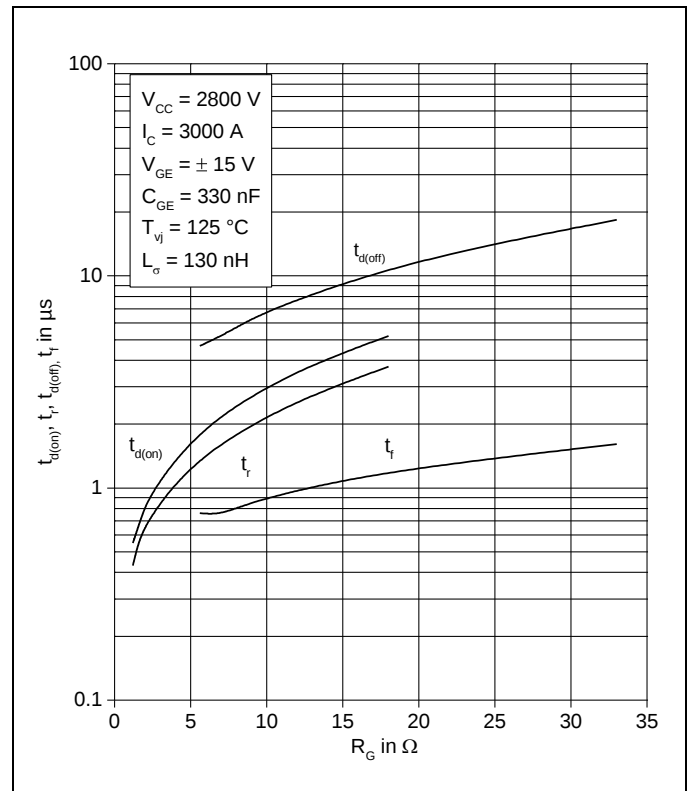


Fig. 8 Typical switching times vs. gate resistor

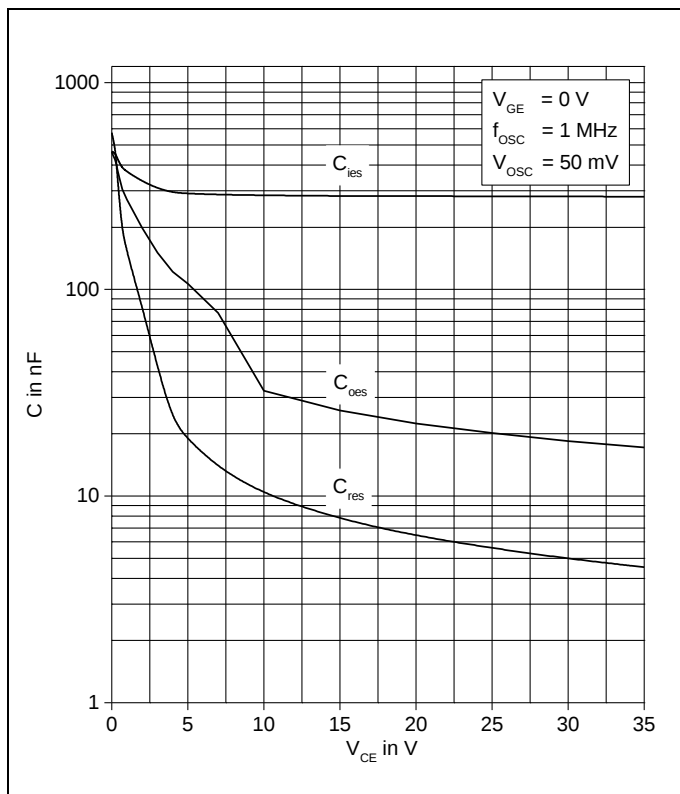


Fig. 9 Typical capacitances vs. collector-emitter voltage

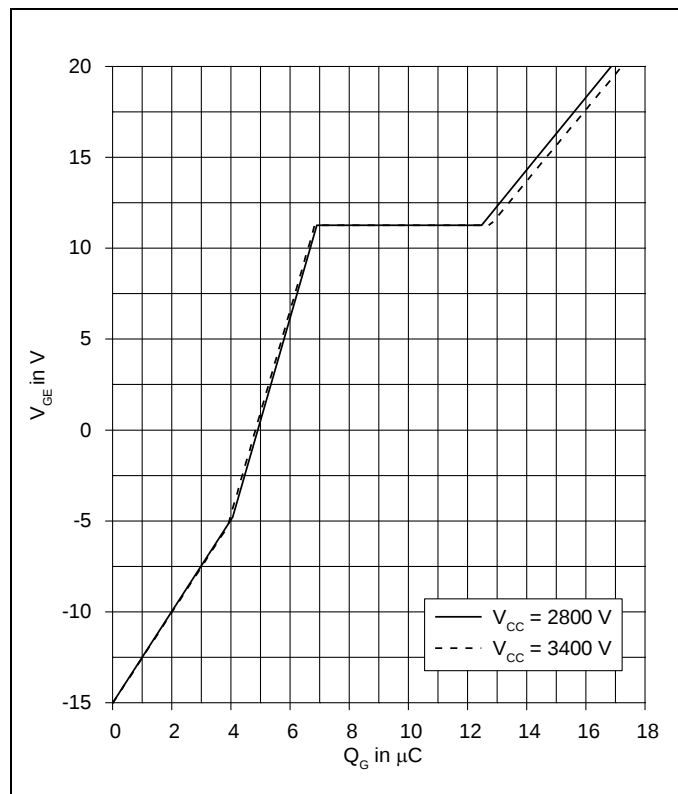


Fig. 10 Typical gate charge characteristics

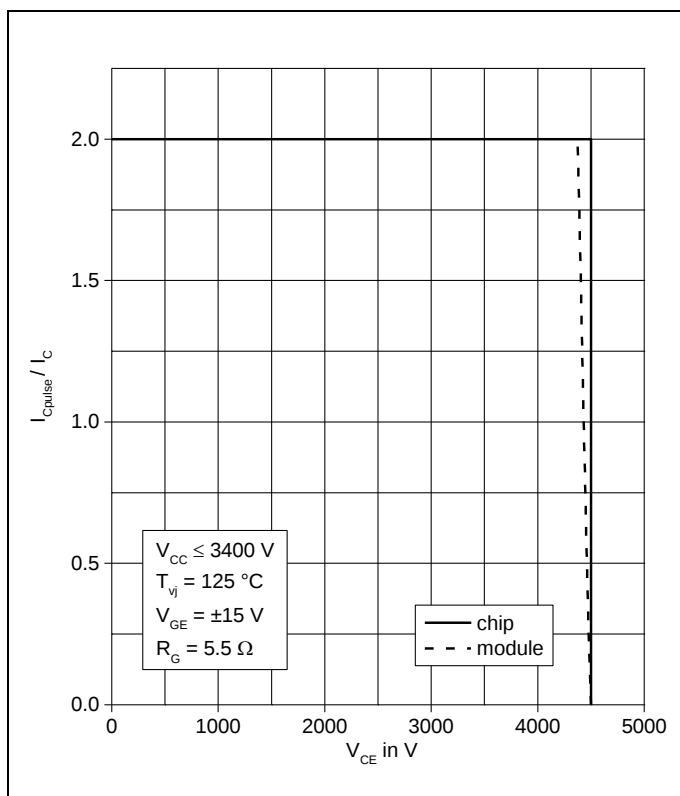


Fig. 11 Turn-off safe operating area (RBSOA)

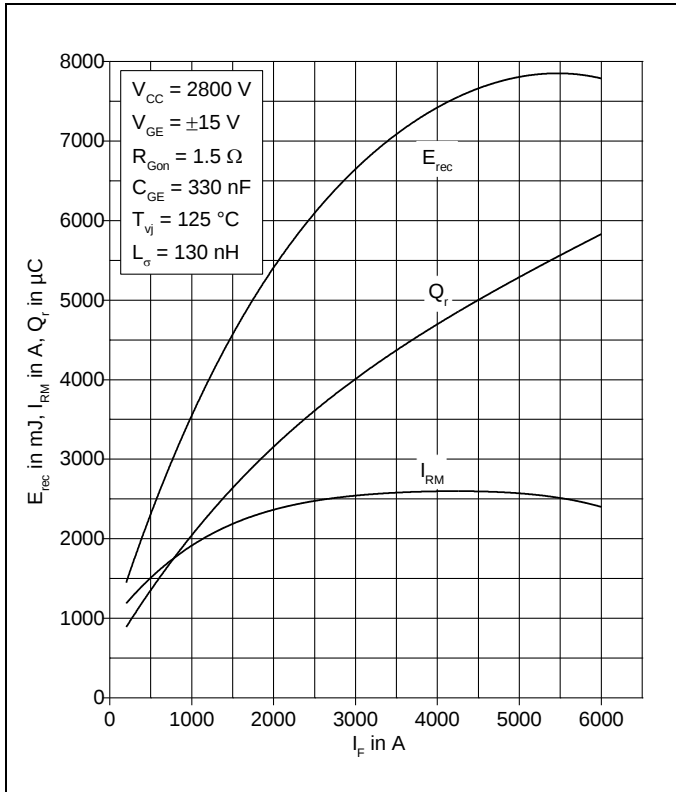


Fig. 12 Typical reverse recovery characteristics vs. forward current

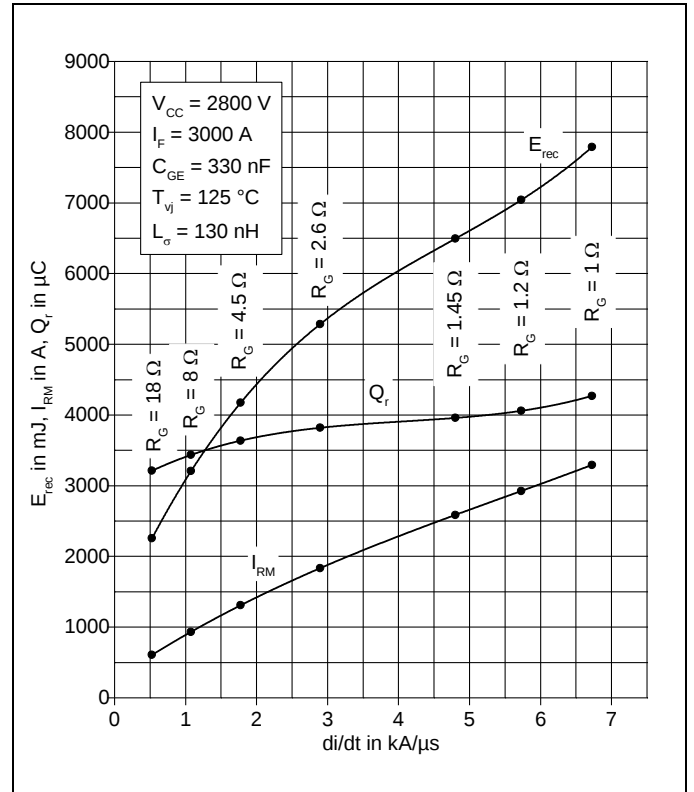


Fig. 13 Typical reverse recovery characteristics vs.  $di/dt$

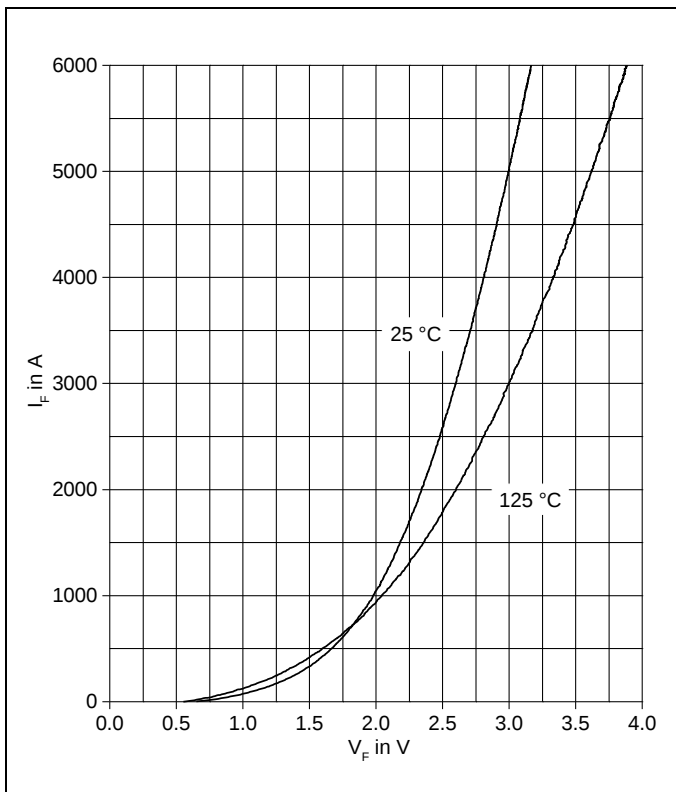


Fig. 14 Typical diode forward characteristics chip level

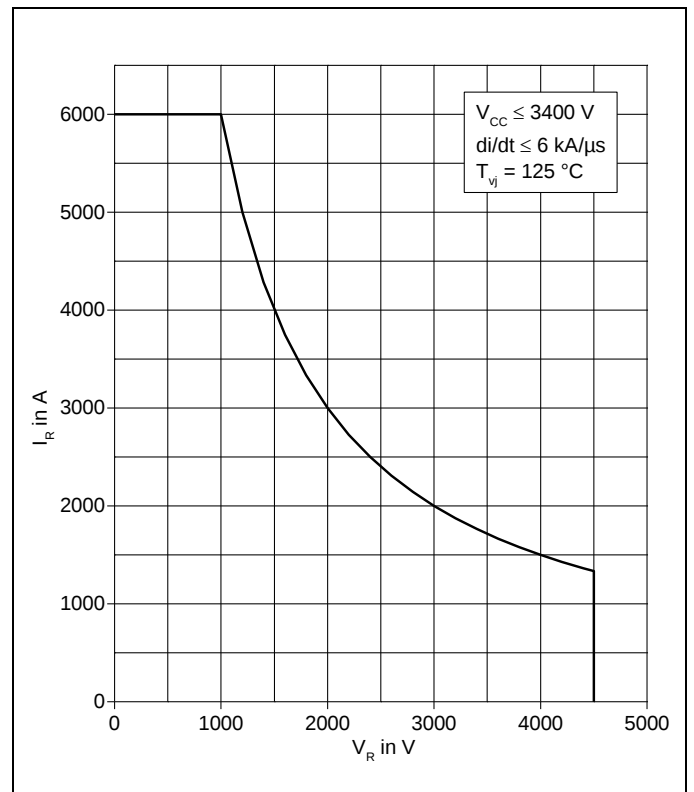


Fig. 15 Safe operating area diode (SOA)

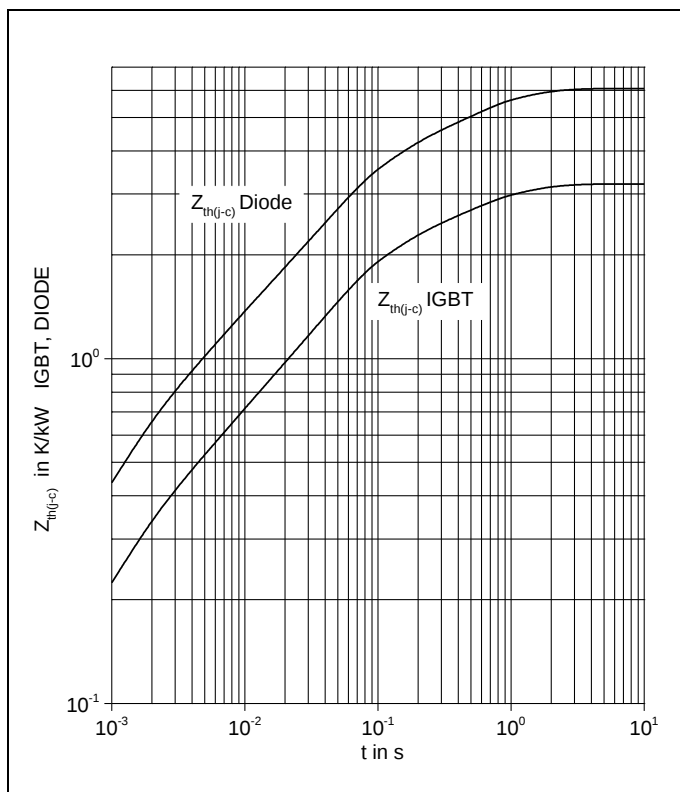


Fig. 16 Thermal impedance vs. time

Analytical function for transient thermal impedance:

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

|       |               |       |       |       |       |   |
|-------|---------------|-------|-------|-------|-------|---|
|       | i             | 1     | 2     | 3     | 4     | 5 |
| IGBT  | $R_i$ in K/kW | 1.200 | 1.490 | 0.269 | 0.246 |   |
|       | $\tau_i$ in s | 0.581 | 0.059 | 0.006 | 0.001 |   |
| DIODE | $R_i$ in K/kW | 2.409 | 2.639 | 0.535 | 0.485 |   |
|       | $\tau_i$ in s | 0.584 | 0.059 | 0.006 | 0.001 |   |

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